RECOMBINANT RHABDOVIRUS ENCODING INTERLEUKIN-12 (IL-12)

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 63/570,881, filed March 28, 2024, and U.S. Provisional Application No. 63/660,073, filed June 14, 2024, the disclosure of each of which is incorporated by reference herein in its entirety.

SEQUENCE LISTING

[0002] The instant application contains a Sequence Listing which has been submitted electronically in XML format and is hereby incorporated by reference in its entirety. Said XML copy, created on March 27, 2025, is named 250298_000811_SL.xml and is 726,236 bytes in size.

FIELD

[0003] The application provides compositions and methods related to a recombinant virus comprising a rhabdovirus genome, e.g., a vesicular stomatitis virus (VSV) genome, and a nucleotide sequence encoding a recombinant protein comprising, e.g., an interleukin-12 (IL-12) polypeptide, or a functional fragment or derivative thereof. In various aspects, the IL-12 polypeptide, or the functional fragment or derivative thereof, may be membrane bound. In various other aspects, the IL-12 polypeptide, or the functional fragment or derivative thereof, may not be membrane bound, e.g., the IL-12 polypeptide, or the functional fragment or derivative thereof, may be a soluble IL-12 polypeptide, or a functional fragment or derivative thereof.

BACKGROUND

[0004] Oncolytic virus therapy is an anti-cancer approach that uses viruses to selectively infect and kill cancer cells without harming healthy cells. Vesicular stomatitis virus (VSV), a member of the *Rhabdoviridae* family, can be a potential oncolytic virus. Oncolytic viruses encoding cytokines have demonstrated strong anti-tumor effects in preclinical models of cancers. Still, systemic accumulation of cytokines after delivery by oncolytic viruses remains potentially lethal to patients. There is a need for approaches to improve properties of cytokines for use in cancer immunotherapy, for example, oncolytic virus therapy.

SUMMARY

[0005] Disclosed herein is a recombinant virus comprising a rhabdovirus genome, for example, a vesicular stomatitis virus (VSV) genome, and a recombinant protein comprising, e.g., a nucleotide sequence encoding an IL-12 polypeptide, or a functional fragment or derivative thereof. In various aspects, the recombinant protein can comprise a transmembrane domain and can, e.g., be membrane bound. In various other aspects, the recombinant protein may not comprise a transmembrane domain and may not be membrane bound (i.e., the recombinant protein may be a soluble and/or secreted protein). Further disclosed are recombinant polynucleotides and recombinant vectors encoding virus polypeptides, as well as host cells that can express the polypeptides and methods for preparing the host cells. Additional disclosure relates to pharmaceutical compositions comprising the recombinant virus, and to methods for treating cancer, e.g., a tumor, and for inducing cancer regression, in a subject in need thereof, using the disclosed recombinant virus.

[0006] In one aspect, provided herein is a recombinant rhabdovirus comprising a nucleotide sequence encoding a recombinant protein, wherein the recombinant protein comprises an IL-12 polypeptide, or a functional fragment or derivative thereof.

[0007] In some embodiments, the recombinant rhabdovirus comprises a rhabdovirus genome, said rhabdovirus genome comprising a gene encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a gene encoding a large protein (L) polypeptide, or a functional fragment or derivative thereof, and the nucleotide sequence encoding the recombinant protein is positioned between the gene encoding the fusogenic polypeptide, or a functional fragment or derivative thereof, and the gene encoding the L polypeptide, or a functional fragment or derivative thereof.

[0008] In some embodiments, the nucleotide sequence encoding the recombinant protein is a template for a positive sense transcript encoding said recombinant protein.

[0009] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

[0010] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[0011] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[0012] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[0013] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[0014] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[0015] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[0016] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[0017] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[0018] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[0019] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[0020] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[0021] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[0022] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[0023] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[0024] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a linker.

[0025] In some embodiments, the linker is from about 5 amino acids to about 30 amino acids in length.

[0026] In some embodiments, the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[0027] In some embodiments, the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[0028] In some embodiments, the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

[0029] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, and/or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

[0030] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[0031] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[0032] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

[0033] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

[0034] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

[0035] In some embodiments, the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

[0036] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[0037] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[0038] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

[0039] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

[0040] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

[0041] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

[0042] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[0043] In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

[0044] In some embodiments, the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

[0045] In some embodiments, the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

[0046] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

[0047] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

[0048] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

[0049] In some embodiments, the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

[0050] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

[0051] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

[0052] In another aspect, provided herein is a recombinant rhabdovirus comprising a nucleotide encoding a recombinant protein comprising an IL-12 polypeptide, wherein the IL-12 polypeptide comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof, and an IL-12 p35 subunit, or a functional fragment or derivative thereof, wherein the IL-12 p40 subunit, or a functional fragment or derivative thereof, and the IL-12 p35 subunit, or a functional fragment or derivative thereof, are connected by a linker, wherein the recombinant rhabdovirus comprises a rhabdovirus genome, said rhabdovirus genome comprising a gene encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a gene encoding a large protein (L) polypeptide, or a functional fragment or derivative thereof, and wherein the nucleotide sequence encoding the recombinant protein is positioned between the gene encoding the fusogenic polypeptide, or a functional fragment or derivative thereof, and the gene encoding the L polypeptide, or a functional fragment or derivative thereof.

[0053] In some embodiments, the nucleotide sequence encoding the recombinant protein is a template for a positive sense transcript encoding said recombinant protein.

[0054] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[0055] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[0056] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[0057] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[0058] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[0059] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[0060] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[0061] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[0062] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[0063] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[0064] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[0065] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[0066] In some embodiments, the linker is from about 5 amino acids to about 30 amino acids in length.

[0067] In some embodiments, the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[0068] In some embodiments, the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[0069] In some embodiments, the recombinant protein further comprises a signal peptide operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[0070] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[0071] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

[0072] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

[0073] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

[0074] In some embodiments, the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

[0075] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[0076] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[0077] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

[0078] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

[0079] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

[0080] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

[0081] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[0082] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

[0083] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

[0084] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

[0085] In some embodiments, the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

[0086] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

[0087] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

[0088] In some embodiments, the recombinant rhabdovirus is a vesiculovirus.

[0089] In some embodiments, the vesiculovirus is a vesicular stomatitis virus (VSV).

[0090] In some embodiments, the rhabdovirus genome further comprises a gene encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof.

[0091] In some embodiments, the rhabdovirus genome further comprises a gene encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof.

[0092] In some embodiments, the rhabdovirus genome further comprises a gene encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof.

[0093] In some embodiments, the L polypeptide is a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof.

[0094] In some embodiments, the rhabdovirus genome comprises a gene encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof, a gene encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof, a gene encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, a gene encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a gene encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof.

[0095] In some embodiments, the recombinant rhabdovirus comprises an RNA molecule, wherein the RNA molecule comprises a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein.

[0096] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[0097] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[0098] In some embodiments, the VSV M polypeptide is a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

[0099] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

[00100] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3.

[00101] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 3.

[00102] In some embodiments, the VSV M polypeptide is a mutant VSV M polypeptide, or a functional fragment or derivative thereof.

[00103] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises an amino acid change at position M51 of the amino acid sequence of SEQ ID NO: 3.

[00104] In some embodiments, the amino acid change comprises a methionine (M) substitution.

[00105] In some embodiments, the methionine (M) substitution comprises a methionine (M) to an arginine (R) substitution (M51R).

[00106] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5, or an amino acid sequence that has at least 80% sequence identity thereto.

[00107] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5.

[00108] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 5.

[00109] In some embodiments, the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

[00110] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49, or an amino acid sequence that has at least 80% sequence identity thereto.

[00111] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

[00112] In some embodiments, the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 49.

[00113] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113, or an amino acid sequence that has at least 80% sequence identity thereto.

[00114] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113.

[00115] In some embodiments, the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 113.

[00116] In some embodiments, upon infection of a cell with the recombinant rhabdovirus, the cell expresses the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof.

[00117] In some embodiments, the cell is a human cell.

[00118] In some embodiments, the cell is a cancer cell.

[00119] In some embodiments, the recombinant rhabdovirus is a replication-competent virus.

[00120] In some embodiments, the recombinant rhabdovirus is a non-replicative.

[00121] In some embodiments, the recombinant rhabdovirus is an oncolytic virus.

[00122] In a further aspect, provided herein is a recombinant polynucleotide comprising:

i. a nucleotide sequence encoding a vesicular stomatitis virus (VSV) nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

ii. a nucleotide sequence encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

iii. a nucleotide sequence encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

iv. a nucleotide sequence encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

v. a nucleotide sequence encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and

vi. a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof.

[00123] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the fusogenic polypeptide, or a functional

fragment or derivative thereof, and the nucleotide sequence encoding the L polypeptide, or a functional fragment or derivative thereof.

[00124] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

[00125] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00126] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00127] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[00128] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[00129] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[00130] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[00131] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[00132] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[00133] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[00134] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[00135] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[00136] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[00137] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[00138] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[00139] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a linker.

[00140] In some embodiments, the linker is from about 5 amino acids to about 30 amino acids in length.

[00141] In some embodiments, the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00142] In some embodiments, the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00143] In some embodiments, the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

[00144] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, and/or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

[00145] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[00146] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[00147] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

[00148] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

[00149] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

[00150] In some embodiments, the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

[00151] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[00152] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[00153] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

[00154] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

[00155] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

[00156] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

[00157] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[00158] In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

[00159] In some embodiments, the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

[00160] In some embodiments, the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

[00161] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

[00162] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

[00163] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

[00164] In some embodiments, the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

[00165] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

[00166] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

[00167] In some embodiments, the recombinant polynucleotide comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, the recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[00168] In some embodiments, the VSV M polypeptide is a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

[00169] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

[00170] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3.

[00171] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 3.

[00172] In some embodiments, the VSV M polypeptide is a mutant VSV M polypeptide, or a functional fragment or derivative thereof.

[00173] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises an amino acid change at position M51 of the amino acid sequence of SEQ ID NO: 3.

[00174] In some embodiments, the amino acid change comprises a methionine (M) substitution.

[00175] In some embodiments, the methionine (M) substitution comprises a methionine (M) to an arginine (R) substitution (M51R).

[00176] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5, or an amino acid sequence that has at least 80% sequence identity thereto.

[00177] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5.

[00178] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 5.

[00179] In some embodiments, the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

[00180] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49, or an amino acid sequence that has at least 80% sequence identity thereto.

[00181] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

[00182] In some embodiments, the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 49.

[00183] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113, or an amino acid sequence that has at least 80% sequence identity thereto.

[00184] In some embodiments, the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113.

[00185] In some embodiments, the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 113.

[00186] In some embodiments, the polynucleotide is DNA.

[00187] In some embodiments, the recombinant polynucleotide comprises the nucleotide sequence of SEQ ID NO: 50, or a nucleotide sequence which has at least 65% sequence identity thereto.

[00188] In some embodiments, the recombinant polynucleotide comprises the amino acid sequence of SEQ ID NO: 50.

[00189] In some embodiments, the recombinant polynucleotide consists of the amino acid sequence of SEQ ID NO: 50.

[00190] In some embodiments, the recombinant polynucleotide comprises the nucleotide sequence of SEQ ID NO: 112, or a nucleotide sequence which has at least 65% sequence identity thereto.

[00191] In some embodiments, the recombinant polynucleotide comprises the amino acid sequence of SEQ ID NO: 112.

[00192] In some embodiments, the recombinant polynucleotide consists of the amino acid sequence of SEQ ID NO: 112.

[00193] In some embodiments, the polynucleotide is RNA.

[00194] In another aspect, provided herein is a recombinant polynucleotide, comprising a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, a recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof, wherein:

i. the VSV M polypeptide, or the functional fragment or derivative thereof, is a mutant VSV M polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising the amino acid sequence of SEQ ID NO: 5;

ii. the fusogenic polypeptide, or the functional fragment thereof, is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof; and

iii. the recombinant protein comprises an IL-12 polypeptide, or a functional fragment

or derivative thereof, said IL-12 polypeptide comprising the amino acid sequence of SEQ ID NO: 159 or SEQ ID NO: 154.

[00195] In some embodiments, the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 159, and the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

[00196] In some embodiments, the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 154, and the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113.

[00197] In a further aspect, provided herein is a recombinant polynucleotide, wherein the recombinant polynucleotide is an RNA molecule comprising:

i. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;
ii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;
iii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;
iv. a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;
v. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and
vi. a nucleotide sequence that is a template for a positive sense transcript encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof.

[00198] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or a functional fragment or derivative thereof.

[00199] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

[00200] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00201] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00202] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[00203] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[00204] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[00205] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[00206] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[00207] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[00208] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[00209] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[00210] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[00211] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[00212] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[00213] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[00214] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a linker.

[00215] In some embodiments, the linker is from about 5 amino acids to about 30 amino acids in length.

[00216] In some embodiments, the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00217] In some embodiments, the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00218] In some embodiments, the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

[00219] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, and/or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

[00220] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[00221] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[00222] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

[00223] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

[00224] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

[00225] In some embodiments, the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

[00226] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[00227] In some embodiments, the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[00228] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

[00229] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

[00230] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

[00231] In some embodiments, the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

[00232] In some embodiments, the one or more amino acid changes comprises one or more alanine (A) substitutions.

[00233] In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

[00234] In some embodiments, the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

[00235] In some embodiments, the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

[00236] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

[00237] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

[00238] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

[00239] In some embodiments, the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

[00240] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

[00241] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

[00242] In some embodiments, the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00243] In some embodiments, the VSV M polypeptide is a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

[00244] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

[00245] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3.

[00246] In some embodiments, the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 3.

[00247] In some embodiments, the VSV M polypeptide is a mutant VSV M polypeptide, or a functional fragment or derivative thereof.

[00248] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises an amino acid change at position M51 of the amino acid sequence of SEQ ID NO: 3.

[00249] In some embodiments, the amino acid change comprises a methionine (M) substitution.

[00250] In some embodiments, the methionine (M) substitution comprises a methionine (M) to an arginine (R) substitution (M51R).

[00251] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5, or an amino acid sequence that has at least 80% sequence identity thereto.

[00252] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5.

[00253] In some embodiments, the mutant VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 5.

[00254] In some embodiments, the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

[00255] In some embodiments, the recombinant protein comprises the amino acid sequence of SEQ ID NO: 49, or an amino acid sequence that has at least 80% sequence identity thereto.

[00256] In some embodiments, the recombinant protein comprises the amino acid sequence of SEQ ID NO: 49.

[00257] In some embodiments, the recombinant protein consists of the amino acid sequence of SEQ ID NO: 49.

[00258] In some embodiments, the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113, or an amino acid sequence that has at least 80% sequence identity thereto.

[00259] In some embodiments, the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113.

[00260] In some embodiments, the recombinant protein consists of the amino acid sequence of SEQ ID NO: 113.

[00261] In another aspect, provided herein is a recombinant polynucleotide, wherein the recombinant polynucleotide is an RNA molecule comprising, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, wherein:

i. the VSV M polypeptide, or the functional fragment or derivative thereof, is a mutant VSV M polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising the amino acid sequence of SEQ ID NO: 5;
ii. the fusogenic polypeptide, or the functional fragment thereof, is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof; and
iii. the recombinant protein comprises an IL-12 polypeptide, or a functional fragment or derivative thereof, said IL-12 polypeptide comprising the amino acid sequence of SEQ ID NO: 159 or SEQ ID NO: 154.

[00262] In some embodiments, the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 159, and the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

[00263] In some embodiments, the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 154, and the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113.

[00264] In a further aspect, provided herein is a vector comprising any of the recombinant polynucleotides as described herein.

[00265] In another aspect, provided herein is a recombinant vesicular stomatitis virus (VSV) comprising any of the recombinant polynucleotides as described herein.

[00266] In a further aspect, provided herein is a composition comprising any of the recombinant rhabdoviruses as described herein, and a carrier and/or excipient.

[00267] In another aspect, provided herein is a composition comprising any of the recombinant polynucleotides as described herein, and a pharmaceutically acceptable carrier and/or a pharmaceutically acceptable excipient.

[00268] In a further aspect, provided herein is a product of manufacture comprising any of the recombinant rhabdoviruses as described herein or any of the compositions as described herein in a sterile vial, ampoule or syringe.

[00269] In another aspect, provided herein is a host cell comprising any of the recombinant rhabdoviruses as described herein.

[00270] In a further aspect, provided herein is a host cell comprising any of the recombinant polynucleotides as described herein.

[00271] In another aspect, provided herein is a method of treating a cancer in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of any of the recombinant rhabdoviruses as described herein or any of the compositions as described herein.

[00272] In some embodiments, the administration of the recombinant rhabdovirus or composition to the subject is under conditions wherein the recombinant rhabdovirus infects cancer cells of the subject to form infected cancer cells, wherein the infected cancer cells express the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and wherein the number of cancer cells within the subject is reduced following the administration.

[00273] In some embodiments, the administration of the recombinant rhabdovirus or composition to the subject is under conditions wherein the recombinant rhabdovirus infects cancer cells of the subject to form infected cancer cells, wherein the infected cancer cells express the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and wherein the number of cancer cells within the subject does not increase following the administration.

[00274] In a further aspect, provided herein is a method for inducing a cancer regression in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of any of the recombinant rhabdoviruses as described herein or any of the compositions as described herein.

[00275] In some embodiments, the cancer regression produces a reduced tumor size.

[00276] In some embodiments, the recombinant rhabdovirus or composition is administered via local delivery.

[00277] In some embodiments, the local delivery is intratumoral delivery.

[00278] In some embodiments, the recombinant rhabdovirus or composition is administered at a dose of from about $1x10^6$/mL $TCID_{50}$/mL to about $1x10^{11}$ $TCID_{50}$/mL.

[00279] In some embodiments, the recombinant rhabdovirus or composition is administered at a dose of from about $1x10^7$ $TCID_{50}$/mL to about $1x10^{10}$ $TCID_{50}$/mL.

[00280] In some embodiments, the recombinant rhabdovirus or composition is administered at a dose of about $1x10^7$ $TCID_{50}$/mL, about $3x10^7$ $TCID_{50}$/mL, about $1x10^8$ $TCID_{50}$/mL, about $3x10^8$ $TCID_{50}$/mL, about $1x10^9$ $TCID_{50}$/mL, about $3x10^9$ $TCID_{50}$/mL, or about $1x10^{10}$ $TCID_{50}$/mL.

[00281] In some embodiments, the recombinant rhabdovirus or composition is administered at a dose of about $1x10^{10}$ $TCID_{50}$/mL.

[00282] In some embodiments, the recombinant rhabdovirus comprises a nucleotide sequence encoding a mutant VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising a methionine (M) to an arginine (R) substitution at position M51 of the amino acid sequence of SEQ ID NO: 3, and the administration of the recombinant rhabdovirus to the subject produces a reduced serum interferon gamma (IFN-γ) release in the subject as compared to a control recombinant rhabdovirus comprising a nucleotide sequence encoding a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

[00283] In some embodiments, the recombinant rhabdovirus comprises a nucleotide sequence encoding a mutant VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising a methionine (M) to an arginine (R) substitution at position M51 of the amino acid sequence of SEQ ID NO: 3, and the administration of the recombinant rhabdovirus to the subject produces a maintained or increased body weight in the subject as compared to a control recombinant rhabdovirus comprising a nucleotide sequence encoding a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

[00284] In some embodiments, the administration of the recombinant rhabdovirus to the subject produces an enhanced tumor-specific CD8 T cell response in the subject as compared to a control recombinant rhabdovirus which does not comprise a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof.

[00285] In some embodiments, the enhanced tumor-specific CD8 T cell response comprises an increased serum interferon gamma (IFN-γ) release.

[00286] In some embodiments, the cancer is selected from head and neck cancer, colon cancer, lung cancer, prostate cancer, ovarian cancer, hepatocellular carcinoma, pancreatic cancer, kidney cancer, melanoma, brain cancer, lymphoma, myeloma, lymphocytic leukemia, myelogenous leukemia, and breast cancer.

[00287] In some embodiments, the method further comprises administering to the subject a therapeutically effective amount of one or more immune checkpoint inhibitors.

[00288] In some embodiments, the immune checkpoint inhibitors comprise one of more of an anti-PD-1 antibody, an anti-PDL1 antibody, or an anti-CTLA-4 antibody.

[00289] In some embodiments, the immune checkpoint inhibitor comprises an anti-PD-1 antibody.

[00290] In some embodiments, the immune checkpoint inhibitor is administered via systemic delivery.

[00291] In some embodiments, the immune checkpoint inhibitor is administered via parenteral delivery.

[00292] In some embodiments, the parenteral delivery is subcutaneous, intraperitoneal, intradermal, intramuscular, or intravenous delivery.

[00293] In some embodiments, the parenteral delivery is intravenous delivery.

[00294] In some embodiments, the immune checkpoint inhibitor is administered at a dose from about 200 mg to about 400 mg.

[00295] In some embodiments, the immune checkpoint inhibitor is administered at a dose of about 350 mg.

[00296] In some embodiments, the subject is human.

BRIEF DESCRIPTION OF THE DRAWINGS

[00297] **Figure 1** is a schematic representation of a Vesicular Stomatitis Virus (VSV) encoding different versions of IL-12. Figure discloses "VPGVGx2" as SEQ ID NO: 17 and "G4Sx3" as SEQ ID NO: 18.

[00298] **Figure 2** shows an *in vivo* experimental timeline for an experiment disclosed herein.

[00299] **Figure 3** shows average body weight changes (% ± SEM [standard error of the mean]) in each treatment group at multiple post-virus infection time points, with treatment at day 0.

[00300] **Figures 4A-4E** show individual body weight changes after treatment at day 0. **Figure 4A** shows individual body weight changes in 5 mice after treatment with PBS. **Figure 4B** shows individual body weight changes in 5 mice after treatment with VSV-Mwt-mIL12p70. **Figure 4C** shows individual body weight changes in 5 mice after treatment with VSV-M51R-mIL12p70. **Figure 4D** shows individual body weight changes in 5 mice after treatment with VSV-M51R-mIL12p35_TM. **Figure 4E** shows individual body weight changes in 5 mice after treatment with VSV-M51R-mIL12p70_TM.

[00301] **Figure 5** shows serum levels of interleukin-12p70 (IL12p70) and interferon gamma (IFNγ) 24 hours post infection (hpi) detected by enzyme-linked immunoassay (ELISA).

[00302] **Figure 6** shows an *in vivo* experimental timeline for an experiment disclosed herein.

[00303] **Figure 7** shows average tumor volumes (mm^3 ± SEM) in each treatment group at multiple post-tumor implantation time points, with treatment days indicated by arrows.

[00304] **Figure 8** shows individual tumor volumes at day 14 after treatment initiation.

[00305] **Figure 9** shows Kaplan-Meier survival curves.

[00306] **Figure 10** shows serum levels of IL12p70 and IFNγ 24 hours post infection detected by ELISA.

[00307] **Figure 11** shows an *in vivo* experimental timeline for an experiment disclosed herein.

[00308] **Figure 12** shows average tumor volumes (mm^3 ± SEM) in each treatment group at multiple post-tumor implantation time points, with treatment days indicated by arrows.

[00309] **Figure 13** shows individual tumor volumes at day 11 (D11) after treatment initiation.

[00310] **Figure 14** shows Kaplan-Meier survival curves.

[00311] **Figure 15** shows individual body weight changes after treatment at day 0.

[00312] **Figure 16** shows serum levels of IL12p70 and IFNγ 24 hpi detected by ELISA.

[00313] **Figures 17A-17K** show examples of VSV-IL-12 constructs described herein. **Figure 17A** shows VSV-M51R-hIL12p70 (secreted IL12 p70). **Figure 17B** shows VSV-M51R-hIL12p40-hIL12p35 (secreted unlinked IL12 p40 and p35). **Figure 17C** shows VSV-M51R-L-hIL12p70 (secreted IL12 p70 downstream of L). **Figure 17D** shows VSV-M51R-hIL12p70.P2A.L (secreted IL12 p70 linked to L with P2A). **Figure 17E** shows VSV-M51R-hIL12p70TM (IL12 p70 with transmembrane region). **Figure 17F** shows VSV-M51R-hIL12p70_hCD4 (IL12p70 linked with CD4). **Figure 17G** shows VSV-M51R-hIL12p70_hCD46 (IL12p70 linked with CD46). **Figure 17H** shows VSV-M51R-hIL12p70_G_4Sx3_CBD (IL12p70 linked with VWF CBD X1). **Figure 17I** shows VSV-M51R-hIL12p70_(G_4Sx3_CBD)x2 (IL12p70 linked with VWF CBD X2). **Figure 17J** shows VSV-M51R-hIL12p70_hIgG1 (IL12p70 linked with IgG1 [switch]). **Figure 17K** shows VSV-M51R-hIL12p70_hIgG4 (IL12p70 linked with IgG4 [switch]). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "G4Sx3" as SEQ ID NO: 18.

[00314] **Figures 18A-18K** show a secreted VSV-M51R-hIL12p70 (secreted human IL12 p70) construct nucleic acid sequence, SEQ ID NO: 112 (**Figures 18A-18H**) and amino acid sequence, SEQ ID NO: 113 (**Figures 18I-18K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17.

[00315] **Figures 19A-19K** show a secreted VSV-M51R-hIL12p40-hIL12p35 (secreted unlinked IL12 p40 and p35, human) construct nucleic acid sequence, SEQ ID NO: 114 (**Figures 19A-19H**) and amino acid sequence, SEQ ID NO: 115 (**Figures 19I-19K**).

[00316] **Figures 20A-20K** show a secreted VSV-M51R-L-hIL12p70 (secreted human IL12 p70 downstream of L) construct nucleic acid sequence, SEQ ID NO: 116 (**Figures 20A-20H**) and corresponding amino acid sequence, SEQ ID NO: 117 (**Figures 20I-20K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17.

[00317] **Figures 21A-21K** show a secreted VSV-M51R-hIL12p70.P2A.L (secreted human IL12 p70 linked to L with P2A) construct nucleic acid sequence, SEQ ID NO: 118 (**Figures 21A-21H**) and corresponding amino acid sequence, SEQ ID NO: 119 (**Figures 21I-21K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17.

[00318] **Figures 22A-22J** show a human transmembrane VSV-M51R-hIL12p70TM (IL12 p70 with transmembrane region) construct nucleic acid sequence, SEQ ID NO: 120 (**Figures 22A-22H**) and corresponding amino acid sequence, SEQ ID NO: 121 (**Figures 22I-22J**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00319] Figures 23A-23L show a human transmembrane VSV-M51R-hIL12p70_hCD4 (IL12p70 linked with CD4) construct nucleic acid sequence, SEQ ID NO: 122 (**Figures 23A-23I**) and corresponding amino acid sequence, SEQ ID NO: 123 (**Figures 23J-23L**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00320] Figures 24A-24K show a human transmembrane VSV-M51R-hIL12p70_hCD46 (IL12p70 linked with CD46) construct nucleic acid sequence, SEQ ID NO: 124 (**Figures 24A-24H**) and corresponding amino acid sequence, SEQ ID NO: 125 (**Figures 24I-24K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00321] Figures 25A-25K show a human transmembrane VSV-M51R-hIL12p70_hIgG1 (IL12p70 linked with hIgG1 [switch]) construct nucleic acid sequence, SEQ ID NO: 132 (**Figures 25A-25H**) and corresponding amino acid sequence, SEQ ID NO: 133 (**Figures 25I-25K**). The human version of the construct comprises IgG1 and the mouse version of the construct comprises IgG2a. Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00322] Figures 26A-26K show a human transmembrane VSV-M51R-hIL12p70_hIgG4 (IL12p70 linked with hIgG4 [switch]) construct nucleic acid sequence, SEQ ID NO: 130 (**Figures 26A-26H**) and corresponding amino acid sequence, SEQ ID NO: 131 (**Figures 26I-26K**). The human version of the construct comprises IgG4 and the mouse version of the construct comprises IgG1. Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00323] Figures 27A-27K show a secreted VSV-M51R-hIL12p70_CBD1 (human IL12p70 linked with CBD1) construct nucleic acid sequence, SEQ ID NO: 126 (**Figures 27A-27H**) and corresponding amino acid sequence, SEQ ID NO: 127 (**Figures 27I-27K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00324] Figures 28A-28L show a secreted VSV-M51R-hIL12p70_CBD2 (human IL12p70 linked with CBD2) construct nucleic acid sequence, SEQ ID NO: 128 (**Figures 28A-28I**) and corresponding amino acid sequence, SEQ ID NO: 129 (**Figures 28J-28L**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00325] Figures 29A-29J show a secreted VSV-M51R-mIL12p40-mIL12p35 (secreted unlinked IL12 p40 and p35, mouse) construct nucleic acid sequence, SEQ ID NO: 110 (**Figures 29A-29H**) and corresponding amino acid sequence, SEQ ID NO: 111 (**Figures 29I-29J**).

[00326] Figures 30A-30J show a mouse transmembrane VSV-M51R-mIL12p70TM construct nucleic acid sequence, SEQ ID NO: 56 (**Figures 30A-30H**) and corresponding amino acid

sequence, SEQ ID NO: 55 (**Figures 30I-30J**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00327] **Figures 31A-31I** show a mouse transmembrane VSV-M51R-mIL12p35TM construct nucleic acid sequence, SEQ ID NO: 58 (**Figures 31A-31G**) and corresponding amino acid sequence, SEQ ID NO: 57 (**Figures 31H-31I**). Figures disclose "GGGGSx3" as SEQ ID NO: 18.

[00328] **Figures 32A-32J** show a mouse secreted VSV-M51R-mIL12p70woSP construct nucleic acid sequence, SEQ ID NO: 60 (**Figures 32A-32H**) and corresponding amino acid sequence, SEQ ID NO: 59 (**Figures 32I-32J**). Figures disclose "VPGVGx2" as SEQ ID NO: 17.

[00329] **Figures 33A-33J** show a mouse secreted (mutein) VSV-M51R-mIL12p70_2xAla construct nucleic acid sequence, SEQ ID NO: 52 (**Figures 33A-33H**) and corresponding amino acid sequence, SEQ ID NO: 51 (**Figures 33I-33J**). Figures disclose "VPGVGx2" as SEQ ID NO: 17.

[00330] **Figures 34A-34J** show a mouse secreted (mutein) VSV-M51R-mIL12p70_3xAla construct nucleic acid sequence, SEQ ID NO: 54 (**Figures 34A-34H**) and corresponding amino acid sequence, SEQ ID NO: 53 (**Figures 34I-34J**). Figures disclose "VPGVGx2" as SEQ ID NO: 17.

[00331] **Figures 35A-35J** show a mouse secreted VSV-M51R-mIL12p70 construct nucleic acid sequence, SEQ ID NO: 50 (**Figures 35A-35H**) and corresponding amino acid sequence, SEQ ID NO: 49 (**Figures 35I-35J**). Figures disclose "VPGVGx2" as SEQ ID NO: 17.

[00332] **Figures 36A-36K** show a mouse transmembrane VSV-M51R-mIL12p70-mCD4-d1-4TM construct nucleic acid sequence, SEQ ID NO: 134 (**Figures 36A-36H**) and corresponding amino acid sequence, SEQ ID NO: 135 (**Figures 36I-36K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00333] **Figures 37A-37J** show a mouse transmembrane VSV-M51R-mIL12p70-H4-2TM construct nucleic acid sequence, SEQ ID NO: 136 (**Figures 37A-37H**) and corresponding amino acid sequence, SEQ ID NO: 137 (**Figures 37I-37J**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "A(EAAAK)4ALEA(EAAAK)4A" as SEQ ID NO: 73.

[00334] **Figures 38A-38K** show a mouse transmembrane VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM construct nucleic acid sequence, SEQ ID NO: 138 (**Figures 38A-38H**) and corresponding amino acid sequence, SEQ ID NO: 139 (**Figures 38I-38K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00335] Figures 39A-39K show a mouse transmembrane VSV-M51R-mIL12p70-D265A_mIgG1TM construct nucleic acid sequence, SEQ ID NO: 140 (**Figures 39A-39H**) and corresponding amino acid sequence, SEQ ID NO: 141 (**Figures 39I-39K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17, "GGGGSx3" as SEQ ID NO: 18, and "GGGGSx4" as SEQ ID NO: 42.

[00336] Figures 40A-40K show a mouse transmembrane VSV-M51R-mIL12p70-mIgG2aTM construct nucleic acid sequence, SEQ ID NO: 142 (**Figures 40A-40H**) and corresponding amino acid sequence, SEQ ID NO: 143 (**Figures 40I-40K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx3" as SEQ ID NO: 18.

[00337] Figures 41A-41K show a mouse transmembrane VSV-mIL12p70TM-N-M51R-GFP construct nucleic acid sequence, SEQ ID NO: 144 (**Figures 41A-41H**) and corresponding amino acid sequence, SEQ ID NO: 145 (**Figures 41I-41K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx4" as SEQ ID NO: 42.

[00338] Figures 42A-42K show a mouse transmembrane VSV-N-mIL12p70TM-P-M51R-GFP construct nucleic acid sequence, SEQ ID NO: 146 (**Figures 42A-42H**) and corresponding amino acid sequence, SEQ ID NO: 147 (**Figures 42I-42K**). Figures disclose "VPGVGx2" as SEQ ID NO: 17 and "GGGGSx4" as SEQ ID NO: 42.

[00339] Figure 43 shows an example assay design that can be used for functional assessment of VSV-12p70TM (rigid linkers).

[00340] Figure 44 shows IL-12 surface expression determined by flow cytometry-based measurement.

[00341] Figure 45 shows a splenocyte IFNγ functional assay.

[00342] Figure 46 shows an example assay design for flow cytometry-based validation and ELISA for IL-12 (rigid linker payloads).

[00343] Figure 47 shows flow cytometry-based detection of membrane-bound IL-12p40.

[00344] Figure 48 shows median fluorescence intensity efluor450-IL-12p40 (18 hpi).

[00345] Figure 49 shows IL-12 levels in 5TGM1 supernatants (18 hpi).

[00346] Figure 50 shows average tumor volumes per group. Figure discloses "VPGVGx2" as SEQ ID NO: 17 and "AEAAKEAAAKEAAAKA" as SEQ ID NO: 74.

[00347] Figure 51 shows individual tumor growth curves per group.

[00348] **Figure 52** shows Kaplan-Meier survival curves. Figure discloses "G4Sx3" as SEQ ID NO: 18 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00349] **Figure 53** shows body weight change after treatment on Day 0. Figure discloses "G4Sx3" as SEQ ID NO: 18 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00350] **Figure 54** shows serum IL-12p70 and IFNγ levels 24 hpi. Figure discloses "G4Sx3" as SEQ ID NO: 18 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00351] **Figure 55** shows body weight change after treatment on Day 0. Figure discloses "G4Sx3" as SEQ ID NO: 18 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00352] **Figure 56** shows individual mice body weight per group. * represents mice either found dead or euthanized because of >20% body weight loss. Figure discloses "G4Sx3" as SEQ ID NO: 18 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00353] **Figure 57** shows Kaplan-Meier survival curves. Figure discloses "G4Sx3" as SEQ ID NO: 18 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00354] **Figure 58** shows serum IL-12p70 and IFNγ levels at 24 hpi. Figure discloses "G4Sx3" as SEQ ID NO: 18 and "A(EAAAK)3A" as SEQ ID NO: 74.

[00355] **Figure 59** shows the components of a VSV-mIFNb-NIS virus and a VSV-M51R-IL12p70 virus (soluble form).

[00356] **Figure 60** shows the anti-tumor efficacy of a single-dose VSV encoding IL-12 administered intratumorally (IT) to a mouse.

[00357] **Figure 61** shows the anti-tumor efficacy of a single-dose VSV encoding IL-12 administered IT to a mouse.

[00358] **Figure 62** shows the anti-tumor efficacy of a single-dose VSV encoding IL-12 administered IT to a mouse.

[00359] **Figure 63** shows the anti-tumor efficacy of a single-dose VSV encoding IL-12 administered IT to a mouse.

[00360] **Figure 64** shows body weight changes in mice treated IT with VSV-M51R-mIL12p70, VSV-mIFNb-NIS, and VSV-Mwt-mIL12p70.

[00361] **Figure 65** shows serum levels of IL-12 24 hpi.

[00362] **Figure 66** shows VSV-M51R-mIL12p70 dosed IT compared to intravenously (IV) in the CMT64 therapeutic model.

[00363] **Figure 67** shows VSV-M51R-mIL12p70 dosed IT compared to IV in the CMT64 therapeutic model.

[00364] **Figure 68** shows VSV-M51R-mIL12p70dosed IT compared to IV in the CMT64 therapeutic model.

[00365] **Figure 69** shows serum IL-12p70 and IFNγ levels after 24 hpi.

[00366] **Figure 70** shows that single-dose IT VSV-M51R-mIL12p70 had robust anti-tumor efficacy compared to VSV-mIFNb-NIS, on treated and contralateral non-treated tumors in MC38 and CMT64 tumors.

[00367] **Figure 71** shows that single-dose IT VSV-M51R-mIL12p70 had robust anti-tumor efficacy compared to VSV-mIFNb-NIS, on treated and contralateral non-treated tumors in MC38 and CMT64 tumors.

[00368] **Figure 72** shows that single-dose IT VSV-M51R-mIL12p70 had robust anti-tumor efficacy compared to VSV-mIFNb-NIS, on treated and contralateral non-treated tumors in MC38 and CMT64 tumors.

[00369] **Figures 73A-73D** show VSV-mIL12p70 transcript variants for reduction of IL-12 leakage from tumors, which can result in systemic exposure to IL-12 and toxicity. **Figure 73A** displays an example of a toxicity mitigation strategy for VSV-mIL12p70 transcript variants. A schematic representation of the dosing regimen is shown in **Figure 73B**. Quantification of average tumor volumes (**Figure 73C**) and average body weights (% body weight change) (**Figure 73D**) across days post-infection are shown for VSV-M51R-GFP-L-mIL12p70 versus VSV-M51R-mIL12p70 groups. Phosphate buffered saline (PBS) was used as a control.

[00370] **Figure 74** shows serum expression levels of IL12p70 (left panel) and IFNγ (right panel) quantified at 24 hours post infection.

[00371] **Figure 75** shows IL-12 expression across treatment groups.

[00372] **Figures 76A-76B** illustrate an IL-12 functional assay involving induction of IFNγ from splenocytes. **Figure 76A** shows an example of an IL-12 functional assay design. **Figure 76B** shows quantification of IFNγ in supernatants collected from 5TGM1 cells infected with IL-12 transmembrane variant and soluble IL-12 variant viruses.

[00373] **Figures 77A-77B** show tumor growth upon administration of VSV-M51R-mIL12 encoding murine single chain IL-12 (soluble form) in combination with an anti-programmed cell death protein-1 (PD-1) antibody on both dosed (**Figure 77A**) and contralateral, non-dosed (**Figure**

77B) tumors. Symbols on the graphs represent group means and error bars represent standard error of the mean (SEM). Error bars are present at Day 10 for all 4 dosing groups but were too small to discern for groups administered VSV-M51R-mIL12 or VSV-M51R-mIL12 + anti-PD-1.

[00374] Figure 78 shows survival upon administration of VSV-M51R-mIL12 encoding murine single chain IL-12 (soluble form) in combination with anti-PD-1 antibody compared with administration of either reagent individually. Data are plotted as Kaplan-Meier curves.

[00375] Figures 79A-79LL show an example of a linear vector map of a VSV-M51R-hIL12p70 construct. The vector can be circular and comprise, e.g., 12,825 bp. Unique cutters are shown in bold text. The full-length VSV-M51R-hIL12p70 construct comprises a polynucleotide sequence, from 5' to 3', SEQ ID NO: 163. The VSV-M51R-hIL12p70 construct represented in the linear vector map comprises nucleotide sequences for, from 5' to 3', a VSV leader sequence (SEQ ID NO: 165), an N protein (SEQ ID NO: 2), a P protein (SEQ ID NO: 10), an M protein (SEQ ID NO: 6), a G signal peptide (GSP) protein (SEQ ID NO: 198), a G protein in frame with GSP protein (SEQ ID NO: 171), an intravirion tail-VSVG in frame with a GSP protein (SEQ ID NO: 174), an hIL12p70 protein (SEQ ID NO: 155) comprising an hIL12p40 protein (SEQ ID NO: 156), a linker (SEQ ID NO: 179), and an hIL12p35 protein (SEQ ID NO: 181), an L protein (SEQ ID NO: 183), and a VSV trailer sequence (SEQ ID NO: 185). The full-length VSV-M51R-hIL12p70 construct comprises a polynucleotide sequence, from 3' to 5', SEQ ID NO: 164. The VSV-M51R-hIL12p70 construct represented in the linear vector map comprises nucleotide sequences for, from 3' to 5', a VSV leader sequence (SEQ ID NO: 166), an N protein (SEQ ID NO: 167), a P protein (SEQ ID NO: 168), an M protein (SEQ ID NO: 169), a GSP protein (SEQ ID NO: 199), a G protein in frame with GSP protein (SEQ ID NO: 172), an intravirion tail-VSVG in frame with GSP protein (SEQ ID NO: 175), an hIL12p70 (SEQ ID NO: 177) comprising a hIL12p40 protein (SEQ ID NO: 178), a linker (SEQ ID NO: 180) and an hIL12p35 protein (SEQ ID NO: 182), an L protein (SEQ ID NO: 184), and a VSV trailer sequence (SEQ ID NO: 186). The VSV-M51R-hIL12p70 construct encodes for a full-length polypeptide sequence comprising, from N-terminus to C-terminus, SEQ ID NO: 113. The VSV-M51R-hIL12p70 construct encodes for a protein comprising an N protein (SEQ ID NO: 1), a P protein (SEQ ID NO: 9), an M protein (SEQ ID NO: 5), a GSP protein (SEQ ID NO: 197), a G protein in frame with a GSP protein (SEQ ID NO: 173), an intravirion tail-VSVG protein in frame with a GSP protein (SEQ ID NO: 176), hIL12p70 protein (SEQ ID NO:

154) comprising an hIL12p40 protein (SEQ ID NO: 12), a linker protein (SEQ ID NO: 17) and an hIL12p35 protein (SEQ ID NO: 63), and an L protein (SEQ ID NO: 94).

[00376] Figures 80A-80C show C57BL/6 mice treated intravenously with one dose of VSV-Mwt-GFP, VSV-Mwt-mIL12p70, or VSV-M51R-mIL12p70 at $1x10^9$ $TCID_{50}$. IL-12p70 (**Figure 80A**) and IFNγ (**Figure 80B**) ELISA was performed on serum collected 24 hours post infection; Body weight (**Figure 80C**) was measured after treatment over time.

[00377] Figure 81 shows mice with established CMT64 subcutaneous tumors treated intratumorally (IT) with PBS, VSV-M51R-GFP, or VSV-M51R-mIL12p70 (5×10^8 $TCID_{50}$) and harvested for tumor-infiltrating lymphocyte (TIL) isolation seven days post infection. To detect antigen specific anti-tumor responses to previously published peptides, an IFNγ ELISpot assay was performed (n=3). ***p<0.001; *p<0.05; Two-way ANOVA compared to PBS. The peptides along the x-axis are listed sequentially, from left to right (following a DMSO [Dimethyl Sulfoxide] negative control condition), as Aim1, Lyst, Rpp40, Naip2, Zhx2, Cep192, Ndufs1, Arhgef11, Nes, Rab13, Akap9, and Arhgef10 (followed by VSV-NP and PMA [Phorbol 12-myristate 13-acetate]/Ionomycin positive control conditions, respectively). For each of the aforementioned conditions, the three bars (per condition) represent the treatment groups, listed sequentially, from left to right, as PBS, VSV-M51R-GFP, and VSV-M51R-mIL12p70.

[00378] Figure 82 shows quantification of IL-12 levels from infected cell supernatants. Human tumor (SCC-15, SCC-25, HT1080, DLD-1, A375) and non-tumor (LaSt293) cell lines were infected with either VSV-M51R-hIL12p70 or VSV-P-hIL12p70-ΔM51 at varying multiplicities of infection (MOI: 0.01, 0.1, 1.0). SCC-25, a highly VSV-resistant line, was also tested at MOI 10. IL-12 levels (pg/mL) were quantified from culture supernatants 24 hours post-infection. Data represent mean ± SE from biological duplicates. Statistical significance was determined using two-way ANOVA test with Tukey's multiple comparison test: *p < 0.05, **p < 0.01, ***p < 0.001, ****p < 0.0001, ns = not significant.

[00379] Figure 83 shows cell viability using a CCK-8 assay. Human tumor (SCC-15, SCC-25, HT1080, DLD-1, A375) and non-tumor (LaSt293) cell lines were infected with two recombinant VSVs: VSV-M51R-hIL12p70 and VSV-P-hIL12p70-ΔM51, at indicated multiplicities of infection (MOI: 0.01, 0.1, 1). Cell viability was assessed 24 hours post-infection and is expressed as a percentage relative to uninfected controls. Error bars represent standard errors of biological replicates.

[00380] **Figures 84A-84B** show virus growth over time in LaSt293 and HT1080 cells. Human HT1080 (**Figure 84A**) cells were seeded at 500,000 cells/well in 6-well plates in DMEM with 10% FBS and incubated 24 hours. Prior to infection, the media was replaced with Opti-MEM. Suspension Last293 (**Figure 84B**) cells were seeded at a density of 2e6 cells/mL in 25mL culture volume and infected immediately. Viruses diluted in Opti-MEM were added to cells to achieve final MOI of 0.1, for each cell line. At 8, 16, 24, 32, and 48 hours, samples were collected. One entire well from the HT1080 6-well plates was harvested, and 500uL was collected from the LaSt293 flasks at each timepoint. Viral titer was quantified by $TCID_{50}$ assay.

[00381] **Figures 85A-85B** show kinetics of human IL12p70 produced over time in LaSt293 and HT1080 cells. Human HT1080 (**Figure 85A**) cells were seeded at 500,000 cells/well in 6-well plates in DMEM with 10% FBS and incubated 24 hours. Prior to infection, the media was replaced with Opti-MEM. Suspension LaSt293 (**Figure 85B**) cells were seeded at a density of 2e6 cells/mL in 25 mL culture volume and infected immediately. Viruses diluted in Opti-MEM were added to cells to achieve final MOI of 0.1, for each cell line. At 8, 16, 24, 32, and 48 hours, samples were collected. One entire well from the HT1080 6-well plates was harvested, and 500 µL was collected from the LaSt293 flasks at each timepoint. Samples were assayed for hIL12p70 concentration by ELISA.

DETAILED DESCRIPTION

[00382] Oncolytic virus therapy is an anti-cancer approach that uses viruses to selectively replicate and kill cancer cells without harming healthy cells. Such viruses may be used as delivery vehicles to express heterologous genes inserted into the viral genome, which may help to selectively hone the systemic anti-tumor immune response in infected cells. Vesicular stomatitis virus (VSV), a member of the *Rhabdoviridae* family, can be a potential oncolytic virus.

[00383] Interleukin-12 (IL-12), an IL-12 family cytokine, can be a promising target for cancer immunotherapy. However, the clinical success of therapeutic approaches involving cytokines has been limited due to pleiotropy and off-target toxicity. In particular, systemic administration of IL-12 may lead to toxicity due to innate lymphocyte-mediated IFNγ production. Cytokine engineering is a potential strategy to develop cytokines with desired activities but lacking toxic side effects.

[00384] Systemic accumulation of IL-12 after delivery by oncolytic viruses remains potentially toxic to patients. There is a need for approaches to improve properties of IL-12 for use in cancer immunotherapy, for example, oncolytic virus therapy.

[00385] The present disclosure provides compositions and methods relating to a recombinant virus comprising a rhabdovirus genome, for example, a vesicular stomatitis virus (VSV) genome, and a nucleotide sequence encoding a recombinant protein comprising, e.g., an IL-12 polypeptide, or a functional fragment or derivative thereof. In various aspects, the recombinant protein can comprise a transmembrane domain and can, e.g., be membrane bound. In various other aspects, the recombinant protein may not comprise a transmembrane domain and may not be membrane bound. When the recombinant protein is not membrane bound, the recombinant protein may be a soluble and/or secreted protein. Recombinant polynucleotides and recombinant vectors encoding virus polypeptides and nucleotide sequence(s) encoding an IL-12 polypeptide(s), or a functional fragment(s) or derivative(s) thereof, as well as host cells and methods for preparing host cells that express the polypeptides are disclosed. The disclosure further provides pharmaceutical compositions comprising the recombinant virus, and methods for treating cancer, e.g., a tumor, and for inducing cancer regression, in a subject in need thereof, using the recombinant virus.

Definitions

[00386] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs.

[00387] Singular forms “a”, “an”, and “the” include plural references unless the context clearly dictates otherwise. Thus, for example, a reference to “a method” includes one or more methods, and/or steps of the type described herein and/or which will become apparent to those persons skilled in the art upon reading this disclosure.

[00388] The term “about” or “approximately” includes being within a statistically meaningful range of a value. Such a range can be within an order of magnitude, preferably within 50%, more preferably within 20%, still more preferably within 10%, and even more preferably within 5% of a given value or range. The allowable variation encompassed by the term “about” or “approximately” depends on the particular system under study, and can be readily appreciated by one of ordinary skill in the art.

[00389] The term "antigen" refers to any agent (e.g., protein, peptide, polysaccharide, glycoprotein, glycolipid, nucleic acid, portions thereof, or combinations thereof) that, when introduced into a host, animal or human, having an immune system (directly or upon expression as in, e.g., DNA vaccines), is recognized by the immune system of the host and is capable of eliciting, or does elicit, an immune response.

[00390] The terms "viral element" and "viral component" are used herein to refer to viral genes (e.g., genes encoding polymerase or structural proteins) or other elements of the viral genome (e.g., packaging signals, regulatory elements, LTRs, ITRs, etc.).

[00391] The term "oncolytic virus" is used herein to refer to a virus that is capable of infecting and replicating in a tumor cell such that the tumor cell may be killed. The oncolytic virus may be replication competent. As a non-limiting example, the oncolytic virus may comprise a rhabdovirus, i.e., any of a group of viruses comprising the family Rhabdoviridae, e.g., a vesicular stomatitis virus (VSV).

[00392] As used herein, the term "vesiculovirus" refers to any virus in the Vesiculovirus genus. Non-limiting examples of vesiculoviruses include Vesicular Stomatitis Virus (VSV) (e.g., VSV-New Jersey, VSV-Indiana), Alagoas vesiculovirus, Cocal vesiculovirus, Jurona vesiculovirus, Carajas vesiculovirus, Maraba vesiculovirus, Piry vesiculovirus, Calchaqui vesiculovirus, Yug Bogdanovac vesiculovirus, Isfahan vesiculovirus, Chandipura vesiculovirus, Perinct vesiculovirus, and Porton-S vesiculovirus. Vesicular Stomatitis Virus (VSV), in the Vesiculovirus genus, is a prototypic rhabdovirus. While VSV is used as an example in the present disclosure, this disclosure can also be used for other vesiculoviruses and other rhabdoviruses. There are two major serotypes of VSV, New Jersey and Indiana, both of which can infect insects and mammals, causing disease in cattle, equines, and swine. The VSV genome is composed of single-stranded, negative-sense RNA of 11-12 kb, which encodes five viral proteins: the nucleoprotein (N), the phosphoprotein (P), the matrix protein (M), the glycoprotein (G) and the viral polymerase (also known as large protein) (L). G monomers associate to form trimeric spikes anchored in the viral membrane.

[00393] The terms "vector", "expression vector", and "cloning vector" refer to any vehicle by which a nucleotide sequence, e.g., an RNA sequence or a DNA sequence, encoding for example, a foreign gene, may be introduced into a cell (e.g., a host cell) to genetically modify the cell and promote expression (e.g., transcription and translation) of said introduced nucleotide

sequence. Non-limiting examples of vectors include synthesized RNA and DNA molecules plasmids, viruses, phages, and the like. In some embodiments, the vector may be a viral vector including, without limitation, a baculoviral vector, a herpes virus vector, a lentiviral vector, a retroviral vector, a vaccinia virus vector, an adeno-associated virus vector, an adenoviral vector, and an alphaviral vector.

[00394] The term "fusogen" or "fusogenic molecule" is used herein to refer to any molecule that can trigger membrane fusion when present on the surface of a virus. A fusogen can be, for example, a protein (e.g., a viral glycoprotein) or a fragment or derivative thereof.

[00395] The term "replication-competent" is used herein to refer to viruses (including wild-type and recombinant viruses) that are capable of infecting and propagating within a cell.

[00396] The term "encoding" can refer to encoding from either the (+) or (-) sense strand of a polynucleotide, for example, for expression in the virus particle.

[00397] The terms "antibody" and "antibodies" refer to monoclonal antibodies, human antibodies, humanized antibodies, chimeric antibodies, single-chain Fvs (scFv), single chain antibodies, Fab fragments, F(ab′) fragments, disulfide-linked Fvs (sdFv), intrabodies, minibodies, diabodies and anti-idiotypic (anti-Id) antibodies (including, e.g., anti-Id antibodies to antigen specific TCR), and epitope-binding fragments of any of the above. The terms "antibody" and "antibodies" also refer to covalent diabodies such as those disclosed in U.S. Pat. Appl. Pub. 2007/0004909 and Ig-DARTS such as those disclosed in U.S. Pat. Appl. Pub. 2009/0060910. Antibodies useful in the present disclosure include immunoglobulin molecules and immunologically active fragments of immunoglobulin molecules, i.e., molecules that contain an antigen binding site. Immunoglobulin molecules can be of any type (e.g., IgG, IgE, IgM, IgD, IgA and IgY), class (e.g., IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2) or subclass.

[00398] The term "operably linked", or the like, refers to a juxtaposition wherein the components described are in a relationship permitting them to function in their intended manner. For example, a control sequence "operably linked" to a coding sequence is ligated in such a way that expression of the coding sequence is achieved under conditions compatible with the control sequences. "Operably linked" sequences include both expression control sequences that are contiguous with a gene of interest and expression control sequences that act in trans or at a distance to control a gene of interest (or sequence of interest). The term "expression control sequence" includes polynucleotide sequences, which are necessary to affect the expression and processing of coding

sequences to which they are ligated. "Expression control sequences" include: appropriate transcription initiation, termination, promoter and enhancer sequences; efficient RNA processing signals such as splicing and polyadenylation signals; sequences that stabilize cytoplasmic mRNA; sequences that enhance translation efficiency (i.e., Kozak consensus sequence); sequences that enhance polypeptide stability; and when desired, sequences that enhance polypeptide secretion. The nature of such control sequences differs depending upon the host organism. For example, in prokaryotes, such control sequences generally include promoter, ribosomal binding site and transcription termination sequence, while in eukaryotes typically such control sequences include promoters and transcription termination sequence. The term "control sequences" is intended to include components whose presence is essential for expression and processing and can also include additional components whose presence is advantageous, for example, leader sequences and fusion partner sequences.

[00399] The term "host cell" refers to any cell that comprises a heterologous nucleic acid. By way of a non-limiting example, the heterologous nucleic acid may be a vector. A host cell, for example, without limitation, may be a cell from any organism that is used, manipulated, modified, selected, transformed, or grown, for the production of a substance by the cell, e.g., the expression by the cell of, a RNA or DNA sequence, a gene, a protein, or an enzyme.

[00400] An "individual" or "subject" or "animal" refers to humans, veterinary animals (e.g., cats, dogs, cows, horses, sheep, pigs, etc.) and experimental animal models (e.g., mice, rats), e.g., of diseases. In a preferred embodiment, the subject is a human.

[00401] The terms "nucleic acid," "polynucleotide," and "nucleotide" used interchangeably herein, include polymeric forms of nucleotides of any length, including ribonucleotides (RNA), deoxyribonucleotides (DNA), or analogs or modified versions thereof. They include single-, double-, and multi-stranded DNA or RNA, genomic DNA, cDNA, DNA-RNA hybrids, and polymers comprising purine bases, pyrimidine bases, or other natural, chemically modified, biochemically modified, non-natural, or derivatized nucleotide bases. A single-stranded nucleic acid can be the sense strand or the antisense strand.

[00402] Nucleic acids are said to have a "5' end" and a "3' end" because mononucleotides are reacted to make oligonucleotides in a manner such that the 5' phosphate of one mononucleotide pentose ring is attached to the 3' oxygen of its neighbor in one direction via a phosphodiester linkage. An end of an oligonucleotide is referred to as the "5' end" if its 5' phosphate is not linked

to the 3' oxygen of a mononucleotide pentose ring. An end of an oligonucleotide is referred to as the "3' end" if its 3' oxygen is not linked to a 5' phosphate of another mononucleotide pentose ring. A nucleic acid sequence, even if internal to a larger oligonucleotide, also may be said to have 5' and 3' ends. In either a linear or circular DNA molecule, discrete elements are referred to as being "upstream" or 5' of the "downstream" or 3' elements.

[00403] The term "fragment" when referring to a protein means a protein that is shorter or has fewer amino acids than the full-length protein. A fragment can be, for example, an N-terminal fragment (i.e., removal of a portion of the C-terminal end of the protein), a C-terminal fragment (i.e., removal of a portion of the N-terminal end of the protein), or an internal fragment. The term "fragment" when referring to a nucleic acid means a nucleic acid that is shorter or has fewer nucleotides than the full-length nucleic acid. A fragment can be, for example, a 5' fragment (i.e., removal of a portion of the 3' end of the nucleic acid), a 3' fragment (i.e., removal of a portion of the 5' end of the protein), or an internal fragment.

[00404] The term "derivative" as used herein refers to a nucleic acid, or protein, or a variant, or an analog thereof comprising one or more mutations and/or chemical modifications as compared to a corresponding full-length wild-type nucleic acid, or protein. Non-limiting examples of chemical modifications involving nucleic acids include, for example, modifications to the base moiety, sugar moiety, phosphate moiety, phosphate-sugar backbone, or a combination thereof.

[00405] "Sequence identity" or "identity" in the context of two polynucleotides or polypeptide sequences makes reference to the residues in the two sequences that are the same when aligned for maximum correspondence over a specified comparison window. When percentage of sequence identity is used in reference to proteins, residue positions which are not identical often differ by conservative amino acid substitutions, where amino acid residues are substituted for other amino acid residues with similar chemical properties (e.g., charge or hydrophobicity) and therefore do not change the functional properties of the molecule. When sequences differ in conservative substitutions, the percent sequence identity may be adjusted upwards to correct for the conservative nature of the substitution. Sequences that differ by such conservative substitutions are said to have "sequence similarity" or "similarity." Means for making this adjustment are well known. Typically, this involves scoring a conservative substitution as a partial rather than a full mismatch, thereby increasing the percentage sequence identity. Thus, for example, where an identical amino acid is given a score of 1 and a non-conservative substitution is given a score of

zero, a conservative substitution is given a score between zero and 1. The scoring of conservative substitutions is calculated, e.g., as implemented in the program PC/GENE.

[00406] "Percentage of sequence identity" includes the value determined by comparing two optimally aligned sequences (greatest number of perfectly matched residues) over a comparison window, wherein the portion of the polynucleotide sequence in the comparison window may comprise additions or deletions (i.e., gaps) as compared to the reference sequence (which does not comprise additions or deletions) for optimal alignment of the two sequences. The percentage is calculated by determining the number of positions at which the identical nucleic acid base or amino acid residue occurs in both sequences to yield the number of matched positions, dividing the number of matched positions by the total number of positions in the window of comparison, and multiplying the result by 100 to yield the percentage of sequence identity. Unless otherwise specified (e.g., the shorter sequence includes a linked heterologous sequence), the comparison window is the full length of the shorter of the two sequences being compared.

[00407] The terms "treat" or "treatment" of a state, disorder, disease, or condition include: (1) preventing, delaying, or reducing the incidence and/or likelihood of the appearance of at least one clinical or sub-clinical symptom of the state, disorder, disease, or condition developing in a subject that may be afflicted with or predisposed to the state, disorder, disease, or condition, but does not yet experience or display clinical or subclinical symptoms of the state, disorder, disease, or condition; or (2) inhibiting the state, disorder, disease, or condition, i.e., arresting, reducing, or delaying the development of the disease, or a relapse thereof, or at least one clinical or sub-clinical symptom thereof; or (3) relieving the state, disorder, disease, or condition, i.e., causing regression of the state, disorder, disease or condition or at least one of the clinical or sub-clinical symptoms of the state, disorder, disease or condition. The benefit to a subject to be treated is either statistically significant or at least perceptible to the patient or to the physician.

[00408] The term "effective" as applied to a dose or an amount refers to the quantity of a compound or pharmaceutical composition that is sufficient to result in a desired activity upon administration to a subject in need thereof. Note that when a combination of active ingredients is administered, the effective amount of the combination may or may not include amounts of each ingredient that would have been effective if administered individually. The exact amount required will vary from subject to subject, depending on the species, age, and general condition of the

subject, the severity of the condition being treated, the particular drug or drugs employed, the mode of administration, and the like.

[00409] The phrase "pharmaceutically acceptable", as used in connection with compositions described herein, refers to molecular entities and other ingredients of such compositions that are physiologically tolerable and do not typically produce untoward reactions when administered to a mammal (e.g., a human). Preferably, the term "pharmaceutically acceptable" means approved by a regulatory agency of the Federal or a state government or listed in the U.S. Pharmacopeia or other generally recognized pharmacopeia for use in mammals, and more particularly in humans.

[00410] In accordance with the disclosure herein, there may be employed conventional molecular biology, microbiology, and recombinant DNA techniques within the skill of the art. Such techniques are explained fully in the literature. See, e.g., Sambrook, Fritsch & Maniatis, Molecular Cloning: A Laboratory Manual, Second Edition. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 1989 (herein "Sambrook et al., 1989"); DNA Cloning: A Practical Approach, Volumes I and II (D.N. Glover ed. 1985); Oligonucleotide Synthesis (M.J. Gait ed. 1984); Nucleic Acid Hybridization [B.D. Hames & S.J. Higgins eds. (1985)]; Transcription And Translation [B.D. Hames & S.J. Higgins, eds. (1984)]; Animal Cell Culture [R.I. Freshney, ed. (1986)]; Immobilized Cells And Enzymes [IRL Press, (1986)]; B. Perbal, A Practical Guide To Molecular Cloning (1984); Ausubel, F.M. et al. (eds.). Current Protocols in Molecular Biology. John Wiley & Sons, Inc., 1994. These techniques include site directed mutagenesis as described in Kunkel, Proc. Natl. Acad. Sci. USA 82: 488- 492 (1985), U. S. Patent No. 5,071, 743, Fukuoka et al., Biochem. Biophys. Res. Commun. 263: 357-360 (1999); Kim and Maas, BioTech. 28: 196-198 (2000); Parikh and Guengerich, BioTech. 24: 4 28-431 (1998); Ray and Nickoloff, BioTech. 13: 342-346 (1992); Wang et al., BioTech. 19: 556-559 (1995); Wang and Malcolm, BioTech. 26: 680-682 (1999); Xu and Gong, BioTech. 26: 639-641 (1999), U.S. Patents Nos. 5,789, 166 and 5,932, 419, Hogrefe, Strategies l4. 3: 74-75 (2001), U. S. Patents Nos. 5,702,931, 5,780,270, and 6,242,222, Angag and Schutz, Biotech. 30: 486-488 (2001), Wang and Wilkinson, Biotech. 29: 976-978 (2000), Kang et al., Biotech. 20: 44-46 (1996), Ogel and McPherson, Protein Engineer. 5: 467-468 (1992), Kirsch and Joly, Nucl. Acids. Res. 26: 1848-1850 (1998), Rhem and Hancock, J. Bacteriol. 178: 3346-3349 (1996), Boles and Miogsa, Curr. Genet. 28: 197-198 (1995), Barrenttino et al., Nuc. Acids. Res. 22: 541-542 (1993), Tessier and Thomas, Meths. Molec. Biol. 57: 229-237, and Pons et al., Meth. Molec. Biol. 67: 209-218.

Recombinant Viruses

[00411] In one aspect, the present disclosure provides a recombinant virus comprising a virus genome, and further comprising a nucleotide sequence encoding, for example, a recombinant protein comprising, e.g., an IL-12 polypeptide, or a functional fragment or derivative thereof.

[00412] In some embodiments, the recombinant virus may be derived from a rhabdovirus. In some embodiments, the recombinant virus may comprise a rhabdovirus genome. The *Rhabdoviridae* family is mainly composed of a cage, bullet-shaped or bacilliform virus and has a negative-sense single-stranded RNA genome that infects vertebrates, invertebrates, or plants. Non-limiting examples of rhabdoviruses that can be used in the present disclosure include rabies, cytolabudoviruses, dicholabdoviruses, ephemeraviruses, lyssaviruses, nobilabdoviruses, and vesiculoviruses. In some embodiments, a recombinant virus described herein is a vesiculovirus including, without limitation, a vesicular stomatitis virus (VSV).

[00413] In some embodiments, a recombinant virus (e.g., a recombinant rhabdovirus) described herein can be replication deficient, i.e., the recombinant virus can be non-replicative, and may only contain an incomplete genome of the virus from which it is derived. In some embodiments, the recombinant virus can be replication-competent. In certain aspects, a recombinant virus according to the disclosure (e.g., a recombinant rhabdovirus described herein) may be provided as an oncolytic virus.

Oncolytic Viruses

[00414] Oncolytic virus therapy is an anti-cancer approach which uses viruses to selectively replicate and kill cancer cells without harming healthy cells. Such viruses are a powerful platform for oncolytic immunotherapy, which involves both direct tumor cell lysis and the induction of immune responses against tumor antigens. In general, viruses can enter cells at high efficiency. Viral genes are subsequently expressed, and the virus replicates. Viruses may also be used as delivery vehicles to express heterologous genes inserted into the viral genome in infected cells, and thus viruses such as oncolytic viruses can deliver encoded molecules which may help, for example, to selectively hone the systemic anti-tumor immune response.

[00415] In certain aspects, the recombinant virus according to the disclosure may be provided as an oncolytic virus. An oncolytic virus can be capable of infecting and replicating within tumor cells, such that the tumor cells are broken down, e.g., lysed, and killed. Therefore, an oncolytic virus of the disclosure may be replication competent. In some embodiments, the virus may be

selectively replication competent in a specific tissue, for example, a tumor tissue. By way of a non-limiting example, a virus is selectively replication competent in a tumor tissue if it replicates more effectively in a tumor tissue than in a non-tumor tissue. The ability of a virus to replicate in different tissue types may be determined using, for example, without limitation, real-time quantitative reverse transcription polymerase chain reaction (qRT-PCR), electrophoresis, chromatography, flow cytometry, tunable resistive pulse sensing (TRPS), microscopy techniques (e.g., fluorescence microscopy, electron microscopy, including transmission electron microscopy), fluorescence *in situ* hybridization (FISH), infectivity assays, enzyme-linked immunosorbent assays (ELISAs), fluorescent-tagged antibody assays, and precipitation assays, loop-mediated amplification (LAMP) assay, plaque assay, focus forming assays (FFAs), 50% tissue culture infective dose ($TCID_{50}$) assay, virus neutralization assays, homogenous virus assays, e.g., fluorescence polarization-based assays, AlphaScreen®/AlphaLISA® technologies, proximity-based assays, e.g. FRET, BRET, TR-FRET, time-resolved fluorescence (TRF), RNA dependent RNA polymerase assays, fluorescence *in vitro* and high throughput assays, cell-based microplate assays, protein assays (e.g., bicinchoninic acid assay, single radial immunodiffusion assay), and the like.

[00416] In some embodiments, oncolytic effects of the oncolytic virus disclosed herein may rely on the virus replicating in and killing infected cells (e.g., cancer cells including tumor cells). Progeny virions may then proceed to infect and kill other tumor cells, thereby spreading within the tumor. Hence, the ability of the oncolytic virus to effectively kill tumor cells and spread within tumors results in optimal anti-tumor effects. Efficient spread and virus replication can be associated with lysis of tumor cells, a process which may also maximize the quantity of tumor antigen released and therefore maximize the potency of the induced anti-tumor immune response.

[00417] An oncolytic virus (e.g., a recombinant rhabdovirus) disclosed herein may be unaltered from the parental virus species (i.e., wild-type), or with gene modifications, e.g., gene additions (i.e., mutant).

[00418] A rhabdovirus is member of the *Rhabdoviridae* family of viruses in the order *Mononegavirales*, encompassing more than 150 viruses of vertebrates, invertebrates, and plants. Examples of rhabdoviruses include rabies virus (RABV) from the *Lyssavirus* genus, vesiculoviruses from *Vesiculovirus* genus, the viral hemorrhagic septicemia virus (VHSV), and infectious hematopoietic necrosis virus, both from the *Novirhabdovirus* genus. Members of the

genus *Lyssavirus* may cause lethal meningoencephalitis in humans and animals while VSV (genus *Vesiculovirus*) may cause symptoms clinically identical to those of foot-and-mouth disease in cattle and occasional, limited infections in humans. Dimarhabdoviruses are the supergroup of rhabdoviruses that infect mammals and mosquitoes. Rhabdoviruses are bullet-shaped enveloped viruses with negative-sense single-stranded RNA genome 11-15 kb in length. The genome of rhabdoviruses can contain up to ten genes among which only five are common to all members of the family. These five common rhabdoviruses genes encode the nucleoprotein (N), the phosphoprotein (P), the matrix protein (M), the glycoprotein (G), and the viral polymerase (also known as large protein) (L). The rhabdoviruses genome associates with N, L, and P to form the nucleocapsid, which is condensed by the M protein into a tightly coiled helical structure. The condensed nucleocapsid is surrounded by a lipid bilayer containing the viral glycoprotein G that constitutes the spikes that protrude from the viral surface. Rhabdoviruses enter a host cell via the endocytic pathway and subsequently fuse with the cellular membrane within the acidic environment of the endosome. Both receptor recognition and membrane fusion are mediated by a single transmembrane viral glycoprotein (G). Fusion between the viral envelope and the endosomal membrane is triggered via a low-pH induced (in the endosome) structural rearrangement of the G resulting in the release the viral genome and associated proteins into the cytoplasm of target cells.

[00419] In some embodiments, vesicular stomatitis virus (VSV), a member of the *Rhabdoviridae* family, can be a potential oncolytic virus. The advantages of VSV may include, for example: (i) an efficient life cycle, allowing for production of mature progeny virus in approximately 6 hours; (ii) multiple mechanisms of viral spread thereby ensuring rapid and efficient propagation of the virus; (iii) a large viral genome, allowing incorporation of substantial foreign DNA inserts; (iv) a lack of disease promotion in healthy humans; and, (v) use as a smallpox vaccine contributing to a considerable clinical knowledge base.

[00420] One aspect of the disclosure provides recombinant vesiculoviruses. Examples of vesiculoviruses that can be used in the present disclosure are listed in **Table 1**.

Table 1. Examples of Vesiculoviruses

Virus	**Example source of virus in nature**
VSV-New Jersey	Mammals, mosquitoes, midges, blackflies, houseflies

VSV-Indiana	Mammals, mosquitoes, sandflies
Alagoas	Mammals, sandflies
Cocal	Mammals, mosquitoes, mites
Jurona	Mosquitoes
Carajas	Sandflies
Maraba	Sandflies
Piry	Mammals
Calchaqui	Mosquitoes
Yug Bogdanovac	Sandflies
Isfahan	Sandflies, ticks
Chandipura	Mammals, sandflies
Perinct	Mosquitoes, sandflies
Porton-S	Mosquitoes

[00421] In some embodiments, an oncolytic virus, e.g., a recombinant rhabdovirus, disclosed herein can be a vesiculovirus such as, but not limited to, a vesicular stomatitis virus (VSV). In some embodiments, the VSV is a replication-competent VSV. In some embodiments, the VSV is non-replicative.

[00422] The genome of vesicular stomatitis virus (VSV), considered a prototypic rhabdovirus, comprises 11,161 nucleotides of negative-sense RNA. This RNA is tightly encapsidated by the viral nucleocapsid (N) polypeptide, and forms the template for the RNA-dependent RNA polymerase (RdRP), the viral components being a 241-kDa large protein (L) polypeptide and a phosphoprotein (P) polypeptide. The RdRP uses the RNA (viral) genome as a template for two reactions: (i) transcription of a short leader RNA (Le+) and 5 mRNAs that encode nucleoprotein (N) polypeptide, phosphoprotein (P) polypeptide, matrix (M) polypeptide, glycoprotein (G) polypeptide, and large protein (L) polypeptide; and (ii) replication to yield full-length antigenomic and then genomic strands.

[00423] In certain aspects, a recombinant rhabdovirus of the present disclosure may comprise a vesiculovirus genome, for example, a VSV genome, or any portion thereof. As a non-limiting example, a recombinant rhabdovirus genome may comprise genes which may encode, e.g., a VSV nucleoprotein (N) polypeptide, a VSV phosphoprotein (P) polypeptide, a VSV matrix (M) polypeptide (e.g., a wild-type VSV M polypeptide or a mutant VSV M polypeptide), a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), and/or a VSV large protein (L) polypeptide, or functional fragments or derivatives thereof.

[00424] In some embodiments, a recombinant rhabdovirus genome (e.g., a VSV genome) described herein comprises one or more genes encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof, a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof, a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and/or a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof. In some embodiments, the VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, is a wild-type VSV M polypeptide. In some embodiments, the VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, is a mutant VSV M polypeptide. In some embodiments, the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide. In some embodiments, the fusogenic polypeptide may comprise, e.g., a combination of F and H polypeptides of a paramyxovirus.

[00425] In some embodiments, a VSV nucleoprotein (N) polypeptide comprises the amino acid sequence of SEQ ID NO: 1, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 1. In certain embodiments, the nucleotide sequence that encodes the VSV nucleoprotein (N) polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 1, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 1. In certain embodiments, the nucleotide sequence that encodes the VSV nucleoprotein (N) polypeptide comprises the nucleotide sequence of SEQ ID NO: 2 or SEQ ID NO: 167, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO:

2 or SEQ ID NO: 167. In certain embodiments, the VSV nucleoprotein (N) polypeptide comprises the amino acid sequence of SEQ ID NO: 1. In certain embodiments, the nucleotide sequence that encodes the VSV nucleoprotein (N) polypeptide comprises the nucleotide sequence of SEQ ID NO: 2 or SEQ ID NO: 167.

[00426] In some embodiments, the VSV nucleoprotein (N) polypeptide comprises the amino acid sequence of SEQ ID NO: 1, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 1.

[00427] In some embodiments, a VSV phosphoprotein (P) polypeptide comprises the amino acid sequence of SEQ ID NO: 9, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 9. In certain embodiments, the nucleotide sequence that encodes the VSV phosphoprotein (P) polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 9, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 9. In certain embodiments, the nucleotide sequence that encodes the VSV phosphoprotein (P) polypeptide comprises the nucleotide sequence of SEQ ID NO: 10 or SEQ ID NO: 168, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 10 or SEQ ID NO: 168. In certain embodiments, the VSV phosphoprotein (P) polypeptide comprises the amino acid sequence of SEQ ID NO: 9. In certain embodiments, the nucleotide sequence that encodes the VSV phosphoprotein (P) polypeptide comprises the nucleotide sequence of SEQ ID NO: 10 or SEQ ID NO: 168.

[00428] In some embodiments, the VSV phosphoprotein (P) polypeptide comprises the amino acid sequence of SEQ ID NO: 9, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 9.

[00429] In some embodiments, a wild-type VSV matrix (M) polypeptide comprises the amino acid sequence of SEQ ID NO: 3, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 3. In certain embodiments, the nucleotide sequence that encodes the wild-type VSV matrix (M) polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 3, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 3. In certain embodiments, the nucleotide sequence that encodes the wild-type VSV matrix (M) polypeptide comprises the nucleotide sequence of SEQ ID NO: 4, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 4. In certain embodiments, the wild-type VSV matrix (M) polypeptide comprises the amino acid sequence of SEQ ID NO: 3. In certain embodiments, the nucleotide sequence that encodes the wild-type VSV matrix (M) polypeptide comprises the nucleotide sequence of SEQ ID NO: 4.

[00430] In some embodiments, the VSV M polypeptide comprises the amino acid sequence of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 3.

[00431] In some embodiments, a VSV glycoprotein (G) polypeptide comprises the amino acid sequence of SEQ ID NO: 92, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at

least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 92. In certain embodiments, the nucleotide sequence that encodes the VSV glycoprotein (G) polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 92, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 92. In certain embodiments, the nucleotide sequence that encodes the VSV glycoprotein (G) polypeptide comprises the nucleotide sequence of SEQ ID NO: 93 or SEQ ID NO: 170, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 93 or SEQ ID NO: 170. In certain embodiments, the VSV glycoprotein (G) polypeptide comprises the amino acid sequence of SEQ ID NO: 92. In certain embodiments, the nucleotide sequence that encodes the VSV glycoprotein (G) polypeptide comprises the nucleotide sequence of SEQ ID NO: 93 or SEQ ID NO: 170.

[00432] In some embodiments, the VSV glycoprotein (G) polypeptide comprises the amino acid sequence of SEQ ID NO: 92, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 92.

[00433] In some embodiments, a VSV glycoprotein (G) polypeptide comprises the amino acid sequence of SEQ ID NO: 173, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 173. In certain embodiments, the nucleotide sequence that encodes the VSV glycoprotein (G) polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 173, or

a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 173. In certain embodiments, the nucleotide sequence that encodes the VSV glycoprotein (G) polypeptide comprises the nucleotide sequence of SEQ ID NO: 171 or SEQ ID NO: 172, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 171 or SEQ ID NO: 172. In certain embodiments, the VSV glycoprotein (G) polypeptide comprises the amino acid sequence of SEQ ID NO: 173. In certain embodiments, the nucleotide sequence that encodes the VSV glycoprotein (G) polypeptide comprises the nucleotide sequence of SEQ ID NO: 171 or SEQ ID NO: 172.

[00434] In some embodiments, the VSV glycoprotein (G) polypeptide comprises the amino acid sequence of SEQ ID NO: 173, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 173.

[00435] In some embodiments, an intravirion tail-VSVG polypeptide comprises the amino acid sequence of SEQ ID NO: 176, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 176. In certain embodiments, the nucleotide sequence that encodes the intravirion tail-VSVG polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 176, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 176. In certain embodiments, the nucleotide

sequence that encodes the intravirion tail-VSVG polypeptide comprises the nucleotide sequence of SEQ ID NO: 174 or 175, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 174 or 175. In certain embodiments, the intravirion tail-VSVG polypeptide comprises the amino acid sequence of SEQ ID NO: 176. In certain embodiments, the nucleotide sequence that encodes the intravirion tail-VSVG polypeptide comprises the nucleotide sequence of SEQ ID NO: 174 or 175.

[00436] In some embodiments, the intravirion tail-VSVG polypeptide comprises the amino acid sequence of SEQ ID NO: 176, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 176.

[00437] In some embodiments, an hIL12p70 polypeptide comprises the amino acid sequence of SEQ ID NO: 154, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 154. In certain embodiments, the nucleotide sequence that encodes the hIL12p70 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 154, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 154. In certain embodiments, the nucleotide sequence that encodes the hIL12p70 polypeptide comprises the nucleotide sequence of SEQ ID NO: 155 or 177, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 155 or 177. In certain

embodiments, the hIL12p70 polypeptide comprises the amino acid sequence of SEQ ID NO: 154. In certain embodiments, the nucleotide sequence that encodes the hIL12p70 polypeptide comprises the nucleotide sequence of SEQ ID NO: 155 or 177.

[00438] In some embodiments, the hIL12p70 polypeptide comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 154.

[00439] In some embodiments, an linker polypeptide comprises the amino acid sequence of SEQ ID NO: 17, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 17. In certain embodiments, the nucleotide sequence that encodes the linker polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 17, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 17. In certain embodiments, the nucleotide sequence that encodes the linker polypeptide comprises the nucleotide sequence of SEQ ID NO: 179 or 180, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 179 or 180. In certain embodiments, the linker polypeptide comprises the amino acid sequence of SEQ ID NO: 17. In certain embodiments, the nucleotide sequence that encodes the linker polypeptide comprises the nucleotide sequence of SEQ ID NO: 179 or 180.

[00440] In some embodiments, the linker polypeptide comprises the amino acid sequence of SEQ ID NO: 17, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 17.

[00441] In some embodiments, a VSV large protein (L) polypeptide comprises the amino acid sequence of SEQ ID NO: 94, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 94. In certain embodiments, the nucleotide sequence that encodes the VSV large protein (L) polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 94, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 94. In certain embodiments, the nucleotide sequence that encodes the VSV large protein (L) polypeptide comprises the nucleotide sequence of SEQ ID NO: 95, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 95. In certain embodiments, the nucleotide sequence that encodes the VSV large protein (L) polypeptide comprises the nucleotide sequence of SEQ ID NO: 183 or 184, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with nucleotide sequence of SEQ ID NO: 183 or 184. In certain embodiments, the VSV large protein (L) polypeptide comprises the amino acid sequence of SEQ ID NO: 94. In certain embodiments, the nucleotide sequence that encodes the VSV large protein (L) polypeptide comprises the nucleotide sequence of SEQ ID NO: 95. In certain embodiments, the nucleotide sequence that encodes the VSV large protein (L) polypeptide comprises the nucleotide sequence of SEQ ID NO: 183 or 184.

[00442] In some embodiments, the VSV large protein (L) polypeptide comprises the amino acid sequence of SEQ ID NO: 94, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 94.

[00443] In some embodiments, a VSV-M51R-hIL12p70 polypeptide comprises the amino acid sequence of SEQ ID NO: 113, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 113. In certain embodiments, the nucleotide sequence that encodes the VSV-M51R-hIL12p70 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 113, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 113. In certain embodiments, the VSV-M51R-hIL12p70 polypeptide comprises the amino acid sequence of SEQ ID NO: 113.

[00444] In some embodiments, the VSV-M51R-hIL12p70 polypeptide comprises the amino acid sequence of SEQ ID NO: 113, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 113.

[00445] A rhabdovirus genome, e.g., a VSV genome, described herein can be genetically modified to include one or more mutations or "mutation classes" in the genome. "Mutation class", "mutation classes" or "classes of mutation" are used interchangeably herein. Example mutation classes include, but are not limited to, a VSV temperature-sensitive N gene mutation, a temperature-sensitive L gene mutation, a point mutation, a G-stem mutation, a non-cytopathic M gene mutation, a gene shuffling or rearrangement mutation, a truncated G gene mutation, an ambisense RNA mutation, a G gene insertion mutation, a gene deletion mutation and the like. Mutations can be insertions, deletions, substitutions, gene rearrangement, or shuffling modifications.

[00446] Some mutations may attenuate the infectivity, virulence or pathogenic effects of the VSV. The attenuation can be additive or synergistic. With synergistic attenuation, the level of

VSV attenuation is greater than additive. Synergistic attenuation of VSV can arise from combining at least two classes of mutation in the same VSV genome, thereby resulting in a reduction of VSV pathogenicity much greater than an additive attenuation level observed for each VSV mutation class alone. A synergistic attenuation of VSV can provide for an LD_{50} at least greater than the additive attenuation level observed for each mutation class alone (i.e., the sum of the two mutation classes), where attenuation levels (i.e., the LD_{50}) are determined in a small animal neurovirulence model.

[00447] The matrix (M) polypeptide of rhabdoviruses, such as VSVs, are small (approximately 20–25 kDa) multifunctional proteins that play a role in virus assembly, maturation, and budding (replication). The M protein also modulates the production of host and virus proteins, e.g., promoting viral egress from the host cell and cell death. From a structural standpoint, the M protein forms a layer between the glycoprotein- (G-) containing outer membrane and the nucleocapsid core which includes the virus nucleoprotein (N), large (L), phosphoprotein (P) and RNA (viral) genome.

[00448] The VSV M gene encodes the virus matrix (M) protein, and two smaller in-frame polypeptides (M2 and M3). The M2 and M3 polypeptides can be translated from the same open reading frame (ORF) as the M protein and lack the first 33 and 51 amino acids, respectively. A recombinant VSV vector comprising non-cytopathic M gene mutations (i.e., VSV vectors that also do not express M2 and M3 proteins) can be generated, and can further comprise one or more additional mutation(s) thereby resulting in a VSV vector that was highly attenuated in cell culture and in animals.

[00449] In certain embodiments, the recombinant rhabdovirus, e.g., recombinant VSV, described herein may comprise a non-cytopathic mutation in the M gene. The VSV (Indiana serotype) M gene encodes a 229 amino acid M (matrix) protein in which the first thirty amino acids of the NH2-terminus comprise a proline-rich PPPY (SEQ ID NO: 187) (PY) motif. M is both a structural protein and inhibits nuclear export of host cell mRNAs. The PY motif of VSV M protein is located at amino acid positions 24-27 in both VSV Indiana (Genbank Accession Number X04452) and New Jersey (Genbank Accession Number M14553) serotypes. The VSV may comprise mutations in the PY motif (e.g., APPY (SEQ ID NO: 188), AAPY (SEQ ID NO: 189), PPAY (SEQ ID NO: 190), APPA (SEQ ID NO: 191), AAPA (SEQ ID NO: 192) and PPPA (SEQ ID NO: 193)). The VSV can comprise any of various amino acid mutations (e.g., deletions,

substitutions, insertions, etc.) into the M protein PSAP (SEQ ID NO: 194) (PS) motif. These and other mutations in the PY motif may be effective to reduce virus yield by blocking a late stage in virus budding. A deletion mutant could be more disruptive to viral structure/function than a substitution mutant. Such disrupted viral structure/function could impact, for example, : a) replication kinetics, and b) other measures of viral fitness, i.e., the capacity of a virus to produce infectious progeny in a given environment.

[00450] The recombinant VSV described herein may comprise one or more M gene mutations. Non-limiting examples of M protein mutations include, e.g., a glycine changed to a glutamic acid at position (21), a leucine changed to a phenylalanine at position (111), a methionine changed to an arginine at position (51), a glycine changed to a glutamic acid at position (22), a methionine changed to an arginine at position (48), a leucine changed to a phenylalanine at position (110), a methionine changed to an alanine at position (51), and a methionine changed to an alanine at position (33). In various embodiments of the methods described herein, the genome of the recombinant VSV encodes a mutant VSV matrix M protein comprising the M51R variant M protein. The M51R mutation can eliminate the ability of the M protein to block cellular nucleo-cytoplasmic transport, and thus can substantially attenuate VSV infectivity.

[00451] In some embodiments, the VSV matrix (M) polypeptide is a mutant VSV M polypeptide. In some embodiments, the mutant VSV M polypeptide may comprise a mutation at methionine (M) 51 (M51R). In some embodiments, the mutation may comprise a substitution from methionine (M) to arginine I. In some embodiments, the mutant VSV M polypeptide may comprise a deletion at methionine (M) 51 (ΔM51). ΔM51 may also be referred to herein as deltaM51, dM51, Δ51M, or d51M, or the like.

[00452] In some embodiments, the mutant VSV matrix (M) polypeptide M51R comprises the amino acid sequence of SEQ ID NO: 5, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 5. In certain embodiments, the nucleotide sequence that encodes the mutant VSV matrix (M) polypeptide M51R comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 5, or a variant thereof having at least about 50%, at least about 55%, at least about

60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 5. In certain embodiments, the nucleotide sequence that encodes the mutant VSV matrix (M) polypeptide M51R comprises the nucleotide sequence of SEQ ID NO: 6 or SEQ ID NO: 169, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 6 or SEQ ID NO: 169. In certain embodiments, the mutant VSV matrix (M) polypeptide M51R comprises the amino acid sequence of SEQ ID NO: 5. In certain embodiments, the nucleotide sequence that encodes the mutant VSV matrix (M) polypeptide M51R comprises the nucleotide sequence of SEQ ID NO: 6 or SEQ ID NO: 169.

[00453] In some embodiments, the VSV M polypeptide comprises the amino acid sequence of SEQ ID NO: 5, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 5.

[00454] In some embodiments, the mutant VSV matrix (M) polypeptide ΔM51 comprises the amino acid sequence of SEQ ID NO: 7, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 7. In certain embodiments, the nucleotide sequence that encodes the mutant VSV matrix (M) polypeptide ΔM51 comprises the nucleotide sequence that encodes the amino acid sequence of the amino acid sequence of SEQ ID NO: 7, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 7. In certain embodiments, the nucleotide sequence that encodes the mutant VSV matrix (M)

polypeptide ΔM51 comprises the nucleotide sequence of SEQ ID NO: 8, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 8. In certain embodiments, the mutant VSV matrix (M) polypeptide ΔM51 comprises the amino acid sequence of SEQ ID NO: 7. In certain embodiments, the nucleotide sequence that encodes the mutant VSV matrix (M) polypeptide ΔM51 comprises the nucleotide sequence of SEQ ID NO: 8.

[00455] In some embodiments, the VSV M polypeptide comprises the amino acid sequence of SEQ ID NO: 8, or an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 8.

[00456] In some embodiments, the VSV genome, provided herein that encodes a VSV N polypeptide, a VSV P polypeptide, a VSV M polypeptide, a VSV G polypeptide, and/or a VSV L polypeptide can be from a VSV Indiana strain as set forth in GenBank® Accession Nos. NC_001560 (GI No. 9627229) or can be from a VSV New Jersey strain.

[00457] In some embodiments, a VSV construct may comprise a hIL-12 gene inserted between a VSV M gene (e.g., a VSV M gene encoding a VSVΔM51 protein) and a VSV P gene to generate a VSV-P-hIL12p70-ΔM51 construct.

[00458] In some embodiments, a VSV-M51R-hIL12p70 construct described herein exhibits increased efficacy compared to a similar construct having IL-12 in a different position within the construct. In some embodiments, the VSV-M51R-hIL12p70 construct exhibits increased killing efficacy of cancer cells compared to the similar construct having IL-12 in a different position within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 100%, increased killing efficacy of cancer cells compared to the similar construct having IL-12 in a different position within the construct. In some embodiments, the VSV-M51R-hIL12p70 construct exhibits an enhanced replication rate compared to the similar construct having IL-12 in a different

position within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 100%, enhanced replication rate compared to the similar construct having IL-12 in a different position within the construct.

[00459] In some embodiments, the VSV-M51R-hIL12p70 construct exhibits decreased toxicity compared to the similar construct having IL-12 in a different position within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 100%, decreased toxicity compared to the similar construct having IL-12 in a different position within the construct.

[00460] In some embodiments, the VSV-M51R-hIL12p70 construct exhibits less IL-12 production compared to the similar construct having IL-12 in a different position within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, or at least about 50%, less IL-12 production compared to the similar construct having IL-12 in a different position within the construct. As a non-limiting example, the similar construct having IL-12 in a different position within the construct may have IL-12 positioned between a polynucleotide encoding a VSV P protein and VSV M protein. In some embodiments, the similar construct having IL-12 in a different position within the construct can comprise a polynucleotide encoding a mutant M protein comprising, for example, a deletion at methionine (M) 51 (ΔM51).

[00461] In some embodiments, high levels of IL-12 may be associated with, e.g., lymphopenia, which may be characterized by low white blood cell counts and/or low lymphocyte counts. In some embodiments, high levels of IL-12 may be associated with anemia, which may be characterized by low red blood cell counts and/or low hemoglobin..

[00462] In some embodiments, a VSV-M51R-hIL12p70 construct described herein exhibits increased efficacy compared to a similar construct having ΔM51 within the construct. In some embodiments, the VSV-M51R-hIL12p70 construct exhibits increased killing efficacy of cancer cells compared to the similar construct having ΔM51 within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 100%, increased killing efficacy of cancer cells compared to the similar construct having ΔM51 within the construct. In some embodiments, the VSV-M51R-hIL12p70 construct exhibits an enhanced replication rate compared to the similar construct having ΔM51 within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 100%, enhanced replication rate compared to the similar construct having ΔM51 within the construct.

[00463] In some embodiments, the VSV-M51R-hIL12p70 construct exhibits decreased toxicity compared to the similar construct having ΔM51 within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 100%, decreased toxicity compared to the similar construct having ΔM51 within the construct.

[00464] In some embodiments, the VSV-M51R-hIL12p70 construct exhibits less IL-12 production compared to the similar construct having ΔM51 within the construct. In certain embodiments, the VSV-M51R-hIL12p70 construct exhibits at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, or at least about 50%, less IL-12 production compared to

the similar construct having ΔM51 within the construct. In some embodiments, the similar construct having ΔM51 within the construct may have IL-12 positioned in a different position within the construct. In some embodiments, the similar construct having ΔM51 within the construct may have IL-12 positioned between a polynucleotide encoding a VSV P protein and VSV M protein.

[00465] Sequences disclosed herein with respect to recombinant rhabdoviruses, e.g., recombinant VSVs, disclosed herein, can be incorporated into a plasmid coding for a positive sense cDNA of the viral genome allowing generation of, for example, a negative sense genome of the recombinant rhabdoviruses, e.g., recombinant VSVs. Thus, a nucleic acid sequence that encodes a VSV polypeptide, for example, can refer to a nucleotide sequence, e.g., an RNA sequence, that is the template for the positive sense transcript that encodes (e.g., via direct translation) that polypeptide.

[00466] In certain aspects, the present disclosure provides a recombinant rhabdovirus comprising an RNA molecule. In some embodiments, the RNA molecule may comprise, or consist essentially of, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide, or a combination of F and H polypeptides of a paramyxovirus), or a functional fragment or derivative thereof, and/or a nucleotide sequence that is a template for a positive sense transcript encoding a VSV large protein (L) polypeptide (polymerase), or a functional fragment or derivative thereof, or any combination thereof. In some embodiments, the RNA molecule may comprise a nucleotide sequence that is a template for a positive sense transcript encoding a recombinant protein, e.g., a recombinant protein comprising an IL-12 polypeptide, or the functional fragment or derivative thereof. In various embodiments, the recombinant protein may comprise a transmembrane domain (e.g., a transmembrane domain derived from a B7.1 antigen) described herein. In various embodiments, the recombinant protein may comprise a signal peptide which may be operably linked to the IL-12 polypeptide. In some embodiments, the recombinant protein may further comprise one or more an additional polypeptide(s) such as, but not limited, to a cluster of differentiation 4 (CD4)

polypeptide, or a functional fragment or derivative thereof, a cluster of differentiation 46 (CD46) polypeptide, or a functional fragment or derivative thereof, a collagen-binding domain (CBD) derived from von Willebrand factor (VWF), or a functional fragment or derivative thereof, an IgG2a polypeptide, or a functional fragment or derivative thereof, an IgG1 polypeptide, or a functional fragment or derivative thereof, and/or an IgG4 polypeptide, or a functional fragment or derivative thereof. In some embodiments, the recombinant protein can be membrane bound. In some embodiments, the recombinant protein may not comprise a transmembrane domain and is not membrane bound. When the recombinant protein is not membrane bound, the recombinant protein may be a soluble and/or secreted protein.

[00467] In various embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned in one of the following positions: between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or a functional fragment or derivative thereof; at the 5' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof; at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof; between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof; or between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[00468] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or the functional fragment or derivative thereof, and the nucleotide

sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or a functional fragment or derivative thereof.

[00469] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 5' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[00470] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof.

[00471] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof.

[00472] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[00473] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence: a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript

encoding VSV L polypeptide, or a functional fragment or derivative thereof; a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein; the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof; a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof; or a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide

sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00474] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, a nucleotide sequence that is the template for a positive sense transcript encoding the recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[00475] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein.

[00476] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is the template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00477] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00478] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a

positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide (e.g., a VSV glycoprotein (G) polypeptide), or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00479] In certain embodiments, recombinant viruses (e.g., recombinant VSVs) of the present disclosure may provide one or more of any viral genes described herein (e.g., genes encoding a VSV N polypeptide, a VSV P polypeptide, a VSV M polypeptide, a VSV G polypeptide, and/or a VSV L polypeptide, or functional fragments or derivatives thereof), and/or one or more of any nucleotides described herein (e.g., nucleotides encoding recombinant proteins comprising an IL-12 polypeptide, or a functional fragments or derivatives thereof, or additional polypeptides) in *trans*, and thus the one or more viral genes and/or nucleotides may be provided in a separate virus from any of the other viral genes and/or nucleotides.

[00480] Any appropriate method may be used to insert a nucleic acid disclosed herein (e.g., nucleotide sequence that is a template for a positive sense transcript encoding a polypeptide such as, but not limited to, a virus polypeptide, and/or a nucleotide sequence that is a template for a positive sense transcript encoding a virus polypeptide) into the genome of a recombinant virus of the present disclosure. For example, any of various nucleic acid generation and/or amplification techniques via, e.g., polymerase chain reaction (PCR) and the like, including from a plasmid, gene excision, reverse genetics, cloning, and/or subcloning steps, virus preparation, growth, propagation, and/or recovery, and/or cell culture approaches comprising, e.g., infection, transduction and/or transfection, or combinations thereof, may be used to insert nucleic acid into the genome of a recombinant virus. Any appropriate method may be used to identify recombinant virus-containing a nucleic acid molecule disclosed herein. Non-limiting examples of such methods include and nucleic acid hybridization techniques including Northern and Southern analysis, and polymerase chain reaction (PCR). In some embodiments, biochemical techniques and/or immunohistochemistry may be used to determine if a recombinant virus contains a specific nucleic acid molecule by detecting the expression of a polypeptide encoded by that specific nucleic acid molecule.

[00481] In some embodiments, upon infection of a cell with a recombinant virus, e.g., a recombinant rhabdovirus, described herein, the cell can express a recombinant protein comprising

the IL-12 polypeptide, or a functional fragment or derivative thereof, described herein. The cell can be a cancer cell (e.g., a tumor cell). The cancer cell can be a human cell.

Fusogenic Molecules

[00482] In some embodiments, the recombinant virus disclosed herein may comprise a rhabdovirus genome, e.g., a vesiculovirus genome such as, but not limited to, a VSV genome, which may comprise fusogenic molecule, or fusogen, e.g., a fusogenic polypeptide. A "fusogen" or "fusogenic molecule" may refer to any molecule that can trigger membrane fusion when present on the surface of a virus. In some embodiments, a fusogen may act on the cell membrane to prevent spontaneous membrane fusion and promote fusion that may occur in a controlled and/or regulated manner. Upon activation, a fusogen may extend trimers anchored at one end by their transmembrane domains and expose an amphiphilic loop or hydrophobic fusion peptide that inserts into the target membrane. At this time, the two interacting domains are positioned in different membranes. Regulated refolding of the fusogenic complex into a hairpin-like structure then brings the fusion peptide and transmembrane domains to the same end of the molecule, which generates a pulling force that brings the two membranes into close (approximately 1 nm) apposition. The accumulated energy from this event is thought to drive fusion through the formation of a hemifusion stalk-like connection, where only the contacting proximal leaflets of the membranes are fused while the inner leaflets remain intact. Expansion of the hemifusion stalk, and the subsequent fusion of the distal leaflets, completes the reaction by opening a fusion pore that permits the contents of the two compartments to mix. Fusion pore expansion is considered a final energy barrier before membrane fusion becomes permanent. Without wishing to be bound by theory, there is evidence that viral fusogens mediate fusion via hemifusion. Many different protein and non-protein fusogenic molecules may be used herein. In some embodiments, the fusogenic molecule is a fusogenic protein or polypeptide.

[00483] In some embodiments, the fusogenic molecule is a viral fusogenic molecule. Non-limiting examples of viral fusogenic molecules include, e.g., vesiculovirus fusogens (e.g., vesicular stomatitis virus G glycoprotein, alphavirus fusogens (e.g., a Sindbis virus glycoprotein), orthomyxovirus fusogens (e.g., influenza HA protein), paramyxovirus fusogens (e.g., a Nipah virus F protein or a measles virus F protein), as well as fusogens from Dengue virus (DV), Lassa fever virus, tick-borne encephalitis virus, Dengue virus, Hepatitis B virus, Rabies virus, Semliki

Forest virus, Ross River virus, Aura virus, Borna disease virus, Hantaan virus, SARS-CoV virus, and various fragments, mutants, and derivatives thereof.

[00484] In some embodiments, the fusogenic molecule is heterologous to the virus from which the virus is derived. In some embodiments, the fusogenic molecule is a mutated protein which does not bind the fusogenic molecule's natural ligand(s).

[00485] The recombinant virus disclosed herein may comprise multiple copies of the fusogenic polypeptide-encoding gene, preferably 1 or 2 copies. The virus may comprise two or more different fusogenic polypeptides, including, without limitation, any of the fusogenic polypeptides listed above. The fusogenic polypeptide or polypeptides expressed by a virus disclosed herein may be identical to a naturally occurring polypeptide, or may be a modified polypeptide. The fusogenic polypeptide-encoding gene (fusogenic gene) may have a naturally occurring nucleic acid sequence or a modified sequence. The sequence of the fusogenic gene may, for example, be modified to increase the fusogenic properties of the encoded polypeptide, or to provide codon optimization, and therefore increase the efficiency of expression of the encoded polypeptide.

[00486] In some embodiments, mutant fusogens are used which maintain their fusogenic ability but have a decreased or eliminated binding ability or specificity. Functional properties of mutant fusogens can be tested, e.g., in cell culture or by determining their ability to stimulate an immune response without causing undesired side effects *in vivo*.

[00487] To select the most effective and non-toxic combinations of fusogens (either wild-type or mutant), viruses bearing such molecules can be tested for selectivity and/or ability to facilitate penetration of the target cell membrane. Viruses that display wild-type fusogens can be used as controls for examining titer effects in mutants. For example, cells can be transduced by the viruses using a standard infection assay. After a specified time, for example, 48 hours post-transduction, cells can be collected and the percentage of transduced cells can be determined by, for example, monitoring reporter gene expression (e.g., using FACS analysis). The selectivity can be scored by calculating the percentage of cells infected by the viruses. Similarly, the effect of mutations on viral titer can be quantified by dividing the percentage of cells infected by viruses comprising a mutant targeting molecule by the percentage of cells infected by virus comprising the corresponding wild type targeting molecule. The titers of viruses can be determined, e.g., by limited dilution of the stock solution and transduction of cells expressing a polypeptide of interest.

[00488] To investigate whether fusogen-mediated cell penetration is dependent upon pH, and to select fusogens with the desired pH dependence, NH_4Cl or another compound that alters pH can be added at the infection step (NH_4Cl will neutralize the acidic compartments of endosomes). In the case of NH_4Cl, the disappearance of cells expressing the reporter will indicate that penetration of viruses is acidic pH-dependent. In addition, to confirm that the activity is pH-dependent, lysosomotropic agents, such as ammonium chloride, chloroquine, concanamycin, bafilomycin Al, monensin, nigericin, etc., may be added into the incubation buffer. These agents can elevate the pH within the endosomal compartments. The inhibitory effect of these agents can reveal the role of pH for viral fusion and entry. The different entry kinetics between viruses displaying different fusogenic molecules may be compared and the most suitable selected for a particular application.

[00489] PCR-based viral entry assays may be utilized to measure kinetics of viral DNA synthesis as an indication of the kinetics of viral entry. For example, viruses comprising a particular TCR-binding molecule and fusogen can be incubated with target cells, unbound viruses can be then removed, and aliquots of the cells can be analyzed by extracting DNA and performing semi-quantitative PCR. The appearance of virus-specific DNA products will indicate the success of viral entry and uncoating.

[00490] The fusogen preferably exhibits fast enough kinetics such that the virus contents can empty into the cytosol before the degradation of the virus. In addition, the fusogen can be modified to reduce or eliminate any binding activity and thus reduce or eliminate any non-specific binding.

Recombinant Proteins

[00491] In various aspects, a recombinant virus, e.g., a recombinant rhabdovirus, of the present disclosure, comprises a nucleotide sequence encoding a recombinant protein. In some embodiments, the recombinant protein comprises an interleukin-12 (IL-12) polypeptide, or a functional fragment or derivative thereof. In some embodiments, the recombinant protein comprises an IL-12 polypeptide and a transmembrane domain. In some embodiments, the recombinant protein does not comprise a transmembrane domain. In some embodiments, the recombinant protein is membrane bound. In some embodiments, the recombinant protein is not membrane bound. When the recombinant protein is not membrane bound, the recombinant protein may be a soluble and/or secreted protein.

[00492] In some embodiments, the nucleotide sequence encoding the recombinant protein described herein is a template for a positive sense transcript encoding the recombinant protein.

[00493] In some embodiments, the nucleotide sequence encoding the IL-12 polypeptide, or a functional fragment or derivative thereof is a template for a positive sense transcript encoding the IL-12 polypeptide, or the functional fragment or derivative thereof.

[00494] In some embodiments, when the recombinant virus infects a cell, e.g., a host cell such as, but not limited to, a mammalian host cell, the cell expresses the IL-12 polypeptide, or functional fragment or derivative thereof. In some embodiments, the cell may be a human cell. In some embodiments, the cell may be a cancer cell, e.g., a tumor cell.

IL-12 Polypeptides

[00495] Interleukin-12 (IL-12) is a heterodimeric molecule composed of an alpha chain (the p35 subunit) and a beta chain (the p40 subunit) which are covalently linked via a disulfide bridge to form a biologically active 70 kDa dimer. Without wishing to be bound by theory, IL-12 is an inflammatory cytokine that may be produced, for example, in response to infection by various immune cells including, but not limited to, B cells, phagocytic cells, and dendritic cells. IL-12 plays a key role in modulating the interaction between the adaptive and innate divisions of the immune system. As an example, IL-12 has been shown to act on T-cells and natural killer (NK) cells, enhance proliferation and activity of cytotoxic lymphocytes, as well as participate in the production of other inflammatory cytokines, in particular, IFNγ. IL-12 has been tested in human clinical trials as an immunotherapeutic agent for the treatment of a number of cancers such as, but not limited to, ovarian cancer, colon cancer, renal cancer, melanoma, and T-cell lymphoma. Further, IL-12 has been tested as an adjuvant for cancer vaccines. IL-12 gene therapy approaches may allow cytokine production at the tumor site to achieve high local levels of IL-12 with low serum concentration, thereby maximizing the anti-tumoral effect of IL-12 while minimizing the systemic toxicity of IL-12.

[00496] A polypeptide (also referred to as a protein, or peptide herein) of the present disclosure (e.g., an IL-12 polypeptide) may include polymeric forms of amino acids of any length, including coded and non-coded amino acids and chemically or biochemically modified or derivatized amino acids. A polypeptide may also include polymers that have been modified, such as polypeptides having modified peptide backbones. A polypeptide typically has an N-terminus and a C-terminus. The N-terminus is the start of an amino acid chain of a protein, terminated by an amino acid with a free amine group (-NH2). The C-terminus is the end of an amino acid chain of a protein, terminated by a free carboxyl group (-COOH).

[00497] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, described herein may function as an immune stimulatory molecule.

[00498] In some embodiments, the IL-12 polypeptide of the present disclosure, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof. In some embodiments, the IL-12 polypeptide, or functional fragment of derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof. In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00499] In some embodiments, the IL-12 polypeptide, or functional fragment or derivative thereof, may be derived from a rodent, e.g., a mouse. In some embodiments, the IL-12 polypeptide, or functional fragment or derivative thereof, may be derived from a human. In some embodiments, the IL-12 p40 subunit, or functional fragment or derivative thereof, may be derived from a rodent, e.g., a mouse. In some embodiments, the IL-12 p40 subunit, or functional fragment or derivative thereof, may be derived from a human. In some embodiments, the IL-12 p35 subunit, or functional fragment or derivative thereof, may be derived from a rodent, e.g., a mouse. In some embodiments, the IL-12 p35 subunit, or functional fragment or derivative thereof, may be derived from a human.

[00500] In some embodiments, the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 69, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 69. In certain embodiments, the nucleotide sequence that encodes IL-12 p40 subunit protein comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 69, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 69. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit protein comprises the nucleotide sequence of SEQ ID NO: 70, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about

70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 70. In certain embodiments, the IL-12 p40 subunit protein comprises the amino acid sequence of SEQ ID NO: 69. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit protein comprises the nucleotide sequence of SEQ ID NO: 70.

[00501] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 69. In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof comprises the amino acid sequence of SEQ ID NO: 69. In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[00502] In some embodiments, the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 61, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 61. In certain embodiments, the nucleotide sequence that encodes IL-12 p40 subunit protein comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 61, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 61. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit protein comprises the nucleotide sequence of SEQ ID NO: 62, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 62. In certain embodiments, the IL-12 p40 subunit protein

comprises the amino acid sequence of SEQ ID NO: 61. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit protein comprises the nucleotide sequence of SEQ ID NO: 62.

[00503] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 61. In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61. In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[00504] In some embodiments, the IL-12 p40 subunit, or functional fragment or derivative thereof, may comprise one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence, e.g., as compared to an amino acid sequence of a reference IL-12 p40 subunit. For example, the IL-12 p40 subunit may include a substitution(s) of one or more amino acids in the amino acid sequence of a parent IL-12 p40 subunit with a similar or homologous amino acid(s) or a dissimilar amino acid(s).

[00505] In some embodiments, the amino acid positions of one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence of an IL-12 p40 subunit, or a functional fragment or derivative thereof described herein, may be described in reference to the amino acid positions of an IL-12 p40 subunit reference sequence. In some embodiments, the IL-12 p40 subunit reference sequence may comprise a precursor form of an IL-12 p40 subunit described herein (i.e., an IL-12 p40 subunit precursor form). In some embodiments, the precursor form of the IL-12 p40 subunit may comprise a signal peptide described herein such as, but not limited to, the amino acid sequence MCPQKLTISWFAIVLLVSPLMA (SEQ ID NO: 31), or a fragment or derivative thereof. In some embodiments, the precursor form of the IL-12 p40 subunit may comprise a signal peptide described herein such as, but not limited to, the amino acid sequence MCHQQLVISWFSLVFLASPLVA (SEQ ID NO: 65), or a fragment or derivative thereof.

[00506] In some embodiments, the IL-12 p40 subunit reference sequence can comprise a precursor form of an IL-12 p40 subunit disclosed herein, for example, the sequence of SEQ ID NO: 27. In some embodiments, the amino acid positions of the one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence

of the IL-12 p40 subunit, or functional fragment or derivative thereof, may be described in reference to the amino acid positions in the amino acid sequence of SEQ ID NO: 27.

[00507] In some embodiments, the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 27, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 27. In certain embodiments, the nucleotide sequence that encodes IL-12 p40 subunit comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 27, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 27. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit comprises the nucleotide sequence of SEQ ID NO: 28, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 28. In certain embodiments, the IL-12 p40 comprises the amino acid sequence of SEQ ID NO: 27. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit comprises the nucleotide sequence of SEQ ID NO: 28.

[00508] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 27. In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof comprises the amino acid sequence of SEQ ID NO: 27. In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 27.

[00509] In some embodiments, the IL-12 p40 subunit reference sequence can comprise a precursor form of an IL-12 p40 subunit disclosed herein, for example, the sequence of SEQ ID NO: 12. In some embodiments, the amino acid positions of the one or more amino acid

substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence of the IL-12 p40 subunit, or functional fragment or derivative thereof, may be described in reference to the amino acid positions in the amino acid sequence of SEQ ID NO: 12.

[00510] In some embodiments, the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 12, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 12. In certain embodiments, the nucleotide sequence that encodes IL-12 p40 subunit comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 12, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 12. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit comprises the nucleotide sequence of SEQ ID NO: 13 or 14, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 13 or 14. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit comprises the nucleotide sequence of SEQ ID NO: 156 or 178, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 156 or 178. In certain embodiments, the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 12. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit comprises the

nucleotide sequence of SEQ ID NO: 13 or 14. In certain embodiments, the nucleotide sequence that encodes the IL-12 p40 subunit comprises the nucleotide sequence of SEQ ID NO: 156 or 178.

[00511] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 12. In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof comprises the amino acid sequence of SEQ ID NO: 12. In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 12.

[00512] In some embodiments, an IL-12 p40 subunit reference sequence may comprise a mature form of an IL-12 p40 subunit described herein (i.e., an IL-12 p40 subunit mature form). In some embodiments, the sequence of the mature form of the IL-12 p40 subunit may be shorter in length than the sequence of the precursor form of the IL-12 p40 subunit described herein owing, at least in part, to the absence of a signal peptide from the mature form which may be present in the precursor form. In some embodiments, the IL-12 p40 subunit reference sequence can comprise a mature form an IL-12 p40 subunit, for example, the sequence of SEQ ID NO: 69. In some embodiments, the amino acid positions of the one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence of the IL-12 p40 subunit, or functional fragment or derivative thereof, may be described in reference to the amino acid positions in the amino acid sequence of SEQ ID NO: 69. In some embodiments, the IL-12 p40 subunit reference sequence can comprise a mature form an IL-12 p40 subunit, for example, the sequence of SEQ ID NO: 61. In some embodiments, the amino acid positions of the one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence of the IL-12 p40 subunit, or functional fragment or derivative thereof, may be described in reference to the amino acid positions in the amino acid sequence of SEQ ID NO: 61.

[00513] In some embodiments, the IL-12 p40 subunit of the present disclosure may include any amino acid sequence having an identity of at least about 60% or more, about 70% or more, 71% or more, 72% or more, 73% or more, 74% or more, 75% or more, 76% or more, 77% or more, 78% or more, 79% or more, 80% or more, 81% or more, 82% or more, 83% or more, 84% or more, 85% or more, 86% or more, 87% or more, 88% or more, 89% or more, 90% or more, 91% or more, 92% or more, 93% or more, 94% or more, 95% or more, 96% or more, 97% or more, 98% or more, 99% or more, 99.1% or more, 99.2% or more, 99.3% or more, 99.4% or more, 99.5% or more,

99.6% or more, 99.7% or more, 99.8% or more, or 99.9% or more to its natural amino acid sequence or parental sequence, and having the activity of normally-occurring (i.e., natural) sequence or parental sequence.

[00514] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof comprises amino acid change(s) in one or more positions. Non-limiting examples of amino acid changes comprise amino acid substitutions and/or insertions and/or deletions. In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof comprises amino acid substitution(s) in one or more positions. As a non-limiting example, the IL-12 p40 subunit, or the functional fragment or derivative thereof may comprise amino acid substitution(s) in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, or 100 or more positions.

[00515] In some embodiments, the IL-12 p40 subunit described herein may comprise one or more amino acid substitutions and/or insertions and/or deletions. Amino acid substitution means that an amino acid residue is substituted for a replacement amino acid residue at the same position. Inserted amino acid residues may be inserted at any position and may be inserted such that some or all of the inserted amino acid residues are immediately adjacent one another or may be inserted such that none of the inserted amino acid residues is immediately adjacent another inserted amino acid residue. In various embodiments, one or more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 27. In various embodiments, one or more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 69. In various embodiments, one or more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 12. In various embodiments, one or more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 61.

[00516] A person with ordinary skill of the art will be able to identify the one or more amino acid changes (e.g., amino acid substitutions and/or insertions and/or deletions) in an IL-12 p40 subunit precursor form sequence described herein (e.g., SEQ ID NO: 12 or 27) within a shorter IL-12 p40 subunit mature form sequence described herein (e.g., SEQ ID NO: 61 or 69) which lacks a signal peptide (e.g., SEQ ID NO: 31 or 65). Any of the amino acid change(s) described in reference to an IL-12 p40 polypeptide comprising an IL-12 p40 subunit mature form sequence described herein

(e.g., SEQ ID NO: 69 or 61) may be applied to an IL-12 p40 polypeptide comprising a precursor form sequence of an IL-12 p40 subunit described herein (e.g., SEQ ID NO: 12 or 27), or vice versa.

[00517] A person with ordinary skill of the art will further be able to identify the one or more amino acid changes (e.g., amino acid substitutions and/or insertions and/or deletions) in an IL-12 p40 mature or precursor form sequence derived from a human described herein (e.g., SEQ ID NO: 61 or 12, respectively) within an IL-12 p40 mature or precursor form sequence derived from a mouse described herein (e.g., SEQ ID NO: 69 or 27, respectively). Any of the amino acid change(s) described in reference to an IL-12 p40 polypeptide comprising a mature or precursor form sequence of an IL-12 p40 subunit derived from a human (e.g., SEQ ID NO: 61 or 12, respectively), may also be applied to an IL-12 p40 polypeptide comprising a mature or precursor form sequence of an IL-12 p40 subunit derived from a mouse (e.g., SEQ ID NO: 69 or 27, respectively), or vice versa.

[00518] In some embodiments, the IL-12 p40 subunit may comprise a substitution at any amino acid contained therein. In some embodiments, the IL-12 p40 subunit may comprise an insertion at any amino acid contained therein. In some embodiments, the IL-12 p40 subunit may comprise a deletion at any amino acid contained therein.

[00519] In certain embodiments, amino acid changes (e.g., substitutions) to a protein or portion thereof are those which: (1) reduce susceptibility to proteolysis, (2) reduce susceptibility to oxidation, (3) alter binding affinity for forming protein complexes, or (4) confer or modify other physicochemical or functional properties. For example, single or multiple amino acid substitutions (preferably conservative amino acid substitutions) may be made in the normally-occurring (i.e., natural) sequence or parental sequence. In some embodiments, the amino acid sequence of the IL-12 p40 subunit disclosed herein may be changed, for example, to increase activity and/or reduce toxicity of the IL-12 polypeptide disclosed herein. In some embodiments, the amino acid sequence of IL-12 p40 subunit disclosed herein may be changed such that the activity of the IL-12 polypeptide is attenuated, for example, for intravenous (IV) delivery.

[00520] By way of a non-limiting example, for the activity of the IL-12 p40 subunit before the substitution, insertion, and/or deletion described herein, the activity of the IL-12 p40 subunit protein or amino acid sequence after the substitution, insertion, and/or deletion is increased by more than 2%, more than 5%, more than 10%, more than 20%, more than 40%, more than 60%,

more than 80%, more than 90%, more than 95%, more than 96%, more than 97%, more than 98%, more than 99%, or 100% or more as compared to the activity before the substitution, deletion, insertion or addition. By way of another non-limiting example, for the toxicity of the IL-12 p40 subunit before the substitution, insertion, and/or deletion described herein, the toxicity of the IL-12 p40 subunit protein or amino acid sequence after the substitution, insertion, and/or deletion is reduced by more than 2%, more than 5%, more than 10%, more than 20%, more than 40%, more than 60%, more than 80%, more than 90%, more than 95%, more than 96%, more than 97%, more than 98%, more than 99%, or 100% or more as compared to the toxicity before the substitution, deletion, insertion and/or addition.

[00521] In some embodiments, the amino acid sequence of the IL-12 p40 subunit may be modified to comprise one or more amino acid changes (e.g., substitutions), that may decrease susceptibility of the polypeptide to proteolysis and/or increase IL-12 biological half-life. In some embodiments, the amino acid sequence of the IL-12 p40 subunit may be modified to comprise one or more amino acid changes (e.g., substitutions), that may decrease susceptibility of the polypeptide to proteolysis and/or reduce IL-12 biological half-life.

[00522] In some embodiments, the IL-12 p40 subunit disclosed herein may also include conservative modifications and/or substitutions at other positions of IL-12 p40. A conservative amino acid substitution should not substantially change the structural characteristics of the parent sequence. For example, amino acids belonging to one of the following groups represent conservative changes: Group I: Ala, Pro, Gly, Gln, Asn, Ser, Thr; Group II: Cys, Ser, Tyr, Thr; Group III: Val, Ile, Leu, Met, Ala, Phe; Group IV: Lys, Arg, His; Group V: Phe, Tyr, Trp, His; and Group VI: Asp, Glu.

[00523] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof may comprise one or more amino acid substitutions at a position corresponding to an amino acid residue including, for example, without limitation positions 37, 39, 40, 41, 80, 81, 82, 106, 108, 115, 216, 217, 218, and 219 in the amino acid sequence of SEQ ID NO: 12. As a non-limiting example, the amino acid substitutions(s) may comprise an alanine (A) substitution, an arginine I substitution, an asparagine (N) substitution, an aspartic acid (D) substitution, a leucine (L) substitution, a lysine (K) substitution, a phenylalanine (F) substitution, a glutamine (Q) substitution, a glutamic acid I substitution, a serine (S) substitution, and a threonine (T) substitution, or any combination thereof.

[00524] In some embodiments, the one or more amino acid substitution is at a position corresponding to an amino acid residue selected from W37, P39, D40, A41, K80, E81, F82, K106, E108, D115, H216, K217, L218, and K219 in the amino acid sequence of SEQ ID NO: 12.

[00525] In some embodiments, the amino acid sequence of the IL-12 p40 subunit disclosed herein may further include one or more amino acid substitutions at a position corresponding to an amino acid residue selected from E81, F82, K106, K217, and K219 in the amino acid sequence of SEQ ID NO: 12. In some embodiments, the amino acid sequence of the IL-12 p40 subunit disclosed herein may further include includes amino acid substitutions at positions corresponding to amino acid residues W37, P39, D40, E81, F82 in the amino acid sequence of SEQ ID NO: 12, or a combination thereof. In some embodiments, the amino acid sequence includes an amino acid substitution corresponding to amino acid residue E81, F82, K106, K217, and K219 in the amino acid sequence of SEQ ID NO: 12.

[00526] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 12, and further include an amino acid substitutions corresponding to the following amino acid substitutions: W37A, P39A, D40A, E81A, F82A, K106, D109A, K217A, E219A, E81A/F82A, W37A/E81A/F82A, E81A/F82A/K106A, E81A/F82A/K106A/K217A, E81F/F82A, E81K/F82A, E81L/F82A, E81H/F82A, E81S/F82A, E81A/F82A/K106N, E81A/F82A/K106Q, E81A/F82A/K106T, E81A/F82A/K106R, and/or P39A/D40A/E81A/F82A.

[00527] In some embodiments, the amino acid substitution(s) in the amino acid sequence of the IL-12 p40 subunit disclosed herein may comprise, for example, an alanine (A) substitution, an arginine I substitution, an asparagine (N) substitution, an aspartic acid (D) substitution, a leucine (L) substitution, a lysine (K) substitution, a phenylalanine (F) substitution, a glutamine (Q) substitution, a glutamic acid I substitution, a serine (S) substitution, and a threonine (T) substitution, or combinations of any thereof. Non-limiting examples of the amino acid substitutions in the recombinant IL-12 p40 polypeptides disclosed herein are provided in **Table 2** below.

Table 2. Example amino acid substitutions in the IL-12 p40 subunit

Position in the amino acid sequence of SEQ ID NO: 12	Original amino acid	Example substitute amino acid

37	W	A, D, K, V, I, L, M, G, S, T
39	P	A, V, I, L, M, G, S, T
40	D	A, V, I, L, M, G, S, T, R, H, K
80	K	A, V, I, L, M, G, S, T, D, E
81	E	A, V I, L, M G, S, T, R, H, K
82	F	A, V, I, L, M, G, S, T
106	K	A, V, I, L, M, G, S, T, D, E
108	E	A, V, I, L, M, G, S, T, R, H, K
109	D	A, V, I, L, M, G, S, T, R, H, K
115	D	A V I, L, M G, S, T, R, H, K
216	H	A V I, L, M G, S, T, D, E
217	K	A V I, L, M G, S, T, D, E
218	L	A, V, I, M, G, S, T, D ,E
219	K	A V, I, L, M G, S, T, D, E

[00528] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof comprises amino acid change(s), e.g., substitution(s) in one or more positions selected from E81, F82, K106, and K217 of the amino acid sequence of SEQ ID NO: 27 or 12. In some embodiments, the amino acid substitution(s) in the amino acid sequence of the IL-12 p40 subunit disclosed herein comprises one or more alanine (A) substitutions. In some embodiments, the alanine (A) substitution comprises E81A, F82A, K106A, or K217A, or a combination thereof. In some embodiments, the alanine substitutions comprise E81A/F82A (2xA). In some embodiments, the alanine substitutions comprise E81A/F82A/K106A (3xA). In some embodiments, the alanine substitutions comprise E81A/F82A/K106A/K217A (4xA).

[00529] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof may comprise one or more amino acid substitutions at a position corresponding to an amino acid residue including, for example, without limitation E3, D7, E12, D14, W15, P17, D18, A19, P20, G21, E22, M23, D29, E32, E33, D34, L40, D41, Q42, S43, E45, L47, T54, I55, Q56, K58, E59, F60, G61, D62, Q65, Y66, E73, K84, E86, D87, G88, 189, W90, D93, D97, K99, E100, K102, N103, K104, F106, E110, N113, Y114, D129, D142, Q144, E156, R159, D161, N162, K163, D166, D170, Q172, D174, A176, C177, P178, A179, A180, E181, S183, P185, E187, N200, S204, F206, R208, D209, D214, N218, Q220, N226, Q229, E231, E235, T242, P243, S245, Y246, F247, S248, C252, Q256, K258, K260, E262, K264, D265, D270, N281, Q289, D290, R291, Y292, Y293, and E299 in the amino acid sequence of SEQ ID NO: 61. As a non-limiting example, the amino acid substitutions(s) may comprise an alanine (A) substitution, an arginine I substitution,

an asparagine (N) substitution, an aspartic acid (D) substitution, a leucine (L) substitution, a lysine (K) substitution, a phenylalanine (F) substitution, a glutamine (Q) substitution, a glutamic acid I substitution, a serine (S) substitution, and a threonine (T) substitution, or any combination thereof.

[00530] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 61, and further include an amino acid substitutions corresponding to the following amino acid substitutions: D18N, D18K, E32Q, E33Q, D34N, D34K, Q42E, S43E, S43K, E45Q, Q56E, E59Q, E59K, D62N, E73Q, D87N, K99E, K99Y, E100Q, N103D, N103Q, N113D, N113Q, Q144E, D161N, R159E, K163E, E187Q, N200D, N200Q, N218Q, Q229E, E235Q, C252S, Q256N, K258E, K260E, E262Q, K264E, N281D, N281Q, and/or E299Q with respect to the amino acid sequence of SEQ ID NO: 61.

[00531] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 61, and further include an amino acid substitutions corresponding to the following amino acid substitutions: D18N, D18K, E32Q, E33Q, D34N, D34K, Q42E, S43E, S43K, E45Q, Q56E, E59Q, E59K, D62N, E73Q, D87N, K99E, K99Y, E100Q, N103D, N103Q, N113D, N113Q, Q144E, D161N, R159E, K163E, E187Q, N200D, N200Q, N218Q, Q229E, E235Q, C252S, Q256N, K258E, K260E, E262Q, K264E, N281D, N281Q, and/or E299Q with respect to the amino acid sequence of SEQ ID NO: 61.

[00532] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 61, and further include an amino acid substitutions corresponding to the following amino acid substitutions: N103D/N113D/N200D/N281D, Q42E/E45Q, E45Q/Q56E, Q42E/E59Q, Q56E/E59Q, Q42E/E45Q/Q56E, E45Q/Q56E/E59Q, E32Q/E59Q, D34N/E59K, D34N/E59K/K99E, D34K/E59K/K99E, E32Q/D34N/E59K/K99E, E32K/D34N/E59K/K99E, D34N/E59Q, E59Q/E187Q, S43E/E59Q, S43K/E49Q, E59Q/K163E, E59Q/K99E, E59Q/K258E, E59Q/K260E, E59K/K99E, D18K/E59K/K99E, E59K/K99E/K264E, E59K/K99Y, E59Y/K99Y, E59Y/K99E, E45K/E59K/K99E, E59K/K99E/Q144E, E59K/K99E/Q144K, E59K/K99E/R159E,

E59K/K99E/K264E, D18K/E59K/K99E/K264E, D18K/E59K/K99E/C252S, D18K/E59K/K99E/C252S/K264E, E59K/K99Y/C252S, E59K/K99E/C252S/K264E, E59K/K99E/C252S, N103D/N113D, N103D/N200D, N103D/N281D, N113D/N200D, N113D/N281D, N200D/N281D, N103D/N113D/N200D, N103D/N113D/N281D, N103D/N200D/N281D, N113D/N200D/N281D, N103Q/N113Q, N103Q/N200Q, N103Q/N281Q, N113Q/N200Q, N113Q/N281Q, N200Q/N281Q, N103Q/N113Q/N200Q, N103Q/N113Q/N281Q, N103Q/N200Q/N281Q, N113Q/N200Q/N281Q, N103Q/N113Q/N200Q/N281Q, E59K/K99E/N103Q/C252S/K264E, E59K/K99E/N113Q/C252S/K264E, E59K/K99E/N200Q/C252S/K264E, E59K/K99E/N281Q/C252S/K264E, E59K/K99E/N103Q/N113Q/C252S/K264E, E59K/K99E/N103Q/N200Q/C252S/K264E, E59K/K99E/N103Q/N281Q/C252S/K264E, E59K/K99E/N113Q/N200Q/C252S/K264E, E59K/K99E/N113Q/N281Q/C252S/K264E, E59K/K99E/N200Q/N281Q/C252S/K264E, E59K/K99E/N103Q/N113Q/N200Q/C252S/K264E, E59K/K99E/N103Q/N200Q/N281Q/C252S/K264E, E59K/K99E/N113Q/N281Q/C252S/K264E, and/or E59K/K99E/N103Q/N113Q/N200Q/N281Q/C252S/K264E with respect to the amino acid sequence of SEQ ID NO: 61.

[00533] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 61, and further include an amino acid substitutions corresponding to the following amino acid substitutions: N103D/N113D/N200D/N281D, Q42E/E45Q, E45Q/Q56E, Q42E/E59Q, Q56E/E59Q, Q42E/E45Q/Q56E, E45Q/Q56E/E59Q, E32Q/E59Q, D34N/E59K, D34N/E59K/K99E, D34K/E59K/K99E, E32Q/D34N/E59K/K99E, E32K/D34N/E59K/K99E, D34N/E59Q, E59Q/E187Q, S43E/E59Q, S43K/E49Q, E59Q/K163E, E59Q/K99E, E59Q/K258E, E59Q/K260E, E59K/K99E, D18K/E59K/K99E, E59K/K99E/K264E, E59K/K99Y, E59Y/K99Y, E59Y/K99E, E45K/E59K/K99E, E59K/K99E/Q144E, E59K/K99E/Q144K, E59K/K99E/R159E, E59K/K99E/K264E, D18K/E59K/K99E/K264E, D18K/E59K/K99E/C252S, D18K/E59K/K99E/C252S/K264E, E59K/K99Y/C252S, E59K/K99E/C252S/K264E, E59K/K99E/C252S, N103D/N113D, N103D/N200D, N103D/N281D, N113D/N200D, N113D/N281D, N200D/N281D, N103D/N113D/N200D, N103D/N113D/N281D, N103D/N200D/N281D, N113D/N200D/N281D, N103Q/N113Q, N103Q/N200Q,

N103Q/N281Q, N113Q/N200Q, N113Q/N281Q, N200Q/N281Q, N103Q/N113Q/N200Q, N103Q/N113Q/N281Q, N103Q/N200Q/N281Q, N113Q/N200Q/N281Q, N103Q/N113Q/N200Q/N281Q, E59K/K99E/N103Q/C252S/K264E, E59K/K99E/N113Q/C252S/K264E, E59K/K99E/N200Q/C252S/K264E, E59K/K99E/N281Q/C252S/K264E, E59K/K99E/N103Q/N113Q/C252S/K264E, E59K/K99E/N103Q/N200Q/C252S/K264E, E59K/K99E/N103Q/N281Q/C252S/K264E, E59K/K99E/N113Q/N200Q/C252S/K264E, E59K/K99E/N113Q/N281Q/C252S/K264E, E59K/K99E/N200Q/N281Q/C252S/K264E, E59K/K99E/N103Q/N113Q/N200Q/C252S/K264E, E59K/K99E/N103Q/N200Q/N281Q/C252S/K264E, E59K/K99E/N113Q/N281Q/C252S/K264E, and/or E59K/K99E/N103Q/N113Q/N200Q/N281Q/C252S/K264E with respect to the amino acid sequence of SEQ ID NO: 61.

[00534] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, of the present disclosure further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof. In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, of the present disclosure comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00535] In some embodiments, the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 71, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 71. In certain embodiments, the nucleotide sequence that encodes IL-12 p35 subunit protein comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 71, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 71. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 72, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about

70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 72. In certain embodiments, the IL-12 p35 subunit protein comprises the amino acid sequence of SEQ ID NO: 71. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 72.

[00536] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 71. In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71. In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[00537] In some embodiments, the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 63, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 63. In certain embodiments, the nucleotide sequence that encodes IL-12 p35 subunit protein comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 63, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 63. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 64, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 64. In certain embodiments, the nucleotide sequence that

encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 181 or 182, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 181 or 182. In certain embodiments, the IL-12 p35 subunit protein comprises the amino acid sequence of SEQ ID NO: 63. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 64. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 181 or 182.

[00538] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 63. In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63. In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[00539] In some embodiments, the IL-12 p35 subunit, or functional fragment or derivative thereof, may comprise one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence, e.g., as compared to an amino acid sequence of a reference IL-12 p35 subunit. For example, the IL-12 p35 subunit may include a substitution(s) of one or more amino acids in the amino acid sequence of a parent IL-12 p35 subunit with a similar or homologous amino acid(s) or a dissimilar amino acid(s).

[00540] In some embodiments, the amino acid positions of one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence of an IL-12 p35 subunit, or a functional fragment or derivative thereof described herein, may be described in reference to the amino acid positions of an IL-12 p35 subunit reference sequence. In some embodiments, the IL-12 p35 subunit reference sequence may comprise a precursor form of an IL-12 p35 subunit described herein (i.e., an IL-12 p35 subunit precursor form). In some embodiments, the precursor form of the IL-12 p35 subunit may comprise a signal peptide described herein such as, but not limited to, the amino acid sequence MCQSRYLLFLATLALLNHLSLA (SEQ ID NO: 33), or a fragment or derivative thereof. In some embodiments, the precursor form of the IL-12

p35 subunit may comprise a signal peptide described herein such as, but not limited to, the amino acid sequence MCPARSLLLVATLVLLDHLSLA (SEQ ID NO: 67), or a fragment or derivative thereof. Non-limiting examples of precursor forms of the IL-12 p35 subunit include the sequences of SEQ ID NO: 29 and SEQ ID NO: 15.

[00541] In some embodiments, the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 29, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 29. In certain embodiments, the nucleotide sequence that encodes IL-12 p35 subunit protein comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 29, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 29. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 30, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 30. In certain embodiments, the IL-12 p35 subunit protein comprises the amino acid sequence of SEQ ID NO: 29. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 30.

[00542] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 29. In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 29. In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 29.

[00543] In some embodiments, the IL-12 p35 subunit reference sequence comprises a precursor form of an IL-12 p35 subunit disclosed herein, for example, the sequence of SEQ ID NO: 15. In some embodiments, the amino acid positions of the one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence of the IL-12 p35 subunit, or functional fragment or derivative thereof, may be described in reference to the amino acid positions in the amino acid sequence of SEQ ID NO: 15.

[00544] In some embodiments, the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 15, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 15. In certain embodiments, the nucleotide sequence that encodes IL-12 p35 subunit protein comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 15, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 15. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 16, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 16. In certain embodiments, the IL-12 p35 subunit protein comprises the amino acid sequence of SEQ ID NO: 15. In certain embodiments, the nucleotide sequence that encodes the IL-12 p35 subunit protein comprises the nucleotide sequence of SEQ ID NO: 16.

[00545] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 15. In some embodiments, the IL-12 p35 subunit, or the functional

fragment or derivative thereof comprises the amino acid sequence of SEQ ID NO: 15. In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 15.

[00546] In some embodiments, an IL-12 p35 subunit reference sequence may comprise a mature form sequence of an IL-12 p35 subunit described herein (i.e., an IL-12 p35 mature form). In some embodiments, the sequence of the mature form of the IL-12 p35 subunit may be shorter in length than the sequence of the precursor form of the IL-12 p35 subunit described herein owing, at least in part, to the absence of a signal sequence from the mature form which may be present in the precursor form. In some embodiments, the IL-12 p35 reference sequence can comprise a mature form of an IL-12 p35 subunit, for example, the sequence of SEQ ID NO: 63. In some embodiments, the amino acid positions of the one or more amino acid substitutions and/or insertions and/or deletions at one or more locations in the amino acid sequence of the IL-12 p35 subunit, or functional fragment or derivative, thereof may be described in reference to the amino acid positions in the amino acid sequence of SEQ ID NO: 63.

[00547] In some embodiments, the IL-12 p35 subunit of the present disclosure may include any amino acid sequence having an identity of at least about 60% or more, about 70% or more, 71% or more, 72% or more, 73% or more, 74% or more, 75% or more, 76% or more, 77% or more, 78% or more, 79% or more, 80% or more, 81% or more, 82% or more, 83% or more, 84% or more, 85% or more, 86% or more, 87% or more, 88% or more, 89% or more, 90% or more, 91% or more, 92% or more, 93% or more, 94% or more, 95% or more, 96% or more, 97% or more, 98% or more, 99% or more, 99.1% or more, 99.2% or more, 99.3% or more, 99.4% or more, 99.5% or more, 99.6% or more, 99.7% or more, 99.8% or more, or 99.9% or more to its natural amino acid sequence or parental sequence, and having the activity of normally-occurring (i.e., natural) sequence or parental sequence.

[00548] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof comprises amino acid change(s) in one or more positions. Non-limiting examples of amino acid changes comprise amino acid substitutions and/or insertions and/or deletions. In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof comprises amino acid substitution(s) in one or more positions. As a non-limiting example, the IL-12 p35 subunit, or the functional fragment or derivative thereof may comprise amino acid substitution(s) in 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54,

55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, or 100 or more positions.

[00549] In some embodiments, the IL-12 p35 subunit described herein may comprise one or more amino acid substitutions and/or insertions and/or deletions. Amino acid substitution means that an amino acid residue is substituted for a replacement amino acid residue at the same position. Inserted amino acid residues may be inserted at any position and may be inserted such that some or all of the inserted amino acid residues are immediately adjacent one another or may be inserted such that none of the inserted amino acid residues is immediately adjacent another inserted amino acid residue. In various embodiments, one or more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 29. In various embodiments, one of more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 71. In various embodiments, one or more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 15. In various embodiments, one of more amino acids may be substituted and/or inserted and/or deleted from the sequence of SEQ ID NO: 63.

[00550] A person with ordinary skill of the art will be able to identify the one or more amino acid changes (e.g., amino acid substitutions and/or insertions and/or deletions) in an IL-12 p35 precursor form sequence described herein (e.g., SEQ ID NO: 15 or 29) within a shorter IL-12 p35 subunit mature form sequence described herein (e.g., SEQ ID NO: 63 or 71). Any of the amino acid change(s) described in reference to an IL-12 p35 polypeptide comprising a mature form sequence of an IL-12 p35 subunit described herein (e.g., SEQ ID NO: 63 or 71) may be applied to an IL-12 p35 polypeptide comprising a precursor form sequence of an IL-12 p35 subunit described herein (e.g., SEQ ID NO: 15 or 29), or vice versa.

[00551] A person with ordinary skill of the art will further be able to identify the one or more amino acid changes (e.g., amino acid substitutions and/or insertions and/or deletions) in an IL-12 p35 mature or precursor form sequence derived from a human described herein (e.g., SEQ ID NO: 63 or 15, respectively) within an IL-12 p35 mature or precursor form sequence derived from a mouse described herein (SEQ ID NO: 71 or 29, respectively). Any of the amino acid change(s) described in reference to an IL-12 p35 polypeptide comprising a mature or precursor form sequence of an IL-12 p35 subunit derived from a human (e.g., SEQ ID NO: 63 or 15, respectively), may also be applied to an IL-12 p35 polypeptide comprising a mature or precursor form sequence

of an IL-12 p35 subunit derived from a mouse (e.g., SEQ ID NO: 71 or 29, respectively), or vice versa.

[00552] In some embodiments, the IL-12 p35 subunit may comprise a substitution at any amino acid contained therein. In some embodiments, the IL-12 p35 subunit may comprise an insertion at any amino acid contained therein. In some embodiments, the IL-12 p35 subunit may comprise a deletion at any amino acid contained therein.

[00553] In certain embodiments, amino acid changes (e.g., substitutions) to a protein or portion thereof are those which: (1) reduce susceptibility to proteolysis, (2) reduce susceptibility to oxidation, (3) alter binding affinity for forming protein complexes, or (4) confer or modify other physicochemical or functional properties. For example, single or multiple amino acid substitutions (preferably conservative amino acid substitutions) may be made in the normally-occurring (i.e., natural) sequence or parental sequence. In some embodiments, the amino acid sequence of the IL-12 p35 subunit disclosed herein may be changed, for example, to increase activity and/or reduce toxicity of the IL-12 polypeptide, or the functional fragment or derivative thereof disclosed herein. In some embodiments, the amino acid sequence of IL-12 p35 subunit disclosed herein may be changed such that the activity of the IL-12 polypeptide is attenuated, for example, for intravenous (IV) delivery.

[00554] By way of a non-limiting example, for the activity of the IL-12 p35 subunit before the substitution, insertion, and/or deletion described herein, the activity of the IL-12 p35 subunit protein or amino acid sequence after the substitution, insertion, and/or deletion is increased by more than 2%, more than 5%, more than 10%, more than 20%, more than 40%, more than 60%, more than 80%, more than 90%, more than 95%, more than 96%, more than 97%, more than 98%, more than 99%, or 100% or more as compared to the activity before the substitution, deletion, insertion or addition. By way of another non-limiting example, for the toxicity of the IL-12 p35 subunit before the substitution, insertion, and/or deletion described herein, the toxicity of the IL-12 p35 subunit protein or amino acid sequence after the substitution, insertion, and/or deletion is reduced by more than 2%, more than 5%, more than 10%, more than 20%, more than 40%, more than 60%, more than 80%, more than 90%, more than 95%, more than 96%, more than 97%, more than 98%, more than 99%, or 100% or more as compared to the toxicity before the substitution, deletion, insertion or addition.

[00555] In some embodiments, the amino acid sequence of the IL-12 p35 subunit may be modified to comprise one or more amino acid changes (e.g., substitutions), that may decrease susceptibility of the polypeptide to proteolysis and/or increase IL-12 biological half-life. In some embodiments, the amino acid sequence of the IL-12 p35 subunit may be modified to comprise one or more amino acid changes (e.g., substitutions), that may decrease susceptibility of the polypeptide to proteolysis and/or reduce IL-12 biological half-life.

[00556] In some embodiments, the IL-12 p35 subunit disclosed herein may also include conservative modifications and/or substitutions at other positions of IL-12 p35.

[00557] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, may comprise one or more amino acid substitutions at a position corresponding to an amino acid residue including, for example, without limitation, of Q20, N21, Q35, E38, S44, E45, E46, H49, K54, D55, T59, V60, E61, C63, L64, P65, E67, L68, N71, S73, C74, L75, N76, E79, N85, L89, F96, M97, L124, M125, Q130, Q135, N136, E143, Q146, N151, E153, K158, E162, E163, D165, I171, R181, I182, R183, V185, T186, D188, R189, V190, S192, Y193, N195, and A196 in the amino acid sequence of SEQ ID NO: 63. As a non-limiting example, the amino acid substitutions(s) may comprise an alanine (A) substitution, an arginine I substitution, an asparagine (N) substitution, an aspartic acid (D) substitution, a leucine (L) substitution, a lysine (K) substitution, a phenylalanine (F) substitution, a glutamine (Q) substitution, a glutamic acid I substitution, a serine (S) substitution, and a threonine (T) substitution, or any combination thereof.

[00558] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 63, and further include an amino acid substitutions corresponding to the following amino acid substitutions: N21D, Q35D, E38Q, D55Q, D55K, N71D, N71Q, L75A, N76D, E79Q, N85D, N85Q, L9A, F96A, M97A, L124A, M125A, Q130E, Q135E, N136D, E143Q, Q146E, N151D, N151K, E153K, E153Q, K158E, E162Q, E163Q, D165N, I171A, N195D, and/or N195Q with respect to the amino acid sequence of SEQ ID NO: 63.

[00559] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 63, and further include an amino acid substitutions corresponding to the following amino acid substitutions:

N21D, Q35D, E38Q, D55Q, D55K, N71D, N71Q, L75A, N76D, E79Q, N85D, N85Q, L9A, F96A, M97A, L124A, M125A, Q130E, Q135E, N136D, E143Q, Q146E, N151D, N151K, E153K, E153Q, K158E, E162Q, E163Q, D165N, I171A, N195D, and/or N195Q with respect to the amino acid sequence of SEQ ID NO: 63.

[00560] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 63, and further include an amino acid substitutions corresponding to the following amino acid substitutions: N71D/N85D/N195D, N151D/E153Q, N151D/D165N, Q130E/N151D, N151D/K158E, E79Q/N151D, D55Q/N151D, N136D/N151D, N21D/N151D, E143Q/N151D, N71Q/N85Q, N71Q/N195Q, N85Q/N195Q, N71Q/N85Q/N195Q, N71D/N85D, N71D/N195D, and/or N85D/N195D with respect to the amino acid sequence of SEQ ID NO: 63.

[00561] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof of the disclosure may include an amino acid sequence having at least 70%, 80%, 90%, 95%, 99%, or 100% sequence identity to the amino acid sequence of SEQ ID NO: 63, and further include an amino acid substitutions corresponding to the following amino acid substitutions: N71D/N85D/N195D, N151D/E153Q, N151D/D165N, Q130E/N151D, N151D/K158E, E79Q/N151D, D55Q/N151D, N136D/N151D, N21D/N151D, E143Q/N151D, N71Q/N85Q, N71Q/N195Q, N85Q/N195Q, N71Q/N85Q/N195Q, N71D/N85D, N71D/N195D, and/or N85D/N195D with respect to the amino acid sequence of SEQ ID NO: 63.

[00562] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof may further comprise a signal peptide. In some embodiments, the IL-12 polypeptide, or functional fragment of derivative thereof, may comprise one or more signal peptides. As a non-limiting example, the IL-12 polypeptide may comprise 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20, or more, signal peptide(s). Non-limiting examples of signal peptides include the amino acid sequence of SEQ ID NOs: 31, 33, 65, or 67. In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof may comprise a signal peptide which comprises the amino acid sequence of SEQ ID NOs: 31, 33, 65, or 67, or a variant thereof, having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about

96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NOs: 31, 33, 65, or 67. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NOs: 31, 33, 65, or 67, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NOs: 31, 33, 65, or 67. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NOs: 32, 34, 66, or 68, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NOs: 32, 34, 66, or 68. In certain embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NOs: 31, 33, 65, or 67. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NOs: 32, 34, 66, or 68.

[00563] In some embodiments, the IL-12 p35 and the IL-12 p40 subunits may be oriented such that the IL-12 p35 subunit, or the functional fragment or derivative thereof, may be operably linked to the signal peptide. In some embodiments, the IL-12 p35 and the IL-12 p40 subunits may be oriented such that the IL-12 p40 subunit, or the functional fragment or derivative thereof, may be operably linked to the signal peptide.

[00564] In some embodiments, a signal peptide is operably linked to an IL-12 p40 subunit, or a functional fragment or derivative thereof, described herein, to form an IL-12 p40 subunit precursor. In some embodiments, a signal peptide is operably linked to an IL-12 p35 subunit, or a functional fragment or derivative thereof, described herein, to form an IL-12 p35 subunit precursor.

[00565] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 31, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%,

at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 31. In certain embodiments, the nucleotide sequence that encodes signal peptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 31, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 31. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 32, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 32. In certain embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 31. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 32.

[00566] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 31 or an amino acid sequence that has at least 80% sequence identity thereto. In some embodiments, the signal peptide consists of the amino acid sequence of SEQ ID NO: 31.

[00567] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 33, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 33. In certain embodiments, the nucleotide sequence that encodes signal peptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 33, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about

92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 33. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 34, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 34. In certain embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 33. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 34.

[00568] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto. In some embodiments, the signal peptide consists of the amino acid sequence of SEQ ID NO: 33.

[00569] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 65, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 65. In certain embodiments, the nucleotide sequence that encodes signal peptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 65, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 65. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 66, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least

about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 66. In certain embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 65. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 66.

[00570] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto. In some embodiments, the signal peptide consists of the amino acid sequence of SEQ ID NO: 65.

[00571] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 67, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 67. In certain embodiments, the nucleotide sequence that encodes signal peptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 67, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 67. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 68, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 68. In certain embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 67. In certain embodiments, the nucleotide sequence that encodes the signal peptide comprises the nucleotide sequence of SEQ ID NO: 68.

[00572] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto. In some embodiments, the signal peptide consists of the amino acid sequence of SEQ ID NO: 67.

[00573] Given that IL-12 is a heterodimeric molecule composed of an alpha chain (the p35 subunit) and a beta chain (the p40 subunit), the simultaneous expression of the two subunits is necessary to produce the biologically active heterodimer. Recombinant IL-12 expression can be achieved with bicistronic vectors comprising the p40 and p35 subunits separated by an IRES (internal ribosome entry site) sequence to permit independent expression of both subunits from a single vector. As an alternative to bicistronic expression, functional single chain IL-12 fusion proteins have been generated by joining the p40 and p35 subunits with linkers, e.g., Gly_6Ser (SEQ ID NO: 35) or $(Gly_4Ser)_3$ (SEQ ID NO: 18) linkers.

[00574] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof and the IL-12 p35 subunit, or the functional fragment or derivative thereof are connected by a first linker. In some embodiments, the first linker is from about 5 amino acids to about 30 amino acids in length. In some embodiments, the first peptide linker may comprise 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30 or more amino acids. In some embodiments, the first linker may be absent. The first linker may comprise or consist of any of various linkers disclosed herein, or any combination thereof. For example, a first linker of the present disclosure may comprise or consist of any of the sequences of SEQ ID NO: 18-19, 36-49, 75-93, or any combination thereof.

[00575] In some embodiments, the first linker comprises the sequence $(VPGVG)_2$ (SEQ ID NO: 17). In some embodiments, the first linker consists of the sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00576] In some embodiments, the first linker comprises the sequence $(G_4S)_2$ (SEQ ID NO: 40). In some embodiments, the first linker consists of the sequence $(G_4S)_2$ (SEQ ID NO: 40).

[00577] In some embodiments, the first linker comprises the sequence $(G_4S)_3$ (SEQ ID NO: 18). In some embodiments, the first linker consists of the sequence $(G_4S)_3$ (SEQ ID NO: 18).

[00578] In some embodiments, the first linker comprises the sequence $(G_4S)_3GS$ (SEQ ID NO: 41). In some embodiments, the first linker consists of the sequence $(G_4S)_3GS$ (SEQ ID NO: 41).

[00579] In some embodiments, the first linker comprises the sequence $(G_4S)_4$ (SEQ ID NO: 42). In some embodiments, the first linker consists of the sequence $(G_4S)_4$ (SEQ ID NO: 42).

[00580] In some embodiments, the first linker comprises the sequence $(G_4S)_5$ (SEQ ID NO: 43). In some embodiments, the first linker consists of the sequence $(G_4S)_5$ (SEQ ID NO: 43).

[00581] In some embodiments, the first linker comprises the sequence $(G_4S)_6$ (SEQ ID NO: 44). In some embodiments, the first linker consists of the sequence $(G_4S)_6$ (SEQ ID NO: 44).

[00582] In some embodiments, the first linker comprises the sequence $(G_4S)_7$ (SEQ ID NO: 45). In some embodiments, the first linker consists of the sequence $(G_4S)_7$ (SEQ ID NO: 45).

[00583] In some embodiments, the first linker comprises the sequence $(G_4S)_8$ (SEQ ID NO: 46). In some embodiments, the first linker consists of the sequence $(G_4S)_8$ (SEQ ID NO: 46).

[00584] In some embodiments, the first linker comprises the sequence $(GGGGS)_n$, wherein n is an integer of 1-10, or more (SEQ ID NO: 47). In some embodiments, the first linker consists of the sequence $(GGGGS)_n$, wherein n is an integer of 1-10, or more (SEQ ID NO: 47).

[00585] In some embodiments, the first linker comprises the sequence $(G_3S)_2$ (SEQ ID NO: 36). In some embodiments, the first linker consists of the sequence $(G_3S)_2$ (SEQ ID NO: 36).

[00586] In some embodiments, the first linker comprises the sequence $(G_3S)_3$ (SEQ ID NO: 37). In some embodiments, the first linker consists of the sequence $(G_3S)_3$ (SEQ ID NO: 37).

[00587] In some embodiments, the first linker comprises the sequence $(G_3S)_4$ (SEQ ID NO: 38). In some embodiments, the first linker consists of the sequence $(G_3S)_4$ (SEQ ID NO: 38).

[00588] In some embodiments, the first linker comprises the sequence $(G_3S)_5$ (SEQ ID NO: 39). In some embodiments, the first linker consists of the sequence $(G_3S)_5$ (SEQ ID NO: 39).

[00589] In some embodiments, the first linker comprises the sequence GGGGGGS (SEQ ID NO: 35). In some embodiments, the first linker consists of the sequence GGGGGGS (SEQ ID NO: 35).

[00590] In some embodiments, the first linker comprises the sequence GSGSSRGGSGSGGSGGGGSK (SEQ ID NO: 48). In some embodiments, the first linker consists of the sequence GSGSSRGGSGSGGSGGGGSK (SEQ ID NO: 48).

[00591] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof is membrane bound. In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof is not membrane bound. In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof is secreted. In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof is soluble.

[00592] As discussed below, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, may be positioned at any location within the VSV genome. Further, the nucleic acids encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, may be positioned at any location within the VSV genome.

[00593] In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned upstream of a nucleic acid encoding a VSV N polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned upstream of a nucleic acid encoding a VSV N polypeptide, or functional fragment or derivative thereof.

[00594] In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned between the nucleic acid encoding the VSV N polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV P polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned between the nucleic acid encoding the VSV N polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV P polypeptide, or functional fragment or derivative thereof.

[00595] In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned between the nucleic acid encoding the VSV P polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV M polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned between the nucleic acid encoding the VSV P polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV M polypeptide, or functional fragment or derivative thereof.

[00596] In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned downstream of a nucleic acid encoding a VSV M polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned downstream of a nucleic acid encoding a fusogenic polypeptide, e.g., a VSV G polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned downstream of a nucleic acid encoding a VSV M polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-

12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned downstream of a nucleic acid encoding a fusogenic polypeptide, e.g., a VSV G polypeptide, or functional fragment or derivative thereof.

[00597] In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned between the nucleic acid encoding the VSV M polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV G polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned between the nucleic acid encoding the VSV M polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV G polypeptide, or functional fragment or derivative thereof.

[00598] In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned between the nucleic acid encoding the VSV M polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV L polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned between the nucleic acid encoding the fusogenic polypeptide, e.g., a VSV G polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding the VSV L polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned between the nucleic acid encoding the VSV M polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding a VSV L polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or derivatives thereof, can be positioned between the nucleic acid encoding the fusogenic polypeptide, e.g., a VSV G polypeptide, or functional fragment or derivative thereof, and the nucleic acid encoding the VSV L polypeptide, or functional fragment or derivative thereof.

[00599] In some embodiments, the nucleic acid encoding the IL-12 polypeptide, or functional fragment or derivative thereof, can be positioned downstream of the nucleic acid encoding the VSV L polypeptide, or functional fragment or derivative thereof. In some embodiments, the nucleic acid encoding the IL-12 p35 and/or the IL-12 p40 subunits, or functional fragments or

derivatives thereof, can be positioned downstream of the nucleic acid encoding the VSV L polypeptide, or functional fragment or derivative thereof.

[00600] The IL-12 transgene position in the VSV genome can affect transcription levels of the IL-12 gene relative to other viral proteins. The positioning of the IL-12 transgene could impact a) replication kinetics of the virus; and b) production level of IL-12 by each infected cell. Replication kinetics, the amount of IL-12 produced per infected cell, and viral fitness can generally affect effectiveness, toxicity, therapeutic index, the type of tumors most effectively targeted, and other factors.

[00601] Without wishing to be bound by theory, a viral transcriptase can transcribe viral mRNA species using a virion RNA (e.g., a VSV genome) as a template. A single promoter site can be located at the 3′ end of the viral genome, and polymerase can attach to the genomic RNA at this site. As the polymerase moves along the viral RNA it can encounter stop-start signals at the boundaries of each of the viral genes (e.g., genes encoding a nucleoprotein (N) polypeptide, a phosphoprotein (P) polypeptide, a matrix (M) polypeptide, a glycoprotein (G) polypeptide, and/or a large protein (L) polypeptide). Such mechanism can be referred to, for example, as stop-start (or stuttering) transcription, and can result in more mRNA being made from genes that are located at the 3' end of the viral genome, and a gradient of progressively less mRNA is made from downstream genes (see, e.g., **Figure 73A**).

[00602] In some embodiments, insertion of the IL-12 transgene within the VSV genome closer to the viral promoter can result in more mRNA being made from the IL-12 transgene than from downstream genes.

[00603] In some embodiments, insertion of the IL-12 transgene within the VSV genome closer to the viral promoter, e.g., downstream of the P gene, can impact the expression of the M gene and/or the G gene, thereby resulting in decreased levels of viral replication.

[00604] In various aspects, the present disclosure provides a recombinant rhabdovirus (e.g., a VSV) comprising a nucleotide encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof; the recombinant protein is not membrane bound; the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof, and an IL-12 p35 subunit, or a functional fragment or derivative thereof, which are connected by a first linker; the rhabdovirus genome (e.g., VSV genome) comprises a gene encoding a fusogenic polypeptide (e.g., a G protein polypeptide),

or a functional fragment or derivative thereof, and a gene encoding a large protein (L) polypeptide, or a functional fragment or derivative thereof; and, the nucleotide sequence encoding the recombinant protein is positioned between the gene encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the gene encoding the L polypeptide, or the functional fragment or derivative thereof.

[00605] In some embodiments, upon infection of a subject in need thereof by a recombinant virus described herein, the recombinant virus may result in reduced, decreased, lowered, lessened, or abated serum interferon gamma (IFNγ) release in the subject, as compared to a control, e.g., a control recombinant virus comprising a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, that is not membrane bound. For example, serum interferon gamma (IFNγ) release may be reduced, decreased, lowered, lessened, or abated in the subject by about 0.5%, about 1%, about 5%, about 10%, about 20%, about 30%, about 40%, about 50%, about 60%, about 70%, about 80%, about 90%, about 99%, or greater. In some embodiments, serum interferon gamma (IFNγ) release may be reduced, decreased, lowered, lessened, or abated in the subject by from about 5% to about 10%, from about 10% to about 20%, from about 50% to about 60%, from about 50% to about 70%, from about 50% to about 80%, from about 50% to about 90%, more than 60%, from about 60% to about 70%, from about 60% to about 80%, from about 60% to about 90%, more than about 70%, from about 70% to about 80%, from about 70% to about 90%, more than about 80%, from about 80% to about 90%, more than 90%, from about 90% to about 95%, from about 90% to about 98%, more than 95%, from about 95% to about 98%, more than about 98%, or more than about 99%. In some embodiments, serum interferon gamma (IFNγ) release may be reduced, decreased, lowered, lessened, or abated in the subject by about 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, or 20% or more. In some embodiments, the recombinant virus comprises a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, which is membrane bound.

[00606] In some embodiments, upon infection of a subject in need thereof by a recombinant virus described herein, the recombinant virus does not result in body weight loss or result in reduced, decreased, lowered, lessened, or abated body weight loss in the subject, as compared to a control, e.g., a control recombinant virus comprising a nucleotide sequence encoding an IL-12 polypeptide that is not membrane bound. For example, body weight loss may be reduced, decreased, lowered, lessened, or abated in the subject by about 0.5%, about 1%, about 5%, about 10%, about 20%,

about 30%, about 40%, about 50%, about 60%, about 70%, about 80%, about 90%, about 99%, or greater. In some embodiments, body weight loss may be reduced, decreased, lowered, lessened, or abated in the subject by from about 5% to about 10%, from about 10% to about 20%, from about 50% to about 60%, from about 50% to about 70%, from about 50% to about 80%, from about 50% to about 90%, more than 60%, from about 60% to about 70%, from about 60% to about 80%, from about 60% to about 90%, more than about 70%, from about 70% to about 80%, from about 70% to about 90%, more than about 80%, from about 80% to about 90%, more than 90%, from about 90% to about 95%, from about 90% to about 98%, more than 95%, from about 95% to about 98%, more than about 98%, or more than about 99%. In some embodiments, body weight loss may be reduced, decreased, lowered, lessened, or abated in the subject by about 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, or 20% or more. In some embodiments, body weight loss in the subject is prevented. In some embodiments, the recombinant virus comprises a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, which is membrane bound.

[00607] In some embodiments, an IL-12 polypeptide, or functional fragment or derivative thereof can be connected to a transmembrane domain. In some embodiments, the IL-12 p40 subunit of the IL-12 polypeptide, or functional fragment or derivative thereof, is connected to the transmembrane domain via a second linker.

[00608] In some embodiments, the IL-12 p35 and the IL-12 p40 subunits may be oriented such that the IL-12 p35 subunit, or the functional fragment or derivative thereof, may be connected to the transmembrane domain via the second linker. In some embodiments, the IL-12 p35 and the IL-12 p40 subunits may be oriented such that the IL-12 p40 subunit, or the functional fragment or derivative thereof, may be connected to the transmembrane domain via the second linker.

[00609] In some embodiments of the above-described orientations of the IL-12 p35 and the IL-12 p40 subunits, cell surface clustering of the IL-12 polypeptide described herein may be enhanced when IL-12 p35 versus the IL-12 p40 subunit is connected to the transmembrane via the second linker. In some embodiments of the above-described orientations of the IL-12 p35 and the IL-12 p40 subunits, cell surface clustering of the IL-12 polypeptide described herein may be diminished when IL-12 p35 versus the IL-12 p40 subunit is connected to the transmembrane via the second

[00610] In some embodiments, the second linker is from about 5 amino acids to about 50 amino acids in length. In some embodiments, the first linker may comprise 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15,

16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, or more amino acids. In some embodiments, the second linker may be absent. The second linker may comprise or consist of any of various linkers disclosed herein, or any combination thereof. For example, a second linker of the present disclosure may comprise or consist of any of the sequences of SEQ ID NO: 18-19, 36-49, 75-93, or any combination thereof.

[00611] In some embodiments, the second linker can be a flexible linker, a rigid linker, or a cleavable linker.

[00612] Flexible linkers can include glycine polymers, glycine-serine polymers, glycine-alanine polymers, alanine-serine polymers, and other flexible linkers known in the art. Glycine and glycine-serine polymers are relatively unstructured, and therefore may be able to serve as a neutral tether between domains of polypeptides described herein (e.g., polypeptides comprising e.g., IL-12 p35 unit, IL-12 p40 subunit, transmembrane domain, and/or additional various polypeptides described herein). Glycine can access more phi-psi space than even alanine, and is much less restricted than residues with longer side chains. The ordinarily skilled artisan will recognize that design of polypeptide described herein can include linkers that are all or partially flexible, such that the linker can include a flexible linker as well as one or more portions that confer less flexible structure to provide for polypeptide structure.

[00613] Rigid linkers can exhibit relatively stiff structures by adopting α-helical structures or by containing multiple proline (pro) residues. The α-helix can be a rigid and stable structure, including intra-segment hydrogen bonds and a closely packed backbone. Various α-helical conformations can form rapidly such as during folding, which can allow for correct folding of connecting protein domains, e.g., without non-native interactions with the linker. Linkers in an α-helix structure can serve as rigid spacers to effectively separate protein domains as well as to reduce their unfavorable interactions. In the absence of an inherent rigid structure, non-helical linkers tend to be rich in pro, which can enhance the stiffness of a linker. Hence, non-helical linkers with pro-rich sequences can provide relatively rigid structures and can reduce inter-domain interference.

[00614] Cleavable linkers may be cleaved under specific conditions such as the presence of reducing reagents or proteases. This type of linker may improve bioactivity, reduce steric hindrance, or achieve independent actions/metabolism of individual domains of recombinant fusion proteins following linker cleavage. Cleavable linkers can be used to improve the bioactivity

of chimeric proteins, or to specifically deliver prodrugs to target sites where the linkers are processed to activate bioactivity. In addition to reduction of disulfide bond, *in vivo* cleavage of cleavable linkers in recombinant fusion proteins may also be achieved by proteases that are expressed, e.g., under pathological conditions (e.g. in cancer), in specific cells (e.g., cancer/tumor cells) or tissues (e.g., tumors), or restricted within specific cellular compartments (e.g., the lysosome). Such cleavable linkers can be designed to be prone to a particular protease by incorporating specific protease-sensitive sequences. Unlike the reduction of a disulfide bond which can occur rapidly in the blood circulation, the specificity of many proteases can allow for slower cleavage of a cleavable linker, e.g., at specific sites *in vivo*. *In vivo* cleavable linkers sensitive to proteases that become active under certain physiological or pathological conditions can be used for drug targeting. Likewise, *in vivo* cleavable linkers which can be cleaved by proteases overexpressed in diseased cells/tissues can also be used for drug targeting. A non-limiting example of targeting intracellular compartments is the cleavable linker which can be specifically cleaved by furin, a cellular endoproteinase involved in the proteolytic activation of various precursor proteins as well as toxins. Cathepsin B, a protease present in the lysosome, has been applied for targeted intracellular activation of cytotoxic proteins.

[00615] Non-limiting examples of amino acid (aa) sequences of flexible, rigid, and cleavable linkers which may be used in the compositions of the present disclosure are provided in **Table 3** (below).

Table 3. Examples of Amino Acid Sequences of Flexible, Rigid, and Cleavable Linkers

Linker sequence (aa)	Linker type	SEQ ID NO
$A(EAAAK)_4ALEA(EAAAK)_4A$	rigid	73
$A(EAAAK)_3A$	rigid	74
(Gly)8	flexible	75
(Gly)6	flexible	76
$(EAAAK)_3$	rigid	77
(EAAAK)n, wherein n=1-4	rigid	78
GGGGS	flexible	79
PAPAP	rigid	80
$A(EAAAK)_2A$	rigid	81
(AP)n, (10-34 aa)	rigid	82
S-S	cleavable (disulfide)	83
VSQTSKLTRAETVFPDV	cleavable	84

RVLAEA	cleavable	85
EDVVCCSMSY	cleavable	86
GGIEGRGS	cleavable	87
TRHRQPRGWE	cleavable	88
AGNRVRRSVG	cleavable	89
RRRRRRRRR	cleavable	90

[00616] In some embodiments, a cleavable linker can be a self-cleaving peptide such as a 2A self-cleaving peptide. Non-limiting examples of 2A self-cleaving peptides include a P2A peptide, an E2A peptide, an F2A peptide, and a T2A peptide. In some embodiments, the 2A self-cleaving peptide is a P2A peptide. As a non-limiting example, the P2A peptide may comprise or consist of the sequence GSGATNFSLLKQAGDVEENPGP (SEQ ID NO: 109).

[00617] In some embodiments, a linker of the present disclosure may comprise or consist of a dipeptide linker such as, but not limited to, leucine-glutamic acid (LE) (SEQ ID NO: 91).

[00618] In some embodiments, the second linker comprises the sequence $(G_4S)_3$ (SEQ ID NO: 18). In some embodiments, the first linker consists of the sequence $(G_4S)_3$ (SEQ ID NO: 18).

[00619] In some embodiments, the second linker comprises the sequence $A(EAAAK)_4ALEA(EAAAK)_4A$ (SEQ ID NO: 73). In some embodiments, the first linker consists of the sequence $A(EAAAK)_4ALEA(EAAAK)_4A$ (SEQ ID NO: 73).

[00620] In some embodiments, the second linker comprises the sequence $A(EAAAK)_3A$ (SEQ ID NO: 74). In some embodiments, the first linker consists of the sequence $A(EAAAK)_3A$ (SEQ ID NO: 74).

[00621] Two basic types of transmembrane domains are alpha-helical and beta-barrels. Alpha-helical transmembrane domains are located in the plasma membrane of eukaryotes. It is estimated that in humans, approximately 30% of all proteins may be alpha-helical membrane proteins. As an Example, one estimate of the human membrane proteome determined there are at least 2,925 unique integral alpha-helical transmembrane sequences encoded by the human genome. Beta-barrel proteins are located in outer membranes of mitochondria, comprising a simple up-and-down topology that may reflect their common evolutionary origin and similar folding mechanism. Transmembrane domain classification by topology may refer to the position of the N- and C-terminal domains. Types I, II, and III can be single-pass molecules, whereas type IV can be multiple-pass molecules. Type I transmembrane domains may be anchored to the lipid membrane with a stop-transfer anchor sequence. The N-terminal domains of Type I transmembrane domains

are targeted to the ER lumen during synthesis, as well as to the extracellular space, in instances where mature forms may be located on cell surface. Type II and III transmembrane domains are anchored via a signal-anchor sequence. Type II transmembrane domains may be targeted to the endoplasmic reticulum (ER) lumen via the C-terminal domain. Type III transmembrane domains have their N-terminal domains targeted to the ER lumen. Type IV transmembrane domains are subclassified as either IV-A, with an N-terminal domain targeted to the cytosol, or IV-B, with an N-terminal domain targeted to the lumen. Non-limiting examples of transmembrane domains which may be used in the practice of the present disclosure include: single-pass transmembrane proteins (TMPs) (e.g., Type-I TMP including E3 Ubiquitin-Protein Ligase; Type-II TMP including 4F2 Cell-Surface Antigen Heavy Chain; Type-III TMP including Linker For Activation of T-cells Family Member 1; and, Type-IV TMP including Junctophilin-1); multi-pass TMPs, e.g., human calcitonin receptor; and, beta-barrel TMP.

[00622] In some embodiments, the transmembrane domain, or a functional fragment or derivative thereof, described herein may be derived from, e.g., tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), cluster of differentiation 4 (CD4) or fragments or derivatives thereof, or combinations thereof.

[00623] In some embodiments, a membrane-bound form of the IL-12 polypeptide described herein may be expressed in a chimeric form using a transmembrane domain derived from, e.g., TNFα, PDGFR and/or CD4.

[00624] A suitable transmembrane-anchored sequence can be important in achieving stable and/or high expression of proteins, e.g., chimeric proteins on the plasma membrane. In particular, a high level of surface expression can be achieved using a transmembrane domain derived from a B7.1 antigen. In some embodiments, the transmembrane domain, or a functional fragment or derivative thereof, described herein may be derived from a B7.1 antigen. In some embodiments, the B7.1 antigen may be of mouse origin. In some embodiments, the B7.1 antigen may be of human origin.

[00625] In various embodiments, the present disclosure provides a recombinant rhabdovirus comprising a nucleotide sequence encoding a recombinant protein, and the recombinant protein comprises:

i. an IL-12 polypeptide comprising an IL-12 p35 subunit, or a functional fragment or derivative thereof, described herein;

ii. a signal peptide operably described herein which can be linked to the IL-12 polypeptide; and

iii. a transmembrane domain, e.g., a transmembrane domain derived from a B7.1 antigen, described herein.

[00626] In some embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 19, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 19. In certain embodiments, the nucleotide sequence that encodes transmembrane domain derived from a B7.1 antigen comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 19, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 19. In certain embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 19.

[00627] In some embodiments, the B7.1 transmembrane domain comprises the amino acid sequence of SEQ ID NO: 19, or a sequence which has at least 80% sequence identity thereto. In some embodiments, the B7.1 transmembrane domain consists of the amino acid sequence of SEQ ID NO: 19.

[00628] In some embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 20, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 20. In certain embodiments, the nucleotide sequence that encodes transmembrane domain derived from a B7.1 antigen comprises the nucleotide sequence that encodes the amino

acid sequence of SEQ ID NO: 20, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 20. In certain embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 20.

[00629] In some embodiments, the B7.1 transmembrane domain comprises the amino acid sequence of SEQ ID NO: 20 or a sequence which has at least 80% sequence identity thereto. In some embodiments, the B7.1 transmembrane domain consists of the amino acid sequence of SEQ ID NO: 20.

[00630] In some embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 23, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 23. In certain embodiments, the nucleotide sequence that encodes transmembrane domain derived from a B7.1 antigen comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 23, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 23. In certain embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 23.

[00631] In some embodiments, the B7.1 transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23, or a sequence which has at least 80% sequence identity thereto. In some embodiments, the B7.1 transmembrane domain consists of the amino acid sequence of SEQ ID NO: 23.

[00632] In some embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 24, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 24. In certain embodiments, the nucleotide sequence that encodes transmembrane domain derived from a B7.1 antigen comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 24, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 24. In certain embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 24.

[00633] In some embodiments, the B7.1 transmembrane domain comprises the amino acid sequence of SEQ ID NO: 24, or a sequence which has at least 80% sequence identity thereto. In some embodiments, the B7.1 transmembrane domain consists of the amino acid sequence of SEQ ID NO: 24.

[00634] In some embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 26, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 26. In certain embodiments, the nucleotide sequence that encodes transmembrane domain derived from a B7.1 antigen comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 26, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about

98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 26. In certain embodiments, the transmembrane domain derived from a B7.1 antigen comprises the amino acid sequence of SEQ ID NO: 26.

[00635] In some embodiments, the B7.1 transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26, or a sequence which has at least 80% sequence identity thereto. In some embodiments, the B7.1 transmembrane domain consists of the amino acid sequence of SEQ ID NO: 26.

[00636] In certain embodiments, a topological domain may be operably linked to a transmembrane domain disclosed herein (e.g., a B7.1 transmembrane domain). The topological domain may be derived, for example, without limitation, from a B7.1 antigen, tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[00637] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or 22, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 21 or 22. In certain embodiments, the nucleotide sequence that encodes topological domain comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 21 or 22, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 21 or 22. In certain embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or 22.

[00638] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or 22, or a sequence which has at least 80% sequence identity thereto. In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 21 or 22.

[00639] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 25. In certain embodiments, the nucleotide sequence that encodes topological domain comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 25, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 25. In certain embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25.

[00640] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25, or a sequence which has at least 80% sequence identity thereto. In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 25.

Additional Polypeptides of the Disclosure

[00641] In certain aspects, any of various recombinant rhabdoviruses of the present disclosure may comprise a recombinant protein which can further comprise one or more additional polypeptides. In some embodiments, the recombinant protein comprises a transmembrane domain. In some embodiments, the recombinant protein can be membrane bound. In some embodiments, the recombinant protein does not comprise a transmembrane domain. In some embodiments, the recombinant protein is not membrane bound. When the recombinant protein is not membrane bound, the recombinant protein may be a soluble and/or secreted protein. Non-limiting examples of the additional polypeptides include a cluster of differentiation 4 (CD4) polypeptide, or a functional fragment or derivative thereof; a cluster of differentiation 46 (CD46) polypeptide, or a functional fragment or derivative thereof; a collagen-binding domain (CBD) derived from von Willebrand factor (VWF) polypeptide, or a functional fragment or derivative thereof; an IgG2a polypeptide, or a functional fragment or derivative thereof; an IgG1 polypeptide, or a functional fragment or derivative thereof; and/or, an IgG4 polypeptide, or a functional fragment or derivative

thereof. In some embodiments, a recombinant protein described herein may further comprise 1, 2, 3, 4, 5, 6, or more additional polypeptides.

[00642] In some embodiments, the one or more additional polypeptides can be positioned between the IL-12 p35 subunit, or the functional fragment or derivative thereof, and the transmembrane domain.

[00643] In some embodiments, an IL-12 p35 subunit, or the functional fragment or derivative thereof, described herein can be connected to the one or more additional polypeptides via a second linker, and the one more additional polypeptides can be connected to a transmembrane domain described herein via a third linker.

[00644] In some embodiments, the second and/or third linker is from about 5 amino acids to about 30 amino acids in length. In some embodiments, the second and/or third linker is from about 5 amino acids to about 40 amino acids in length. In some embodiments, the second and/or third linker is from about 5 amino acids to about 50 amino acids in length. In some embodiments, the second and/or third linker may comprise 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, or more amino acids. In some embodiments, the second and/or third linker may be absent. The second and/or third linker may comprise or consist of any of various linkers disclosed herein, or any combination thereof. For example, a second and/or third linker of the present disclosure may comprise or consist of any of the sequences of SEQ ID NO: 18-19, 36-49, 75-93, or any combination thereof.

[00645] In some embodiments, the second and/or third linker can be a flexible linker, a rigid linker, or a cleavable linker such as, but not limited to, any such linkers as set forth in Table 3.

[00646] In some embodiments, the second and/or the third linker is a flexible linker.

[00647] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence $(G4S)_3$ (SEQ ID NO: 18). In some embodiments, the second and/or the third linker consists of the amino acid sequence of (SEQ ID NO: 18).

[00648] In some embodiments, the second linker and/or the third linker is a rigid linker.

[00649] In some embodiments, the second and/or the third linker comprises the amino acid sequence $A(EAAAK)_4ALEA(EAAAK)_4A$ (SEQ ID NO: 73). In some embodiments, the second and/or the third linker consists of the amino acid sequence of SEQ ID NO: 73.

[00650] In some embodiments, the second and/or the third linker comprises the amino acid sequence $A(EAAAK)_3A$ (SEQ ID NO: 74). In some embodiments, the second and/or the third linker consists of the amino acid sequence of SEQ ID NO: 74.

[00651] In some embodiments, the CD4 polypeptide comprises the amino acid sequence of SEQ ID NO: 96, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 96. In certain embodiments, the nucleotide sequence that encodes CD4 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 96, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 96. In certain embodiments, the nucleotide sequence that encodes the CD4 polypeptide comprises the nucleotide sequence of SEQ ID NO: 97, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 97. In certain embodiments, the CD4 polypeptide comprises the amino acid sequence of SEQ ID NO: 96. In certain embodiments, the nucleotide sequence that encodes the CD4 polypeptide comprises the nucleotide sequence of SEQ ID NO: 97.

[00652] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 96. In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 96. In some embodiments, the CD4 polypeptide consists of the amino acid sequence of SEQ ID NO: 96.

[00653] In some embodiments, the CD4 polypeptide comprises the amino acid sequence of SEQ ID NO: 153, or a variant thereof having at least about 50%, at least about 55%, at least about 60%,

at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 153. In certain embodiments, the nucleotide sequence that encodes CD4 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 153, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 153. In certain embodiments, the nucleotide sequence that encodes the CD4 polypeptide comprises the nucleotide sequence of SEQ ID NO: 152, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 152. In certain embodiments, the CD4 polypeptide comprises the amino acid sequence of SEQ ID NO: 153. In certain embodiments, the nucleotide sequence that encodes the CD4 polypeptide comprises the nucleotide sequence of SEQ ID NO: 152.

[00654] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 153. In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 153. In some embodiments, the CD4 polypeptide consists of the amino acid sequence of SEQ ID NO: 153.

[00655] In various embodiments, a CD4 polypeptide disclosed herein may act like an extension, e.g., to position an IL-12 polypeptide of the present disclosure further away from a membrane of a recombinant virus, e.g., a recombinant rhabdovirus. In some embodiments, the CD4 polypeptide can provide additional flexibility and degrees of freedom such that the IL-12 polypeptide can better interact with molecules external to the virus.

[00656] In some embodiments, the CD46 polypeptide comprises the amino acid sequence of SEQ ID NO: 98, or a variant thereof having at least about 50%, at least about 55%, at least about 60%,

at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 98. In certain embodiments, the nucleotide sequence that encodes CD46 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 98, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 98. In certain embodiments, the nucleotide sequence that encodes the CD46 polypeptide comprises the nucleotide sequence of SEQ ID NO: 99, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 99. In certain embodiments, the CD46 polypeptide comprises the amino acid sequence of SEQ ID NO: 98. In certain embodiments, the nucleotide sequence that encodes the CD46 polypeptide comprises the nucleotide sequence of SEQ ID NO: 99.

[00657] In some embodiments, the CD46 polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 98. In some embodiments, the CD46 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 98. In some embodiments, the CD46 polypeptide consists of the amino acid sequence of SEQ ID NO: 98.

[00658] In some embodiments, the one or more VWF CBDs comprises the amino acid sequence of SEQ ID NO: 100, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 100. In certain embodiments, the nucleotide sequence that encodes one or more VWF CBDs comprises the

nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 100, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 100. In certain embodiments, the nucleotide sequence that encodes the one or more VWF CBDs comprises the nucleotide sequence of SEQ ID NO: 101, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 101. In certain embodiments, the one or more VWF CBDs comprises the amino acid sequence of SEQ ID NO: 100. In certain embodiments, the nucleotide sequence that encodes the one or more VWF CBDs comprises the nucleotide sequence of SEQ ID NO: 101.

[00659] In some embodiments, the one or more VWF CBDs, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 100. In some embodiments, the one or more VWF CBDs, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 100. In some embodiments, the one or more VWF CBDs consists of the amino acid sequence of SEQ ID NO: 100.

[00660] In some embodiments, the one or more additional polypeptides comprises two or more VWF CBDs, or the functional fragment or derivative thereof, and each of the VWF CBDs, or the functional fragment or derivative thereof, is connected to the subsequent VWF CBD via a fourth linker.

[00661] In some embodiments, the one or more additional polypeptides comprise two VWF CBDs, or functional fragments or derivatives thereof. In some embodiments, the one or more additional polypeptides comprise three VWF CBDs, or functional fragments or derivatives thereof. In some embodiments, the one or more additional polypeptides comprise four VWF CBDs, or functional fragments or derivatives thereof. In some embodiments, the one or more additional polypeptides comprise five VWF CBDs, or functional fragments or derivatives thereof. In some

embodiments, the one or more additional polypeptides comprise six or more VWF CBDs, or functional fragments or derivatives thereof.

[00662] In some embodiments, the fourth linker is from about 5 amino acids to about 30 amino acids in length. In some embodiments, the fourth linker is from about 5 amino acids to about 40 amino acids in length. In some embodiments, the fourth linker is from about 5 amino acids to about 50 amino acids in length. In some embodiments, the fourth linker may comprise 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, or more amino acids. In some embodiments, the fourth linker may be absent. The fourth linker may comprise or consist of any of various linkers disclosed herein, or any combination thereof. For example, a fourth linker of the present disclosure may comprise or consist of any of the sequences of SEQ ID NO: 18-19, 36-49, 75-93, or any combination thereof.

[00663] In some embodiments, the fourth linker can be a flexible linker, a rigid linker, or a cleavable linker such as, but not limited to, any such linkers as set for the Table 3.

[00664] In some embodiments, the fourth linker is a flexible linker.

[00665] In some embodiments, the fourth linker comprises the amino acid sequence $(G4S)_3$ (SEQ ID NO: 18). In some embodiments, the fourth linker consists of the amino acid sequence of (SEQ ID NO: 18).

[00666] In some embodiments, the fourth is a rigid linker.

[00667] In some embodiments, the fourth linker comprises the amino acid sequence $A(EAAAK)_4ALEA(EAAAK)_4A$ (SEQ ID NO: 73). In some embodiments, the second and/or the third linker consists of the amino acid sequence of SEQ ID NO: 73.

[00668] In some embodiments, the fourth linker comprises the amino acid sequence $A(EAAAK)_3A$ (SEQ ID NO: 74). In some embodiments, the fourth linker consists of the amino acid sequence of SEQ ID NO: 74.

[00669] In some embodiments, the IgG2a polypeptide comprises the amino acid sequence of SEQ ID NO: 102, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 102. In certain embodiments,

the nucleotide sequence that encodes IgG2a polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 102, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 102. In certain embodiments, the nucleotide sequence that encodes the IgG2a polypeptide comprises the nucleotide sequence of SEQ ID NO: 103, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 103. In certain embodiments, the IgG2a polypeptide comprises the amino acid sequence of SEQ ID NO: 102. In certain embodiments, the nucleotide sequence that encodes the IgG2a polypeptide comprises the nucleotide sequence of SEQ ID NO: 103.

[00670] In some embodiments, the IgG2a polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 102. In some embodiments, the IgG2a polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 102. In some embodiments, the IgG2a polypeptide consists of the amino acid sequence of SEQ ID NO: 102.

[00671] In some embodiments, the IgG2a polypeptide, or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 102.

[00672] In some embodiments, the IgG1 polypeptide comprises the amino acid sequence of SEQ ID NO: 151, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 151. In certain embodiments, the nucleotide sequence that encodes IgG1 polypeptide comprises the nucleotide sequence that

encodes the amino acid sequence of SEQ ID NO: 151, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 151. In certain embodiments, the IgG1 polypeptide comprises the amino acid sequence of SEQ ID NO: 151.

[00673] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 151. In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 151. In some embodiments, the IgG1 polypeptide consists of the amino acid sequence of SEQ ID NO: 151.

[00674] In some embodiments, the IgG1 polypeptide comprises the amino acid sequence of SEQ ID NO: 150, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 150. In certain embodiments, the nucleotide sequence that encodes IgG1 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 150, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 150. In certain embodiments, the nucleotide sequence that encodes the IgG1 polypeptide comprises the nucleotide sequence of SEQ ID NO: 149, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 149. In certain embodiments, the IgG1 polypeptide comprises

the amino acid sequence of SEQ ID NO: 150. In certain embodiments, the nucleotide sequence that encodes the IgG1 polypeptide comprises the nucleotide sequence of SEQ ID NO: 149.

[00675] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 150. In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 150. In some embodiments, the IgG1 polypeptide consists of the amino acid sequence of SEQ ID NO: 150.

[00676] In some embodiments, the IgG1 polypeptide comprises the amino acid sequence of SEQ ID NO: 104, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 104. In certain embodiments, the nucleotide sequence that encodes IgG1 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 104, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 104. In certain embodiments, the nucleotide sequence that encodes the IgG1 polypeptide comprises the nucleotide sequence of SEQ ID NO: 105, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 105. In certain embodiments, the IgG1 polypeptide comprises the amino acid sequence of SEQ ID NO: 104. In certain embodiments, the nucleotide sequence that encodes the IgG1 polypeptide comprises the nucleotide sequence of SEQ ID NO: 105.

[00677] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 104. In some embodiments, the IgG1 polypeptide, or the functional

fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 104. In some embodiments, the IgG1 polypeptide consists of the amino acid sequence of SEQ ID NO: 104.

[00678] In some embodiments, the IgG1 polypeptide or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 104.

[00679] In some embodiments, the IgG4 polypeptide comprises the amino acid sequence of SEQ ID NO: 106, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 106. In certain embodiments, the nucleotide sequence that encodes IgG4 polypeptide comprises the nucleotide sequence that encodes the amino acid sequence of SEQ ID NO: 106, or a variant thereof having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the amino acid sequence of SEQ ID NO: 106. In certain embodiments, the nucleotide sequence that encodes the IgG4 polypeptide comprises the nucleotide sequence of SEQ ID NO: 107, or a nucleotide sequence having at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 91%, at least about 92%, at least about 93%, at least about 94%, at least about 95%, at least about 96%, at least about 97%, at least about 98% or at least about 99%, sequence identity with the nucleotide sequence of SEQ ID NO: 107. In certain embodiments, the IgG4 polypeptide comprises the amino acid sequence of SEQ ID NO: 106. In certain embodiments, the nucleotide sequence that encodes the IgG4 polypeptide comprises the nucleotide sequence of SEQ ID NO: 107.

[00680] In some embodiments, the IgG4 polypeptide, or the functional fragment or derivative thereof comprises an amino acid sequence that has at least 80% sequence identity to the amino acid sequence of SEQ ID NO: 106. In some embodiments, the IgG4 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 106. In some embodiments, the IgG4 polypeptide consists of the amino acid sequence of SEQ ID NO: 106.

Recombinant Polynucleotides

[00681] In one aspect, the present disclosure provides recombinant polynucleotides encoding one or more of the above-described polypeptides. In one aspect, the present disclosure provides a recombinant rhabdovirus, e.g., a recombinant vesicular stomatitis virus (VSV), comprising the recombinant polynucleotides disclosed herein.

[00682] In some embodiments, provided herein is a recombinant polynucleotide comprising:

a) a nucleotide sequence encoding a vesicular stomatitis virus (VSV) nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

b) a nucleotide sequence encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

c) a nucleotide sequence encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

d) a nucleotide sequence encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

e) a nucleotide sequence encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and

f) a nucleotide sequence encoding a recombinant protein comprising (i) IL-12 polypeptide, or a functional fragment or derivative thereof, and (ii) a transmembrane domain.

[00683] In some embodiments, provided herein is a recombinant polynucleotide comprising:

a) a nucleotide sequence encoding a vesicular stomatitis virus (VSV) nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

b) a nucleotide sequence encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

c) a nucleotide sequence encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

d) a nucleotide sequence encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

e) a nucleotide sequence encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and

f) a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, wherein the recombinant protein is not membrane bound.

[00684] In some embodiments, the recombinant protein comprises a transmembrane domain. In some embodiments, the recombinant protein can be membrane bound. In some embodiments, the recombinant protein does not comprise a transmembrane domain. In some embodiments, the recombinant protein is not membrane bound. When the recombinant protein is not membrane bound, the recombinant protein may be a soluble and/or secreted protein.

[00685] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof, described herein.

[00686] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof, described herein.

[00687] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof, described herein.

[00688] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a first linker, described herein.

[00689] In various embodiments, the recombinant protein can further comprise a signal peptide described herein which can be operably linked to the IL-12 polypeptide. The signal peptide can be operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, or the IL-12 p35 subunit, or the functional fragment or derivative thereof. In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, described herein. In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof, described herein.

[00690] As a non-limiting example, the transmembrane domain can be derived from a B7.1 antigen of the present disclosure. In certain embodiments, the transmembrane domain can be

derived, e.g., without limitation, from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4). A topological domain described herein can be operably linked to the transmembrane domain, e.g., a transmembrane domain derived from a B7.1 antigen. In some embodiments, the topological domain can be derived from a B7.1 antigen. In certain embodiments, the topological domain can be derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[00691] In various embodiments, any of various recombinant polynucleotides of the present disclosure can further comprise one or more additional polypeptide described herein such as, but not limited to, a cluster of differentiation 4 (CD4) polypeptide, or a functional fragment or derivative thereof, described herein; a cluster of differentiation 46 (CD46) polypeptide, or a functional fragment or derivative thereof, described herein; a collagen-binding domain (CBD) derived from von Willebrand factor (VWF), or a functional fragment or derivative thereof, described herein; an IgG2a polypeptide, or a functional fragment or derivative thereof, described herein; an IgG1 polypeptide, or a functional fragment or derivative thereof, described herein; and/or an IgG4 polypeptide, or a functional fragment or derivative thereof, described herein, or any combination thereof.

[00692] In some embodiments, the one or more additional polypeptides are positioned between the IL-12 p35 subunit, or the functional fragment or derivative thereof, and the transmembrane domain.

[00693] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, is connected to the one or more additional polypeptides via a second linker described herein, and the one more additional polypeptides are connected to the transmembrane domain via a third linker described herein.

[00694] When the one or more additional polypeptides comprises two or more VWF CBDs, or functional fragments or derivatives thereof, each of the VWF CBDs, or the functional fragments or derivatives thereof, can be connected to the subsequent VWF CBD via a fourth linker described herein. In some embodiments, e.g., without limitation, the one or more additional polypeptides can comprise two VWF CBDs, or functional fragments or derivatives thereof.

[00695] In various embodiments of any of the above-described recombinant polynucleotides, the nucleotide sequence encoding the recombinant protein can be positioned, e.g., between the

nucleotide sequence encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof; at the 3' end of the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof; at the 5' end of the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof; between the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof; or between the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[00696] In various embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[00697] In various embodiments, the nucleotide sequence encoding the recombinant protein is positioned at the 3' end of the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[00698] In various embodiments, the nucleotide sequence encoding the recombinant protein is positioned at the 5' end of the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof.

[00699] In various embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof.

[00700] In various embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[00701] In various embodiments, a recombinant polynucleotide of the present disclosure can comprise a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence: a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P

polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, the recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof; a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, a VSV L polypeptide, or a functional fragment or derivative thereof, and the recombinant protein; the recombinant protein, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof; a VSV N polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof; or a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[00702] In some embodiments, the recombinant polynucleotide of the present disclosure comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, the recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[00703] In some embodiments, the recombinant polynucleotide of the present disclosure comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative

thereof, a VSV L polypeptide, or a functional fragment or derivative thereof, and the recombinant protein.

[00704] In some embodiments, the recombinant polynucleotide of the present disclosure comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, the recombinant protein, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[00705] In some embodiments, the recombinant polynucleotide of the present disclosure comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[00706] In some embodiments, the recombinant polynucleotide of the present disclosure comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[00707] Any of the recombinant polynucleotides of the present disclosure may comprise a VSV M polypeptide, or a functional fragment or derivative thereof, described herein. In certain embodiments, the VSV M polypeptide is a wild-type VSV M polypeptide. In certain embodiments, the VSV M polypeptide is a mutant VSV M polypeptide, e.g., a mutant VSV M polypeptide comprising a mutation at methionine (M) 51 such as, but not limited to, a substitution from methionine (M) to arginine I.

[00708] Any of the recombinant polynucleotides of the present disclosure may comprise a fusogenic polypeptide, or a functional fragment or derivative thereof, described herein. A non-

limiting example of a fusogenic polypeptide which may be used in the compositions and methods described herein is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

[00709] In some embodiments, a recombinant polynucleotide described herein is DNA.

[00710] In some embodiments, a recombinant polynucleotide described herein is RNA.

[00711] In some embodiments, provided herein is a recombinant polynucleotide which is an RNA molecule comprising:

i. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

ii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

iii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

iv. a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

v. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and/or

vi. a nucleotide sequence that is a template for a positive sense transcript encoding recombinant protein comprising (i.) an IL-12 polypeptide, or a functional fragment or derivative thereof, and (ii.) a transmembrane domain.

[00712] In some embodiments, provided herein is a recombinant polynucleotide which is an RNA molecule comprising:

i. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

ii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

iii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

iv. a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

v. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and/or

vi. a nucleotide sequence that is a template for a positive sense transcript encoding recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, wherein the recombinant protein is not membrane bound.

[00713] In some embodiments, the recombinant protein comprises a transmembrane domain. In some embodiments, the recombinant protein can be membrane bound. In some embodiments, the recombinant protein does not comprise a transmembrane domain. In some embodiments, the recombinant protein is not membrane bound. When the recombinant protein is not membrane bound, the recombinant protein may be a soluble and/or secreted protein.

[00714] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof, described herein.

[00715] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof, described herein.

[00716] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof, described herein.

[00717] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a first linker, described herein.

[00718] In various embodiments, the recombinant protein can further comprise a signal peptide described herein which can be operably linked to the IL-12 polypeptide. The signal peptide can be operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, or the IL-12 p35 subunit, or the functional fragment or derivative thereof. In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, described herein. In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof, described herein.

[00719] As a non-limiting example, the transmembrane domain can be derived from a B7.1 antigen of the present disclosure. In certain embodiments, the transmembrane domain can be derived, e.g., without limitation, from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4). A topological domain described herein can be operably linked to the transmembrane domain, e.g., a transmembrane domain derived from a B7.1 antigen. In some embodiments, the topological domain can be derived from a B7.1 antigen. In certain embodiments, the topological domain can be derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[00720] In various embodiments, a recombinant polynucleotide of the present disclosure can further comprise one or more additional polypeptide described herein such as, but not limited to, a cluster of differentiation 4 (CD4) polypeptide, or a functional fragment or derivative thereof, described herein; a cluster of differentiation 46 (CD46) polypeptide, or a functional fragment or derivative thereof, described herein; a collagen-binding domain (CBD) derived from von Willebrand factor (VWF), or a functional fragment or derivative thereof, described herein; an IgG2a polypeptide, or a functional fragment or derivative thereof, described herein; an IgG1 polypeptide, or a functional fragment or derivative thereof, described herein; and/or an IgG4 polypeptide, or a functional fragment or derivative thereof, described herein, or any combination thereof.

[00721] In some embodiments, the one or more additional polypeptides are positioned between the IL-12 p35 subunit, or the functional fragment or derivative thereof, and the transmembrane domain.

[00722] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, is connected to the one or more additional polypeptides via a second linker described herein, and the one more additional polypeptides are connected to the transmembrane domain via a third linker described herein.

[00723] When the one or more additional polypeptides comprises two or more VWF CBDs, or functional fragments or derivatives thereof, each of the VWF CBDs, or the functional fragments or derivatives thereof, can be connected to the subsequent VWF CBD via a fourth linker described herein. In some embodiments, e.g., without limitation, the one or more additional polypeptides can comprise two VWF CBDs, or functional fragments or derivatives thereof.

[00724] In some embodiments, provided herein is a recombinant rhabdovirus of the present disclosure, and the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned in one of the following positions: between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof; at the 5' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof; at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof; between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof; or between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[00725] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[00726] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 5' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[00727] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof.

[00728] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof.

[00729] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[00730] In certain embodiments, a recombinant polynucleotide described herein can comprise, from the 3' end to the 5' end of said recombinant polynucleotide: a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof; a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein; a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide

sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof; a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof; or a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00731] In some embodiments, the recombinant polynucleotide of the present disclosure comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M

polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00732] In some embodiments, the recombinant polynucleotide of the present disclosure comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein.

[00733] In some embodiments, the recombinant polynucleotide of the present disclosure comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00734] In some embodiments, the recombinant polynucleotide of the present disclosure comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense

transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00735] In some embodiments, the recombinant polynucleotide of the present disclosure comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[00736] In certain embodiments, the recombinant polynucleotides encoding the polypeptides disclosed herein may comprise one or more regulatory elements. The regulatory element may be capable of modulating expression of the polypeptides. Non-limiting examples of regulatory elements are promoters, initiation sites, polyadenylation (polyA) tails, IRES elements, enhancers, response elements, and termination signals. In some embodiments, the promoter is an inducible promoter.

[00737] Nucleic acid inserted into the genome of a VSV can be flanked by viral intragenic regions containing the gene transcription start and stop codes required for transcription of the inserted nucleic acid sequences by the viral polymerase.

Additional Nucleotides of the Disclosure

[00738] A nucleotide sequence that is a template for a positive sense transcript encoding a NIS polypeptide may be positioned downstream of nucleotide sequence encoding a Paramyxovirus (e.g., a measles virus) F polypeptide or nucleotide encoding a Paramyxovirus (e.g., a measles virus) H polypeptide. For example, a nucleotide sequence that is a template for a positive sense

transcript encoding a NIS polypeptide can be positioned between the nucleotide sequence that is a template for a positive sense transcript encoding a Paramyxovirus (e.g., a measles virus) F or H polypeptide and nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide. Such a position of may allow the viruses to express an amount of NIS polypeptide that (a) is effective to allow selective accumulation of iodide in infected cells, thereby allowing both imaging of viral distribution using radioiso-topes and radiotherapy targeted to infected cancer cells, and (b) is not so high as to be toxic to infected cells.

[00739] Any appropriate nucleotide sequence that is a template for a positive sense transcript encoding a NIS polypeptide can be inserted into the genome of a recombinant virus disclosed herein, for example, a recombinant virus comprising a rhabdovirus (e.g., vesiculovirus, including, without limitation, VSV) genome. For example, a nucleotide sequence that is a template for a positive sense transcript encoding a human NIS polypeptide may be inserted into the genome of a vesicular stomatitis virus. Examples of a nucleotide encoding NIS polypeptides include, without limitation, nucleotide encoding a human NIS polypeptide of the nucleotide sequence set forth in GenBank® Accession Nos. NM_000453.2 (GI No. 164663746), BC105049.1 (GI No. 85397913), or BC105047.1 (GI No. 85397519), nucleotide encoding a mouse NIS polypeptide of the nucleotide sequence set forth in GenBank® Accession Nos. NM_053248.2 (GI No. 162138896), AF380353.1 (GI No. 14290144), or AF235001.1 (GI No. 12642413), nucleotide encoding a chimpanzee NIS polypeptide of the nucleotide sequence set forth in GenBank® Accession No. XM_524154 (GI No. 114676080), nucleotide encoding a dog NIS polypeptide of the nucleotide sequence set forth in GenBank® Accession No. XM_541946 (GI No. 73986161), nucleotide encoding a cow NIS polypeptide of the nucleotide sequence set forth in GenBank® Accession No. XM_581578 (GI No. 297466916), nucleotide encoding a pig NIS polypeptide of the nucleotide sequence set forth in GenBank® Accession No. NM_214410 (GI No. 47523871), and nucleotide encoding a rat NIS polypeptide of the nucleotide sequence set forth in GenBank® Acces-sion No. NM_052983 (GI No. 158138504).

[00740] In some embodiments, the recombinant virus of the present disclosure may further comprise a nucleotide sequence that is a template for a positive sense transcript encoding a reporter polypeptide. A non-limiting example of a reporter polypeptide that may be used in accordance with the present disclosure is luciferase. In some embodiments, the luciferase may be selected from *Renilla* luciferase, Rluc8 mutant *Renilla* luciferase, (dCpG)Luciferase, NanoLuc reporter,

firefly luciferase, *Gaussia* luciferase (gLuc), MetLuc, *Vibrio fischeri* lumazine protein, *Vibrio harveyi* luminaze protein, inoflagellate luciferase, firefly luciferase YY5 mutant, firefly luciferase LGR mutant, firefly luciferase mutant E, and functional fragments or derivatives thereof.

[00741] In some embodiments, the reporter polypeptide is a fluorescent protein. In some embodiments, the fluorescent protein may be selected from green fluorescent protein (GFP), GFP-like fluorescent proteins, (GFP-like), enhanced green fluorescent protein (EGFP), yellow fluorescent protein (YFP), enhanced yellow fluorescent protein (EYFP), blue fluorescent protein (BFP), enhanced blue fluorescent protein (EBFP), cyan fluorescent protein (CFP), enhanced cyan fluorescent protein (ECFP), red fluorescent protein, superfolder GFP, superfolder YFP, orange fluorescent protein, red fluorescent protein, small ultrared fluorescent protein, FMN-binding fluorescent protein, dsRed, qFP611, Dronpa, TagRFP, KFP, EosFP, IrisFP, Dendra, Kaede, KikGr1, emerald fluorescent protein, Azami Green, mWasabi, TagGFP, TurboGFP, AcGFP, ZsGreen, T-Sapphire, and functional fragments or derivatives thereof.

[00742] Any appropriate method can be used to insert a nucleic acid sequence disclosed herein (e.g., a nucleotide sequence that is a template for a positive sense transcript encoding an IFN polypeptide) into the genome of a vesicular stomatitis virus.

Non-limiting Examples of Recombinant Polynucleotides

[00743] In certain aspects, the present disclosure provides recombinant polynucleotides comprising any nucleotide sequence(s) disclosed herein which can encode any polypeptides disclosed herein, e.g., recombinant proteins comprising an IL-12 polypeptide, or a functional fragment or derivative thereof.

[00744] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence that is a VSV leader sequence. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises, from 5' to 3', the sequence of SEQ ID NO: 165, or a nucleotide sequence having at least 80% sequence identity thereto. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed

herein comprises, from 3' to 5', the sequence of SEQ ID NO: 166, or a nucleotide sequence having at least 80% sequence identity thereto.

[00745] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 50, preferably the nucleotide sequence of SEQ ID NO: 50. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 50, or a nucleotide sequence having at least 80% sequence identity thereto.

[00746] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 52, preferably the nucleotide sequence of SEQ ID NO: 52. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 52, or a nucleotide sequence having at least 80% sequence identity thereto.

[00747] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 54, preferably the nucleotide sequence of SEQ ID NO: 54. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 54, or a nucleotide sequence having at least 80% sequence identity thereto.

[00748] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or

derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 56, preferably the nucleotide sequence of SEQ ID NO: 56. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 56, or a nucleotide sequence having at least 80% sequence identity thereto.

[00749] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 58, preferably the nucleotide sequence of SEQ ID NO: 58. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 58, or a nucleotide sequence having at least 80% sequence identity thereto.

[00750] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 60, preferably the nucleotide sequence of SEQ ID NO: 60. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 60, or a nucleotide sequence having at least 80% sequence identity thereto.

[00751] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 110, preferably the nucleotide sequence of SEQ ID NO: 110. In some embodiments, the polynucleotide sequence comprising the

nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 110, or a nucleotide sequence having at least 80% sequence identity thereto.

[00752] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 112, preferably the nucleotide sequence of SEQ ID NO: 112. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 112, or a nucleotide sequence having at least 80% sequence identity thereto.

[00753] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 163, preferably the nucleotide sequence of SEQ ID NO: 163. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 163, or a nucleotide sequence having at least 80% sequence identity thereto.

[00754] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 164, preferably the nucleotide sequence of SEQ ID NO: 164. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 164, or a nucleotide sequence having at least 80% sequence identity thereto.

[00755] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 114, preferably the nucleotide sequence of SEQ ID NO: 114. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 114, or a nucleotide sequence having at least 80% sequence identity thereto.

[00756] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 116, preferably the nucleotide sequence of SEQ ID NO: 116. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 116, or a nucleotide sequence having at least 80% sequence identity thereto.

[00757] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 118, preferably the nucleotide sequence of SEQ ID NO: 118. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 118, or a nucleotide sequence having at least 80% sequence identity thereto.

[00758] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%,

98%, 99%, or 100% identical to the sequence of SEQ ID NO: 120, preferably the nucleotide sequence of SEQ ID NO: 120. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 120, or a nucleotide sequence having at least 80% sequence identity thereto.

[00759] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 122, preferably the nucleotide sequence of SEQ ID NO: 122. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 122, or a nucleotide sequence having at least 80% sequence identity thereto.

[00760] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 124, preferably the nucleotide sequence of SEQ ID NO: 124. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 124, or a nucleotide sequence having at least 80% sequence identity thereto.

[00761] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 126, preferably the nucleotide sequence of SEQ ID NO: 126. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the

functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 126, or a nucleotide sequence having at least 80% sequence identity thereto.

[00762] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 128, preferably the nucleotide sequence of SEQ ID NO: 128. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 128, or a nucleotide sequence having at least 80% sequence identity thereto.

[00763] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 130, preferably the nucleotide sequence of SEQ ID NO: 130. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 130, or a nucleotide sequence having at least 80% sequence identity thereto.

[00764] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 132, preferably the nucleotide sequence of SEQ ID NO: 132. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 132, or a nucleotide sequence having at least 80% sequence identity thereto.

[00765] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or

derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 134, preferably the nucleotide sequence of SEQ ID NO: 134. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 134, or a nucleotide sequence having at least 80% sequence identity thereto.

[00766] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 136, preferably the nucleotide sequence of SEQ ID NO: 136. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 136, or a nucleotide sequence having at least 80% sequence identity thereto.

[00767] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 138, preferably the nucleotide sequence of SEQ ID NO: 138. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 138, or a nucleotide sequence having at least 80% sequence identity thereto.

[00768] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 140, preferably the nucleotide sequence of SEQ ID NO: 140. In some embodiments, the polynucleotide sequence comprising the

nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 140, or a nucleotide sequence having at least 80% sequence identity thereto.

[00769] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 142, preferably the nucleotide sequence of SEQ ID NO: 142. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 142, or a nucleotide sequence having at least 80% sequence identity thereto.

[00770] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 144, preferably the nucleotide sequence of SEQ ID NO: 144. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 144, or a nucleotide sequence having at least 80% sequence identity thereto.

[00771] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence at least 80%, such as at least 80%, 81%, 82%, 83%, 84%, 85%, 86%, 87%, 89%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99%, or 100% identical to the sequence of SEQ ID NO: 146, preferably the nucleotide sequence of SEQ ID NO: 146. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises the sequence of SEQ ID NO: 146, or a nucleotide sequence having at least 80% sequence identity thereto.

[00772] In some embodiments, a recombinant polynucleotide comprising a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof, disclosed herein comprises a nucleotide sequence that is a VSV trailer sequence. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises, from 5' to 3', the sequence of SEQ ID NO: 185, or a nucleotide sequence having at least 80% sequence identity thereto. In some embodiments, the polynucleotide sequence comprising the nucleotide sequence encoding the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, disclosed herein comprises, from 3' to 5', the sequence of SEQ ID NO: 186, or a nucleotide sequence having at least 80% sequence identity thereto.

Vectors

[00773] In a further aspect, the present disclosure provides a vector comprising any of the above-described recombinant polynucleotides. Such recombinant vectors may comprise recombinant polynucleotides encoding any of the various polypeptides disclosed above.

[00774] In some embodiments, the vector is a viral vector. Viral vectors which may be used in accordance with the disclosure include, without limitation, a rhabdovirus vector (e.g., VSV), a baculoviral vector, a herpes virus vector, a lentiviral vector, a retroviral vector, a vaccinia virus vector, an adeno-associated virus vector, an adenoviral vector, and an alphaviral vector. In some embodiments, the viral vector is a vaccinia virus vector.

[00775] In some embodiments, the vector is represented by a linear vector map as exemplified in **Figures 79A-79LL**.

[00776] In some embodiments, the vector is a non-viral vector. Non-viral vectors which may be used in accordance with the disclosure include, without limitation, single or double stranded DNA molecules that are used as templates for homology directed repair (HDR) based gene editing, minicircle plasmids, and transposon systems.

[00777] In certain aspects, the present disclosure provides a recombinant rhabdovirus, e.g., a recombinant vesicular stomatitis virus (VSV), comprising recombinant polynucleotides encoding polypeptides disclosed herein.

Host Cells and Virus Production

[00778] In one aspect, the present disclosure provides a host cell comprising a recombinant virus or recombinant polynucleotide described herein. A host cell can be any cell that comprises a heterologous nucleic acid. By way of a non-limiting example, the heterologous nucleic acid may be a vector. A host cell, for example, without limitation, may be a cell from any organism that is used, manipulated, modified, selected, transformed, or grown, for the production of a substance by the cell, e.g. the expression by the cell of, an RNA or DNA sequence, a gene, a protein, or an enzyme.

[00779] In some embodiments, the host cell may be selected based on the vector backbone. In some embodiments, a cosmid or plasmid or may be introduced into a prokaryote host cell for replication of several types of vectors. Bacterial cells including, may be used as host cells for vector replication and/or expression or for phage viruses. Eukaryotic cells that can be used as host cells include, but are not limited to mammals, insects and yeast. Non-limiting examples of mammalian eukaryotic host cells are PC12, NIH3T3, HeLa, COS, Jurkat, 293, CHO, and Saos.

[00780] Packaging cells useful for production of the recombinant viruses described herein include, e.g., animal cells permissive for the virus, or cells modified to be permissive for the virus; or the packaging cell construct, for example, with the use of a transformation agent such as calcium phosphate. Non-limiting examples of packaging cell lines useful for producing recombinant viruses described herein include, e.g., human embryonic kidney 293 (HEK-293) cells (e.g., American Type Culture Collection [ATCC] No. CRL-1573), HEK-293 cells that contain the SV40 Large T-antigen (HEK-293T or 293T), HEK293T/17 cells, human sarcoma cell line HT-1080 (CCL-121), lymphoblast-like cell line Raj I (CCL-86), glioblastoma-astrocytoma epithelial-like cell line U87-MG (HTB-14), T-lymphoma cell line HuT78 (TIB-161), NIH/3T3 cells, Chinese Hamster Ovary cells (CHO) (e.g., ATCC Nos. CRL9618, CCL61, CRL9096), HeLa cells (e.g., ATCC No. CCL-2), Vero cells, NIH 3T3 cells (e.g., ATCC No. CRL-1658), Huh-7 cells, BHK cells (e.g., ATCC No. CCL10), PC12 cells (ATCC No. CRL1721), COS cells, COS-7 cells (ATCC No. CRL1651), RATI cells, mouse L cells (ATCC No. CCLI.3), HLHepG2 cells, CAP cells, CAP-T cells, and the like.

[00781] Further non-limiting examples of packaging cells and/or systems that may be useful for the production of recombinant viruses described herein include, for example, L929 cells, the FLY viral packaging cell system outlined in Cosset et al (1995) J Virol 69,7430-7436, NS0 (murine

myeloma) cells, human amniocytic cells (e.g., CAP, CAP-T), yeast cells (including, but not limited to, *S. cerevisiae*, *Pichia pastoris*), plant cells (including, but not limited to, Tobacco NT1, BY-2), insect cells (including but not limited to SF9, S2, SF21, Tni (e.g. High 5)) or bacterial cells (including, but not limited to, *E. coli*).

[00782] Additional packaging cells and systems, packaging techniques and vectors for packaging the nucleic acid genome into the pseudotyped virus may include method steps comprising, e.g., construction of structural protein expression cassettes comprising plasmids for vector-inducible expression of virus structural proteins, and incorporation of any additional elements by polymerase chain reaction (PCR) amplification or by using synthetic oligonucleotides. By way of a non-limiting example, for selection, screening, and/or characterization of packaging cell lines, cells transfected with expression cassette constructs may be selected with, e.g., G418 or hygromycin. Pooled foci of drug-resistant cells may be cloned by limiting dilution, and individual clones may be screened for packaging activity, e.g., by transfection with a vector using, e.g., Lipofection or electroporation. Those clones with the highest levels of activity may be expanded for further use. Northern and western blot analysis of vector-specific or structural protein-specific RNA and proteins expressed in packaging cells may be performed, for example, to confirm presence or absence of such vector-specific or structural protein-specific RNA and proteins and/or determine levels of the vector-specific or structural protein-specific RNA and proteins. The titer of replication-incompetent vector particles in clarified packaging cell line culture supernatants may be determined, e.g., by infection of naïve monolayers with serial dilutions, X-gal staining and counting the total number of stained cells per well at the appropriate dilution. Vector titer may be designated as infectious units (IU)/ml. Contaminating replication-competent virus in culture supernatants may detected by standard plaque assay (plaque-forming units or PFU/ml) and by serial undiluted passages in naïve cells. Methods of packaging include using packaging cells that permanently express the viral components, or by transiently transfecting cells with plasmids.

[00783] In one aspect, the current disclosure provides cells for production of the recombinant VSV of the disclosure. Example cells include, but are not limited to, any cell in which VSV grows, e.g., mammalian cells and some insect (e.g., Drosophila) cells. A vast number of primary cells and cell lines commonly known in the art can be used as host cells. By way of example, a cell line that can used to produce a recombinant virus disclosed herein includes but is not limited to BHK (baby hamster kidney) cells, CHO (Chinese hamster ovary) cells, HeLa (human) cells, mouse L

cells, Vero (monkey) cells (including Vero-αHis cells), Vero-Ace-2 cells, Vero-TRMPSS2 cells, Vero-E6 cells, ESK-4, PK-15, EMSK cells, MDCK (Madin-Darby canine kidney) cells, MDBK (Madin-Darby bovine kidney) cells, 293 (human) cells, Hep-2 cells, primary chick embryo fibroblasts, primary chick embryo fibroblasts, quasi-primary continuous cell lines (e.g. AGMK-African green monkey kidney cells), human diploid primary cell lines (e.g. WI-38 and MRC5 cells), and Monkey Diploid Cell Line (e.g. FRhL-Fetal Rhesus Lung cells).

[00784] In a related aspect, described herein is a method of producing a recombinant virus disclosed herein. Such a method may comprise culturing a packaging cell in conditions sufficient to produce a plurality of recombinant viruses. In some embodiments, the method further comprises collecting the recombinant viruses. In one specific embodiment, the collecting step comprises one or more of the following steps: clearing cell debris, treating the supernatant containing recombinant viruses with Dnase I and $MgCl_2$, concentrating the recombinant viruses, and purifying the recombinant viruses.

[00785] In the methods described herein, plasmids/vectors used for recombinant virus production can be introduced into the packaging cells using, e.g., electroporation (using for example Multiporator, Genepulser, MaxCyte Transfection Systems), PEI, Ca^{2+}-mediated transfection or via liposomes (for example: "Lipofectamine"), non-liposomal compounds (for example: "Fugene" or nucleofection) into cells.

[00786] Recombinant VSV particles described herein can be produced using, e.g., by providing in an appropriate host cell: (a) DNA that can be transcribed to encode VSV antigenomic (+) RNA (complementary to the VSV genome), (b) a recombinant source of VSV nucleoprotein (N) protein, (c) a recombinant source of VSV phosphoprotein (P) protein, (d) a recombinant source of VSV large protein (L), and I foreign DNA; under conditions such that the DNA is transcribed to produce the antigenomic RNA, and a VSV is produced that contains genomic RNA complementary to the antigenomic RNA produced and foreign RNA, which is not naturally a part of the VSV genome, from the DNA. Methods and compositions useful for generating recombinant VSV particles may be found, for example, in U.S. Patent Nos. 7,153,510; 9,861,668; 8,012,489; 9,630,996; 8,287,878; 9,248,178; U.S. Patent Publication Nos. 2014/0271564; 2012/0121650; Fukishi et al., J. Gen. Virol., 2005, 86:2269-2274, each of which are Incorporated by reference herein In their entirety.

[00787] Any DNA that can be transcribed to produce VSV antigenomic (+) RNA (complementary to the VSV genome) can be used for the construction of a recombinant DNA

containing foreign DNA encoding a heterologous (foreign) protein or peptide, for use in producing the recombinant VSV particles described herein. In certain embodiments, the DNA that can be transcribed to encode VSV antigenomic (+) RNA comprises at least genes for the VSV N protein, the VSV P protein, and the VSV L protein. In certain embodiments, the DNA that can be transcribed to encode VSV antigenomic (+) RNA comprises at least genes for the VSV N protein, the VSV P protein, the VSV L protein, and the foreign protein or peptide (e.g., a fusogenic molecule). In certain embodiments, DNA that can be transcribed to encode VSV antigenomic (+) RNA can further encode the VSV matrix (M) protein and/or G glycoprotein.

[00788] DNA that can be transcribed to produce VSV (for example) antigenomic (+) RNA (such DNA being referred to herein as "VSV (−) DNA") is available in the art and/or can be obtained by standard methods. VSV (−) DNA for any serotype or strain known in the art, e.g., the New Jersey or Indiana serotypes of VSV, can be used. The complete nucleotide and deduced protein sequence of the VSV genome is known, and is available as Genbank VSVCG, Accession No. J02428; NCBI Seq ID 335873; An example of the complete sequence of the VSV(−) DNA that is contained in plasmid pVSVFL(+) is deposited with the American Type Culture Collection (ATCC), and assigned Accession No. 97134. In some embodiments, the nucleotide sequence of plasmid pVSVFL(+) comprises the nucleotide sequence of SEQ ID NO: 11. In some embodiments, the plasmid is anti-genomic VSV and uses a T7 promoter, see Marqués, M. C., Andreu-Moreno, I., Sanjuán, R., et al. An efficient plasmid-based system for the recovery of recombinant vesicular stomatitis virus encoding foreign glycoproteins. *Sci Rep*, 14, 14644 (**2024**).

[00789] VSV (−) DNA, if not already available, can be prepared as follows: VSV genomic RNA can be purified from virus preparations, and reverse transcription with long distance polymerase chain reaction can be used to generate the VSV (−) DNA. Alternatively, after purification of genomic RNA, VSV mRNA can be synthesized *in vitro*, and cDNA can be prepared, followed by insertion into cloning vectors. Individual cDNA clones of VSV RNA can be joined by use of small DNA fragments covering the gene junctions, generated by use of reverse transcription and polymerase chain reaction (RT-PCR) (from VSV genomic RNA).

[00790] In certain embodiments, one or more, usually unique, restriction sites (e.g., in a polylinker) are introduced into the VSV (−) DNA, in intergenic regions, or 5′ of the sequence complementary to the 3′ end of the VSV genome, or 3′ of the sequence complementary to the 5′ end of the VSV genome, to facilitate insertion of the foreign DNA.

[00791] In certain embodiments, the VSV (−) DNA is constructed to have a promoter operatively linked thereto. The promoter should be capable of initiating transcription of the (−) DNA in an animal or insect cell in which it is desired to produce the recombinant VSV. Promoters which may be used include, but are not limited to, the SV40 early promoter region, the promoter contained in the 3′ long terminal repeat of Rous sarcoma virus, the herpes thymidine kinase promoter, the regulatory sequences of the metallothionein gene; heat shock promoters (e.g., hsp70 for use in Drosophila S2 cells); the ADC (alcohol dehydrogenase) promoter, PGK (phosphoglycerol kinase) promoter, alkaline phosphatase promoter, and the following animal transcriptional control regions, which exhibit tissue specificity and can be used in transgenic animals: elastase I gene control region which is active in pancreatic acinar cells; insulin gene control region which is active in pancreatic beta cells; immunoglobulin gene control region which is active in lymphoid cells; mouse mammary tumor virus control region which is active in testicular, breast, lymphoid, and mast cells; albumin gene control region which is active in liver; alpha-fetoprotein gene control region which is active in liver; alpha 1-antitrypsin gene control region which is active in the liver; beta-globin gene control region which is active in myeloid cells; myelin basic protein gene control region which is active in oligodendrocyte cells in the brain; and myosin light chain-2 gene control region which is active in skeletal muscle. Preferably, the promoter is an RNA polymerase promoter, preferably a bacteriophage or viral or insect RNA polymerase promoter, including, but not limited to, the promoters for T7 RNA polymerase, SP6 RNA polymerase, and T3 RNA polymerase. If an RNA polymerase promoter is used in which the RNA polymerase is not endogenously produced by the host cell in which it is desired to produce the recombinant VSV, a recombinant source of the RNA polymerase must also be provided in the host cell.

[00792] The VSV (−) DNA can be operably linked to a promoter before or after insertion of foreign DNA. In certain embodiments, a transcriptional terminator is situated downstream of the VSV (−) DNA.

[00793] In another embodiment, a DNA sequence that can be transcribed to produce a ribozyme sequence is situated at the immediate 3′ end of the VSV (−) DNA, prior to the transcriptional termination signal, so that upon transcription a self-cleaving ribozyme sequence is produced at the 3′ end of the antigenomic RNA, which ribozyme sequence will autolytically cleave (after a U) this fusion transcript to release the exact 3′ end of the VSV antigenomic (+) RNA. Any ribozyme

sequence may be used if the correct sequence is recognized and cleaved. In a preferred aspect, hepatitis delta virus (HDV) ribozyme is used.

[00794] An example of a VSV (−) DNA for use, for insertion of foreign DNA, can thus comprise (in 5′ to 3′ order) the following operably linked components: the T7 RNA polymerase promoter, VSV (−) DNA, a DNA sequence that is transcribed to produce an HDV ribozyme sequence (immediately downstream of the VSV (−) DNA), and a T7 RNA polymerase transcription termination site.

[00795] Examples of plasmids that can be used in the present disclosure are pVSVFL(+) or pVSVSS1.

[00796] In certain embodiments, foreign DNA is inserted into an intergenic region, or a portion of the VSV (−) DNA that is transcribed to form the noncoding region of a viral mRNA. In certain embodiments, the foreign DNA is inserted into a coding region of the VSV genome that is non-essential to the virus's development, growth and/or functions. In certain embodiments, the VSV G gene is disrupted. In certain embodiments, the foreign DNA insertion does not disrupt the G gene or VSV G protein function.

Pharmaceutical Compositions

[00797] Also disclosed herein are compositions, e.g., pharmaceutical compositions, comprising the recombinant viruses and/or polynucleotides described herein, and a carrier and/or excipient such as, but not limited to, a pharmaceutically acceptable carrier and/or excipient. In addition, disclosed herein are pharmaceutical dosage forms comprising the recombinant viruses described herein.

[00798] Pharmaceutical compositions based on the recombinant viruses and/or polynucleotides disclosed herein can be formulated in any conventional manner using one or more physiologically acceptable carriers and/or excipients. The recombinant viruses and/or polynucleotides may be formulated for administration by, for example, injection, inhalation or insulation (either through the mouth or the nose) or by oral, buccal, parenteral or rectal administration, or by administration directly to a tumor.

[00799] The pharmaceutical compositions can be formulated for a variety of modes of administration, including systemic, topical, or localized administration. Techniques and formulations can be found in, for example, Remington's Pharmaceutical Sciences, Meade Publishing Co., Easton, Pa. For systemic administration, injection is preferred, including

intramuscular, intravenous, intraperitoneal, and subcutaneous. For the purposes of injection, the pharmaceutical compositions can be formulated in liquid solutions, preferably in physiologically compatible buffers, such as Hank's solution or Ringer's solution. In addition, the pharmaceutical compositions may be formulated in solid form and redissolved or suspended immediately prior to use. Lyophilized forms of the pharmaceutical composition are also suitable.

[00800] For oral administration, the pharmaceutical compositions may take the form of, for example, tablets or capsules prepared by conventional means with pharmaceutically acceptable excipients such as binding agents (e.g. pregelatinized maize starch, polyvinylpyrrolidone or hydroxypropyl methylcellulose); fillers (e.g. lactose, microcrystalline cellulose or calcium hydrogen phosphate); lubricants (e.g. magnesium stearate, talc or silica); disintegrants (e.g. potato starch or sodium starch glycolate); or wetting agents (e.g. sodium lauryl sulfate). The tablets can also be coated by methods well known in the art. Liquid preparations for oral administration may take the form of, for example, solutions, syrups or suspensions, or they may be presented as a dry product for constitution with water or other suitable vehicle before use. Such liquid preparations may be prepared by conventional means with pharmaceutically acceptable additives such as suspending agents (e.g. sorbitol syrup, cellulose derivatives or hydrogenated edible fats); emulsifying agents (e.g. lecithin or acacia); non-aqueous vehicles (e.g. ationd oil, oily esters, ethyl alcohol or fractionated vegetable oils); and preservatives (e.g. methyl or propyl-p-hydroxybenzoates or sorbic acid). The preparations can also contain buffer salts, flavoring, coloring and sweetening agents as appropriate.

[00801] The pharmaceutical compositions can be formulated for parenteral administration by injection, e.g., by bolus injection or continuous infusion. Formulations for injection can be presented in a unit dosage form, e.g., in ampoules or in multi-dose containers, with an optionally added preservative. The pharmaceutical compositions can further be formulated as suspensions, solutions, or emulsions in oily or aqueous vehicles, and may contain other agents including suspending, stabilizing and/or dispersing agents.

[00802] Additionally, the pharmaceutical compositions can also be formulated as a depot preparation. These long-acting formulations can be administered by implantation (e.g., subcutaneously or intramuscularly) or by intramuscular injection. Thus, for example, the compounds may be formulated with suitable polymeric or hydrophobic materials (e.g., as an emulsion in an acceptable oil) or ion exchange resins, or as sparingly soluble derivatives, for

example, as a sparingly soluble salt. Other suitable delivery systems include microspheres, which offer the possibility of local noninvasive delivery of drugs over an extended period of time. This technology can include microspheres having a precapillary size, which can be injected via a coronary catheter into any selected part of an organ without causing inflammation or ischemia. The administered therapeutic is then slowly released from the microspheres and absorbed by the surrounding cells present in the selected tissue.

[00803] The recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, disclosed herein, can be administered with a device for allowing sustained release. A formulation for sustained release of the recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, can include, e.g., a polymeric excipient, e.g., collagen or a swellable or non-swellable gel. A therapeutically effective amount of the recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, can be provided within a polymeric excipient, wherein the composition comprising the excipient and recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, is implanted at a site of cancer cells, e.g., in proximity to or within a tumor. Bodily fluids present in a subject gradually dissolve the excipient, leading to continuously released effective amounts of the recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, over a period of time. Alternatively, a device for allowing sustained release may contain a series of alternating active and spacer layers. Each active layer typically contains a dose of the recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, embedded in excipient. Each spacer layer contains only excipient and/or low concentrations, e.g., lower than an effective amount, of the recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof. As each successive layer of the device dissolves, pulsed doses of the recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, are delivered. The size and/or formulation of the spacer layers determines the time interval between doses and is optimized according to the therapeutic regimen of interest.

[00804] Systemic administration can also be by transmucosal or transdermal means. For transmucosal or transdermal administration, penetrants appropriate to the barrier to be permeated are used in the formulation. Such penetrants are generally known in the art, and include, for example, for transmucosal administration, bile salts, and fusidic acid derivatives. In addition, detergents may be used to facilitate permeation. Transmucosal administration can occur using

nasal sprays or suppositories. For topical administration, the recombinant viruses described herein can be formulated into ointments, salves, gels, or creams as generally known in the art. A wash solution can also be used locally to treat an injury or inflammation in order to accelerate healing.

[00805] Pharmaceutical forms suitable for injectable use can include sterile aqueous solutions or dispersions; formulations including sesame oil, peanut oil or aqueous propylene glycol; and sterile powders for the extemporaneous preparation of sterile injectable solutions or dispersions. In all cases, the form must be sterile and must be fluid. It must be stable under the conditions of manufacture and certain storage parameters (e.g., refrigeration and freezing) and must be preserved against the contaminating action of microorganisms, such as bacteria and fungi.

[00806] In some embodiments, the pharmaceutical composition is stable upon storage at room temperature (e.g., 15-25 °C), cold storage (e.g., 2-8 °C), and frozen storage (e.g., about -20 °C or about -65 °C). In some embodiments, the pharmaceutical composition is stable upon storage for at least one day, at least one week, at least two weeks, at least three weeks, at least one month, at least 2 months, at least 3 months, at least 4 months, at least 5 months, at least 6 months, at least 7 months, at least 8 months, at least 9 months, at least 10 months, at least 11 months, or at least 1 year of storage. In some embodiments, the pharmaceutical composition is stable upon storage, comprising at least 50%, at least 60%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, or at least 95% of the initial titer of the recombinant virus as described herein.

[00807] If formulations disclosed herein are used as a therapeutic to boost an immune response in a subject, a therapeutic agent can be formulated into a composition in a neutral or salt form. Pharmaceutically acceptable salts, include the acid addition salts (formed with the free amino groups of the protein) and which are formed with inorganic acids such as, for example, hydrochloric or phosphoric acids, or such organic acids as acetic, oxalic, tartaric, mandelic, and the like. Salts formed with the free carboxyl groups can also be derived from inorganic bases such as, for example, sodium, potassium, ammonium, calcium, or ferric hydroxides, and such organic bases as isopropylamine, trimethylamine, histidine, procaine and the like.

[00808] A carrier can also be a solvent or dispersion medium containing, for example, water, ethanol, polyol (for example, glycerol, propylene glycol, and liquid polyethylene glycol, and the like), suitable mixtures thereof, and vegetable oils. The proper fluidity can be maintained, for example, using a coating, such as lecithin, by the maintenance of the required particle size in the case of dispersion and by the use of surfactants. The prevention of the action of microorganisms

can be brought about by various antibacterial and antifungal agents known in the art. In many cases, it will be preferable to include isotonic agents, for example, sugars or sodium chloride. Prolonged absorption of the injectable compositions can be brought about by the use in the compositions of agents delaying absorption, for example, aluminum monostearate and gelatin.

[00809] Sterile injectable solutions can be prepared by incorporating the active compounds or constructs in the required amount in the appropriate solvent with various of the other ingredients enumerated above, as required, followed by filtered sterilization.

[00810] Upon formulation, solutions can be administered in a manner compatible with the dosage formulation and in such amount as is therapeutically effective. The formulations are easily administered in a variety of dosage forms, such as the type of injectable solutions described above, but slow-release capsules or microparticles and microspheres and the like can also be employed.

[00811] For parenteral administration in an aqueous solution, for example, the solution should be suitably buffered if necessary and the liquid diluent first rendered isotonic with sufficient saline or glucose. These particular aqueous solutions are especially suitable for intravenous, intratumorally, intramuscular, subcutaneous and intraperitoneal administration. In this context, sterile aqueous media that can be employed will be known to those of skill in the art considering the present disclosure. For example, one dosage could be dissolved in 1 ml of isotonic NaCl solution and either added to 1000 ml of hypodermoclysis fluid or injected at the proposed site of infusion.

[00812] The person responsible for administration will, in any event, determine the appropriate dose for the individual subject. For example, a subject may be administered recombinant viruses described herein on a daily or weekly basis for a time period or on a monthly, bi-yearly or yearly basis depending on need or exposure to a pathogenic organism or to a condition in the subject (e.g., cancer).

[00813] In addition to the compounds formulated for parenteral administration, such as intravenous, intratumorally, intradermal or intramuscular injection, other pharmaceutically acceptable forms include, e.g., tablets or other solids for oral administration; liposomal formulations; time release capsules; biodegradable and any other form currently used.

[00814] One may also use intranasal or inhalable solutions or sprays, aerosols, or inhalants. Nasal solutions can be aqueous solutions designed to be administered to the nasal passages in drops or sprays. Nasal solutions can be prepared so that they are similar in many respects to nasal

secretions. Thus, the aqueous nasal solutions usually are isotonic and slightly buffered to maintain a pH of 5.5 to 7.5. In addition, antimicrobial preservatives, similar to those used in ophthalmic preparations, and appropriate drug stabilizers, if required, may be included in the formulation. Various commercial nasal preparations are known and can include, for example, antibiotics and antihistamines and are used for asthma prophylaxis.

[00815] Oral formulations can include excipients as, for example, pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharine, cellulose, magnesium carbonate and the like. These compositions take the form of solutions, suspensions, tablets, pills, capsules, sustained release formulations or powders. In certain defined embodiments, oral pharmaceutical compositions will include an inert diluent or assimilable edible carrier, or they may be enclosed in hard- or soft-shell gelatin capsule, or they may be compressed into tablets, or they may be incorporated directly with the food of the diet. For oral therapeutic administration, the active compounds may be incorporated with excipients and used in the form of ingestible tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like.

[00816] The tablets, troches, pills, capsules and the like may also contain the following: a binder, as gum tragacanth, acacia, cornstarch, or gelatin; excipients, such as dicalcium phosphate; a disintegrating agent, such as corn starch, potato starch, alginic acid and the like; a lubricant, such as magnesium stearate; and a sweetening agent, such as sucrose, lactose or saccharin may be added or a flavoring agent, such as peppermint, oil of wintergreen, or cherry flavoring. When the dosage unit form is a capsule, it may contain, in addition to materials of the above type, a liquid carrier. Various other materials may be present as coatings or to otherwise modify the physical form of the dosage unit. For instance, tablets, pills, or capsules may be coated with shellac, sugar or both. A syrup of elixir may contain the active compounds sucrose as a sweetening agent methyl and propylparabens as preservatives, a dye and flavoring, such as cherry or orange flavor.

[00817] Further embodiments disclosed herein can concern kits for use with methods and compositions. Kits can also include a suitable container, for example, vials, tubes, mini- or microfuge tubes, test tube, flask, bottle, syringe, or other container. Where an additional component or agent is provided, the kit can contain one or more additional containers into which this agent or component may be placed. Kits herein will also typically include a means for containing the recombinant viruses and any other reagent containers in close confinement for commercial sale. Such containers may include injection or blow-molded plastic containers into

which the desired vials are retained. Optionally, one or more additional active agents such as, e.g., anti-inflammatory agents, anti-viral agents, anti-fungal, anti-bacterial agents, or anti-tumor agents may be needed for compositions described.

[00818] Dose ranges and frequency of administration can vary depending on the nature of the recombinant viruses and the medical condition, as well as parameters of a specific patient and the route of administration used. In some embodiments, recombinant viral compositions can be administered to a subject at a dose ranging from about $1x10^5$ plaque forming units (pfu) to about $1x10^{15}$ pfu, depending on mode of administration, the route of administration, the nature of the disease and condition of the subject. In some cases, the recombinant viral compositions can be administered at a dose ranging from about $1x10^8$ pfu to about $1x10^{15}$ pfu, or from about $1x10^{10}$ pfu to about $1x10^{15}$ pfu, or from about $1x10^8$ pfu to about $1x10^{12}$ pfu. A more accurate dose can also depend on the subject in which it is being administered. For example, a lower dose may be required if the subject is juvenile, and a higher dose may be required if the subject is an adult human subject. In certain embodiments, a more accurate dose can depend on the weight of the subject. In certain embodiments, for example, a juvenile human subject can receive from about $1x10^8$ pfu to about $1x10^{10}$ pfu, while an adult human subject can receive a dose from about $1x10^{10}$ pfu to about $1x10^{12}$ pfu.

[00819] In some embodiments, recombinant viral compositions described herein can be administered at a dose such as, but not limited to, 10^{12}, 10^{13}, 10^{14}, 10^{15}, and 10^{16} vector genomes/mL. Further examples of recombinant viral composition doses include about 10^{12}, about 10^{13}, about 10^{14}, about 10^{15}, and about 10^{16} vector genomes (vg)/mL, or between about 10^{12} to about 10^{16}, between about 10^{12} to about 10^{15}, between about 10^{12} to about 10^{14}, between about 10^{12} to about 10^{13}, between about 10^{13} to about 10^{16}, between about 10^{14} to about 10^{16}, between about 10^{15} to about 10^{16}, or between about 10^{13} to about 10^{15} vg/mL. Other examples of recombinant viral composition doses include about 10^{12}, about 10^{13}, about 10^{14}, about 10^{15}, and about 10^{16} vector genomes (vg)/kg of body weight, or between about 10^{12} to about 10^{16}, between about 10^{12} to about 10^{15}, between about 10^{12} to about 10^{14}, between about 10^{12} to about 10^{13}, between about 10^{13} to about 10^{16}, between about 10^{14} to about 10^{16}, between about 10^{15} to about 10^{16}, or between about 10^{13} to about 10^{15} vg/kg of body weight. In one example, the recombinant viral composition dose is between about 10^{13} to about 10^{14} vg/mL or vg/kg. In another example, the recombinant viral composition dose is between about 10^{12} to about 10^{13} vg/mL or vg/kg (e.g., between about

10^{12} to about 10^{13} vg/kg). In another example, the recombinant viral composition dose is between about 10^{12} to about 10^{14} vg/mL or vg/kg (e.g., between about 10^{12} to about 10^{14} vg/kg).

[00820] In some embodiments, recombinant viral compositions described herein can be administered at a dose such as, but not limited to, $1x10^{7}$, $1x10^{8}$, $1x10^{9}$, $1x10^{10}$, $1x10^{11}$, $1x10^{12}$, $1x10^{13}$, $1x10^{14}$, $1x10^{15}$ and $1x10^{16}$ $TCID_{50}$/mL. Further examples of recombinant viral composition doses include about 1x107, about $1x10^{8}$, about $1x10^{9}$, about $1x10^{10}$, about $1x10^{11}$, about $1x10^{12}$, about $1x10^{13}$, about $1x10^{14}$, about $1x10^{15}$ and about $1x10^{16}$ $TCID_{50}$/mL, or between about $1x10^{7}$ to about $1x10^{16}$, between about $1x10^{7}$ to about $1x10^{15}$, between about $1x10^{7}$ to about $1x10^{14}$, between about $1x10^{7}$ to about $1x10^{13}$, between about $1x10^{7}$ to about $1x10^{12}$, between about $1x10^{7}$ to about $1x10^{11}$, between about $1x10^{7}$ to about $1x10^{10}$, between about $1x10^{7}$ to about $1x10^{9}$, between about $1x10^{7}$ to about $1x10^{8}$, between about $1x10^{8}$ to about $1x10^{16}$, between about $1x10^{8}$ to about $1x10^{15}$, between about $1x10^{8}$ to about $1x10^{14}$, between about $1x10^{8}$ to about $1x10^{13}$, between about $1x10^{8}$ to about $1x10^{12}$, between about $1x10^{8}$ to about $1x10^{11}$, between about $1x10^{8}$ to about $1x10^{10}$, between about $1x10^{8}$ to about $1x10^{9}$, between about $1x10^{9}$ to about $1x10^{16}$, between about $1x10^{9}$ to about $1x10^{15}$, between about $1x10^{9}$ to about $1x10^{14}$, between about $1x10^{9}$ to about $1x10^{13}$, between about $1x10^{9}$ to about $1x10^{12}$, between about $1x10^{9}$ to about $1x10^{11}$, between about $1x10^{9}$ to about $1x10^{10}$, between about $1x10^{10}$ to about $1x10^{16}$, between about $1x10^{10}$ to about $1x10^{15}$, between about $1x10^{10}$ to about $1x10^{14}$, between about $1x10^{10}$ to about $1x10^{13}$, between about $1x10^{10}$ to about $1x10^{12}$, between about $1x10^{10}$ to about $1x10^{11}$, between about $1x10^{11}$ to about $1x10^{16}$, between about $1x10^{11}$ to about $1x10^{15}$, between about $1x10^{11}$ to about $1x10^{14}$, between about $1x10^{11}$ to about $1x10^{13}$, between about $1x10^{11}$ to about $1x10^{12}$, between about $1x10^{12}$ to about $1x10^{16}$, between about $1x10^{12}$ to about $1x10^{15}$, between about $1x10^{12}$ to about $1x10^{14}$, between about $1x10^{12}$ to about $1x10^{13}$, between about $1x10^{13}$ to about $1x10^{16}$, between about $1x10^{13}$ to about $1x10^{15}$, between about $1x10^{13}$ to about $1x10^{14}$, between about $1x10^{14}$ to about $1x10^{16}$, between about $1x10^{14}$ to about $1x10^{15}$, and between about $1x10^{15}$ to about $1x10^{16}$ $TCID_{50}$/mL. In some embodiments, the recombinant viral composition dose is about $2x10^{7}$, about $2x10^{8}$, about $2x10^{9}$, about $2x10^{10}$, about $2x10^{11}$, about $2x10^{12}$, about $2x10^{13}$, about $2x10^{14}$, about $2x10^{15}$, about $2x10^{16}$, about $3x10^{7}$, about $3x10^{8}$, about $3x10^{9}$, about $3x10^{10}$, about $3x10^{11}$, about $3x10^{12}$, about $3x10^{13}$, about $3x10^{14}$, about $3x10^{15}$, about $3x10^{16}$, about $4x10^{7}$, about $4x10^{8}$, about $4x10^{9}$, about $4x10^{10}$, about $4x10^{11}$, about $4x10^{12}$, about $4x10^{13}$, about $4x10^{14}$, about $4x10^{15}$, about $4x10^{16}$, about $5x10^{7}$, about $5x10^{8}$, about $5x10^{9}$, about $5x10^{10}$, about $5x10^{11}$, about $5x10^{12}$,

about $5x10^{13}$, about $5x10^{14}$, about $5x10^{15}$, about $5x10^{16}$, about $6x10^{7}$, about $6x10^{8}$, about $6x10^{9}$, about $6x10^{10}$, about $6x10^{11}$, about $6x10^{12}$, about $6x10^{13}$, about $6x10^{14}$, about $6x10^{15}$, about $6x10^{16}$, about $7x10^{7}$, about $7x10^{8}$, about $7x10^{9}$, about $7x10^{10}$, about $7x10^{11}$, about $7x10^{12}$, about $7x10^{13}$, about $7x10^{14}$, about $7x10^{15}$, about $7x10^{16}$, about $8x10^{7}$, about $8x10^{8}$, about $8x10^{9}$, about $8x10^{10}$, about $8x10^{11}$, about $8x10^{12}$, about $8x10^{13}$, about $8x10^{14}$, about $8x10^{15}$, about $8x10^{16}$, about $9x10^{7}$, about $9x10^{8}$, about $9x10^{9}$, about $9x10^{10}$, about $9x10^{11}$, about $9x10^{12}$, about $9x10^{13}$, about $9x10^{14}$, about $9x10^{15}$, or about $9x10^{16}$ $TCID_{50}$/mL.

[00821] In some embodiments, recombinant viral compositions described herein can be administered at a dose such as, but not limited to, $1x10^{7}$, $3x10^{7}$, $1x10^{8}$, $3x10^{8}$, $1x10^{9}$, $3x10^{9}$, and $1x10^{10}$ $TCID_{50}$/mL. Further examples of recombinant viral composition doses include about $1x10^{7}$, about $3x10^{7}$, about $1x10^{8}$, about $3x10^{8}$, about $1x10^{9}$, about $3x10^{9}$, and about $1x10^{10}$ $TCID_{50}$/mL, or between about $1x10^{7}$ to about $1x10^{10}$, between about $1x10^{7}$ to about $3x10^{9}$, between about $1x10^{7}$ to about $1x10^{9}$, between about $1x10^{7}$ to about $3x10^{8}$, between about $1x10^{7}$ to about $1x10^{8}$, between about $1x10^{7}$ to about $3x10^{7}$, between about $3x10^{7}$ to about $1x10^{10}$, between about $3x10^{7}$ to about $3x10^{9}$, between about $3x10^{7}$ to about $1x10^{9}$, between about $3x10^{7}$ to about $3x10^{8}$, between about $3x10^{7}$ to about $1x10^{8}$, between about $1x10^{8}$ to about $1x10^{10}$, between about $1x10^{8}$ to about $3x10^{9}$, between about $1x10^{8}$ to about $1x10^{9}$, between about $1x10^{8}$ to about $3x10^{8}$, between about $3x10^{8}$ to about $1x10^{10}$, between about $3x10^{8}$ to about $3x10^{9}$, between about $3x10^{8}$ to about $1x10^{9}$, between about $1x10^{9}$ to about $1x10^{10}$, between about $1x10^{9}$ to about $3x10^{9}$, and between about $3x10^{9}$ to about $1x10^{10}$ $TCID_{50}$/mL. In some embodiments, the recombinant viral composition dose is about $2x10^{7}$, about $2x10^{8}$, about $2x10^{9}$, about $3x10^{7}$, about $3x10^{8}$, about $3x10^{9}$, about $4x10^{7}$, about $4x10^{8}$, about $4x10^{9}$, about $5x10^{7}$, about $5x10^{8}$, about $5x10^{9}$, about $6x10^{7}$, about $6x10^{8}$, about $6x10^{9}$, about $7x10^{7}$, about $7x10^{8}$, about $7x10^{9}$, about $8x10^{7}$, about $8x10^{8}$, about $8x10^{9}$, about $9x10^{7}$, about $9x10^{8}$, or about $9x10^{9}$, $TCID_{50}$/mL. Values and ranges intermediate to the recited values are also intended to be part of this disclosure.

[00822] In one example, the recombinant viral composition dose can be about $1x10^{7}$, about $3x10^{7}$, about $1x10^{8}$, about $3x10^{8}$, about $1x10^{9}$, about $3x10^{9}$, and about $1x10^{10}$ $TCID_{50}$/mL. In some embodiments, the recombinant viral composition can be administered via intratumoral (IT) delivery.

[00823] In one example, the recombinant viral composition dose can be about $1x10^{9}$ $TCID_{50}$/mL. In various embodiments, the recombinant viral composition dose can be $1x10^{9}$

$TCID_{50}$/mL. The recombinant viral composition can comprise, e.g., a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, which can be either membrane bound or not membrane bound. In some embodiments, the recombinant viral composition can be administered via intravenous (IV) delivery. In some embodiments, recombinant viral compositions comprising a nucleotide sequence encoding an IL-12 polypeptide which is membrane bound can demonstrate less toxicity and/or equal anti-tumor efficacy as compared to a recombinant viral composition comprising a nucleotide sequence encoding an IL-12 polypeptide which is not membrane bound, when administered via intravenous (IV) delivery. In certain embodiments, recombinant viral compositions comprising a nucleotide sequence encoding an IL-12 polypeptide which is membrane bound can be administered via intravenous (IV) delivery.

[00824] In a further example, the recombinant viral composition dose can be about $5x10^8$ $TCID_{50}$/mL. In various embodiments, the recombinant viral composition dose can be $5x10^8$ $TCID_{50}$/mL. The recombinant viral composition can comprise, e.g., a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, which can be either membrane bound or not membrane bound. In some embodiments, the recombinant viral composition can be administered via intravenous (IV) delivery. In some embodiments, the recombinant viral composition can be administered via intratumoral (IT) delivery. In some embodiments, recombinant viral compositions comprising a nucleotide sequence encoding an IL-12 polypeptide which is either membrane bound or not membrane bound can exhibit anti-tumor efficacy, e.g., when the recombinant viral compositions are administered via intratumoral (IT) delivery. In some embodiments, no toxicity is observed when recombinant viral compositions comprising a nucleotide sequence encoding an IL-12 polypeptide which is not membrane bound are administered via intratumoral (IT) delivery. In certain embodiments, recombinant viral compositions comprising a nucleotide sequence encoding an IL-12 polypeptide which is not membrane bound can be administered via intratumoral (IT) delivery.

[00825] In a further example, the recombinant viral composition dose can be between about $7x10^6$ to about $7x10^7$ $TCID_{50}$/mL. In various embodiments, the recombinant viral composition dose can be $7x10^6$ to $7x10^7$ $TCID_{50}$/mL. The recombinant viral composition can comprise, e.g., a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, which can be not membrane bound. In some embodiments, the recombinant viral composition can be administered via intratumoral (IT) delivery. In some embodiments, no toxicity is observed when

recombinant viral compositions comprising a nucleotide sequence encoding an IL-12 polypeptide which is not membrane bound are administered via intratumoral (IT) delivery.

[00826] In some embodiments, a recombinant virus and/or recombinant polynucleotide, or a pharmaceutical composition thereof, of the present disclosure, is administered to a subject over a specific time course.

[00827] In some embodiments, a recombinant virus and/or recombinant polynucleotide, or a pharmaceutical composition thereof, may be administered in accordance with a repeat dosing regimen wherein the recombinant virus and/or recombinant polynucleotide, or the pharmaceutical composition thereof, may be administered a first time (e.g., in an initial dose) and then re-administered any number of subsequent times thereafter at any amount over the time course of treatment of a subject. For example, the recombinant virus and/or recombinant polynucleotide, or the pharmaceutical composition thereof, may be re-administered once, twice, three times, four times, five times, six times, seven times, eight times, nine times, ten times, or more, over the time course of the treatment of a subject, which can occur over any number of days, weeks, or years. In some embodiments, a recombinant virus and/or recombinant polynucleotide, or a pharmaceutical composition thereof, may be administered only in one dose.

[00828] In various embodiments, when a recombinant virus and/or recombinant polynucleotide, or a pharmaceutical composition thereof, is administered in accordance with a repeat dosing regimen, the recombinant virus and/or recombinant polynucleotide, or the pharmaceutical composition thereof, may be on a 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15,16, 17, 18, 19, 20 or more weekly basis for any number of cycles, e.g., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or more cycles of treatment. In some embodiments, one cycle of treatment may be defined as 1 administration every 10, 11, 12, 13, 14, 15,16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30 or more days.

[00829] In some embodiments, when a recombinant virus and/or recombinant polynucleotide, or a pharmaceutical composition thereof as described herein, is administered in accordance with a repeat dosing regimen, the recombinant virus and/or recombinant polynucleotide, or the pharmaceutical composition thereof, may be administered on a 3 weekly basis for 4 cycles, in which one cycle can be 1 administration every 21 days. In some embodiments, such recombinant virus and/or recombinant polynucleotide, or pharmaceutical composition thereof, can comprise, e.g., a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof,

which is not membrane bound. Repeat doses of a repeat dosing regimen may be administered by the same route as used in the first dose or may be administered by any other route.

[00830] In some embodiments, a repeat dosing regimen may be appropriate in cases in which observations, e.g., of clinical symptoms, tumor size, or monitoring assays, indicate that a tumor or group of cancer cells has stopped shrinking or that the degree of viral activity is declining while the tumor remains present.

[00831] In some embodiments, the recombinant virus and/or recombinant polynucleotide, or the pharmaceutical composition thereof, may be administered in accordance with a stepwise dosing regimen. Stepwise dosing of a recombinant virus and/or recombinant polynucleotide, or pharmaceutical composition thereof, can refer to breaking up (i.e., dividing) dosing of the same recombinant virus and/or recombinant polynucleotide, or pharmaceutical composition thereof, over multiple administrations. In some embodiments, the dosing of the same recombinant virus and/or recombinant polynucleotide, or pharmaceutical composition thereof, is broken up once, twice, three times, four times, five times, six times, seven times, eight times, nine times, ten times, or more, over the time course of the treatment of a subject which can occur over any number of days, weeks, or years. In some embodiments, when a stepwise dose regimen is used in the administration of a recombinant virus and/or recombinant polynucleotide, or a pharmaceutical composition thereof, the stepwise dosing regimen may result in a gradual increase in therapeutic transgene levels with each administration. A stepwise dosing regimen used in the administration of a recombinant virus and/or recombinant polynucleotide, or pharmaceutical composition thereof, can result in enhanced control over transgene expression in a cell.

[00832] Compositions disclosed herein may be administered by any means known in the art. For example, compositions may include administration to a subject intravenously, intratumorally, intradermally, intraarterially, intraperitoneally, intralesionally, intracranially, intraarticularly, intraprostaticaly, intrapleurally, intratracheally, intranasally, intravitreally, intravaginally, intrarectally, topically, intramuscularly, intrathecally, subcutaneously, subconjunctival, intravesicularly, mucosally, intravesically, intrapericardially, intraumbilically, intraocularly, orally, locally, by inhalation, by injection, by infusion, by continuous infusion, by localized perfusion, via a catheter, via a lavage, in a cream, or in a lipid composition. In some embodiments, the compositions disclosed herein are administered intravenously or intratumorally.

[00833] Recombinant viruses or recombinant polynucleotides of the present disclosure or pharmaceutical compositions comprising such viruses or polynucleotides may be directly administered, for example, via direct injection. By way of a non-limiting example, a virus or polynucleotide may be injected directly into a group of cancer cells or into a tumor. In some embodiments, the tumor may be palpable through the skin of a subject. Ultrasound guidance may also be useful in the practice of such a method. In some embodiments, direct administration of a recombinant virus disclosed herein may be achieved via a catheter line or other medical access device, and may be used in conjunction with an imaging system such as, to localize a group of cancer cells. By such methods, an implantable dosing device typically is placed in proximity to a group of cancer cells using a guidewire inserted into the medical access device. An effective dose of a recombinant virus or recombinant polynucleotide, or pharmaceutical compositions thereof, disclosed herein may be directly administered to a tumor or group of cancer cells that is visible within an exposed surgical field.

[00834] Recombinant viruses or recombinant polynucleotides of the present disclosure or pharmaceutical compositions comprising such viruses or polynucleotides may be delivered systemically. Systemic delivery may be achieved intravenously via injection or via an intravenous delivery device designed for administration of multiple doses of the recombinant viruses or recombinant polynucleotides of the present disclosure or pharmaceutical compositions thereof. The intravenous delivery device may include, without limitation, peripheral intravenous catheters, peripherally inserted central catheters, midline catheters, surgically placed catheters or ports, and winged infusion needles.

[00835] Recombinant viruses or recombinant polynucleotides of the present disclosure or pharmaceutical compositions comprising such viruses or polynucleotides may be delivered locally (e.g., intratumorally). For example, recombinant viruses or recombinant polynucleotides of the present disclosure or pharmaceutical compositions comprising such viruses or polynucleotides provided herein can be administered locally by injection into tumors.

[00836] The course of therapy with a recombinant virus or recombinant polynucleotide provided herein may be monitored by evaluating changes in clinical symptoms or by direct monitoring of the number of cancer cells or size of a tumor. For a solid tumor, the effectiveness of virus treatment can be assessed by measuring the size or weight of the tumor before and after treatment. Tumor size can be measured either by using imaging techniques (e.g., X-ray, magnetic

resonance imaging, or computerized tomography), by evaluation of non-imaging optical data (e.g., spectral data), or directly (e.g., by use of calipers). For a group of cancer cells (e.g., leukemia cells), the effectiveness of viral treatment can be determined by measuring the absolute number of cancer cells in the circulation of a patient before and after treatment. The effectiveness of viral treatment also can be assessed by monitoring the levels of a cancer specific antigen. Non-limiting examples of cancer specific antigens include carcinoembryonic antigen (CEA), carbohydrate antigen 19-4, carbohydrate antigen 15-3, CA 125, prostatic acid phosphatase (PAP), alpha-fetoprotein (AFP), and prostate specific antigen (PSA).

[00837] Any method known to one skilled in the art maybe used for large scale production of recombinant viruses, polynucleotides, packaging cells, and vector constructs described herein. For example, master and working seed stocks may be prepared under GMP conditions in qualified primary CEFs or by other methods. Packaging cells may be plated on large surface area flasks, grown to near confluence and recombinant viruses purified. Cells may be harvested, and recombinant viruses released into the culture media isolated and purified, or intracellular recombinant viruses released by mechanical disruption (cell debris can be removed by large-pore depth filtration and cell, e.g., host cell, DNA digested with endonuclease). Viruses may be subsequently purified and concentrated by tangential-flow filtration, followed by diafiltration. The resulting concentrated bulk may be formulated by dilution with a buffer containing stabilizers, filled into vials, and lyophilized. Compositions and formulations may be stored for later use. For use, lyophilized recombinant viruses may be reconstituted by addition of diluent.

[00838] Certain additional agents used in the combination therapies can be formulated and administered by any means known in the art.

[00839] Compositions as disclosed herein can also include adjuvants such as aluminum salts and other mineral adjuvants, tensioactive agents, bacterial derivatives, vehicles, and cytokines. Adjuvants can also have immunomodulating properties. For example, adjuvants can stimulate Th1 or Th2 immunity. Compositions and methods as disclosed herein can also include adjuvant therapy.

Treatment Methods

[00840] The recombinant viruses or compositions, e.g., pharmaceutical compositions comprising a recombinant virus(es) and/or a recombinant polynucleotide(s) and a carrier and/or excipient,

disclosed herein may be used for various therapeutic applications (*in vivo* and *ex vivo*) and as research tools.

[00841] In one aspect, described herein is a method for treating a disease (e.g., cancer) in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of a recombinant virus and/or a recombinant polynucleotide, or a pharmaceutical composition thereof. As used herein, the phrase "therapeutically effective amount" means an amount of a composition (e.g., a pharmaceutical composition) that produces the desired effect for which the composition is administered. The subject can be from any suitable species, such as eukaryotic or mammalian subjects (e.g., non-human mammalian subject or human subject). A mammal can be, for example, a non-human mammal, a human, a rodent, a rat, a mouse, or a hamster. Other non-human mammals include, for example, non-human primates, e.g., monkeys and apes, dogs, cats, horses, cows, pigs, and sheep. The term "non-human" excludes humans. Specific examples include, but are not limited to, humans, rodents, mice, rats, and non-human primates. In a specific example, the subject is a human. The human may be a patient.

[00842] In some embodiments, the recombinant virus and/or the recombinant polynucleotide, or pharmaceutical composition thereof is administered to a subject as a weight-based dose. A "weight-based dose" (e.g., a dose in mg/kg) is a dose of the recombinant virus and/or the recombinant polynucleotide, or pharmaceutical composition thereof that will change depending on the subject's weight.

[00843] In some embodiments, the recombinant virus and/or the recombinant polynucleotide, or pharmaceutical composition thereof is administered to a subject as a fixed dose. A "fixed dose" (e.g., a dose in mg) means that one dose of the recombinant virus and/or the recombinant polynucleotide, or pharmaceutical composition thereof, is used for all subjects regardless of any specific subject-related factors, such as weight. In a certain embodiment, a fixed dose of a recombinant virus and/or a recombinant polynucleotide, or pharmaceutical composition thereof is based on a predetermined weight or age.

[00844] In certain aspects, the present disclosure provides methods for treating cancer (*e.g.*, to reduce tumor size, inhibit tumor growth, or reduce the number of viable tumor cells). For example, a recombinant virus and/or a recombinant polynucleotide, or a pharmaceutical composition thereof, may be administered to a subject having cancer to reduce tumor size, inhibit cancer cell

or tumor growth, reduce the number of viable cancer cells within the subject, and/or to induce host immunogenic responses against a tumor.

[00845] A recombinant virus as provided herein may be propagated in host cells to increase the number of available copies of the virus, e.g., by at least 2-fold, 5-fold, 10-fold, 50-fold, 100-fold, 500-fold, 1,000-fold, 5,000-fold or 10,000-fold. In some embodiments, a recombinant virus as provided herein can be expanded until a concentration of interest is obtained in standard cell culture media, e.g., RPMI-1640 or DMEM e.g., supplemented with 5-10% fetal bovine serum, e.g., in 5% CO_2 at 37 °C. A viral titer is typically assayed via inoculation of cells, e.g., BHK-21 cells, in culture.

[00846] In certain aspects, the present disclosure provides methods for inducing cancer regression in a subject in need thereof. The method may comprise administering to the subject an effective amount of a recombinant virus and/or a recombinant polynucleotide, or a pharmaceutical composition thereof, of the present disclosure. In some embodiments, the cancer regression can produce reduced tumor size.

[00847] In some embodiments, the administration of the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, disclosed herein to the subject is under conditions wherein the recombinant virus infects cancer cells of the subject to form infected cancer cells. When the recombinant virus infects the cancer cells of the subject, the infected cancer cells express the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and the number of cancer cells within the subject is reduced following the administration.

[00848] In some embodiments, the administration of the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, to the subject is under conditions wherein the recombinant virus infects cancer cells of the subject to form infected cancer cells, wherein the infected cancer cells express the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and wherein the number of cancer cells within the subject does not increase following the administration.

[00849] In certain embodiments, the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, is administered via local delivery. In some embodiments, the local delivery is intratumoral delivery.

[00850] In some embodiments, the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, is administered via systemic delivery. In some embodiments, the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, is administered via parenteral delivery. Non-limiting examples of parenteral delivery include subcutaneous, intraperitoneal, intradermal, intramuscular, or intravenous delivery. In some embodiments, the parental delivery is intravenous delivery.

[00851] In some embodiments, the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, may be administered, for example, intravenously, subcutaneously, intramuscularly, transdermally, intranasally, intravesically, orally, or mucosally.

[00852] In some embodiments, the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, provided herein may be administered to a subject in need thereof by, for example, via direct injection into a group of cancer cells (e.g., a tumor), i.e., via intratumoral delivery. In some embodiments, the recombinant virus and/or the recombinant polynucleotide, or the pharmaceutical composition thereof, provided herein may be administered to a subject in need thereof by via intravenous delivery.

[00853] The recombinant viruses as provided herein may be administered to a subject in a pharmaceutically acceptable delivery vehicle or a biologically compatible solution, via administration either directly into a group of cancer cells, e.g., intratumorally or systemically, e.g., intravenously. Suitable pharmaceutical formulations depend partly upon the use, the route of entry (e.g., via injection), or other applicable factors. Such suitable pharmaceutical formulations should not prevent the composition from exerting its effect or from reaching a target cell, e.g., a cell to which the virus is desired to be delivered. For example, pharmaceutical compositions that are injected into the blood stream should be soluble.

[00854] In some embodiments, administration of a recombinant virus and/or a recombinant polynucleotide, or a pharmaceutical composition thereof, described herein to a subject in need thereof may produce a reduced, decreased, lowered, lessened, or abated serum interferon gamma (IFNγ) release in the subject, as compared to a control recombinant virus, e.g., a control recombinant virus comprising a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, that is not membrane bound. For example, serum interferon gamma (IFNγ) release may be reduced, decreased, lowered, lessened, or abated in the subject by about 0.5%, about 1%, about 5%, about 10%, about 20%, about 30%, about 40%, about 50%, about 60%, about

70%, about 80%, about 90%, about 99%, or greater. In some embodiments, serum interferon gamma (IFNγ) release may be reduced, decreased, lowered, lessened, or abated in the subject by from about 5% to about 10%, from about 10% to about 20%, from about 50% to about 60%, from about 50% to about 70%, from about 50% to about 80%, from about 50% to about 90%, more than 60%, from about 60% to about 70%, from about 60% to about 80%, from about 60% to about 90%, more than about 70%, from about 70% to about 80%, from about 70% to about 90%, more than about 80%, from about 80% to about 90%, more than 90%, from about 90% to about 95%, from about 90% to about 98%, more than 95%, from about 95% to about 98%, more than about 98%, or more than about 99%. In some embodiments, serum interferon gamma (IFNγ) release may be reduced, decreased, lowered, lessened, or abated in the subject by about 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, or 20% or more. In some embodiments, the recombinant virus and/or recombinant polynucleotide, or the pharmaceutical composition thereof, comprises a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, which is membrane bound.

[00855] In some embodiments, administration of a recombinant virus and/or a recombinant polynucleotide, or a pharmaceutical composition thereof, described herein to a subject in need thereof may not result in body weight loss or result in reduced, decreased, lowered, lessened, or abated body weight loss in the subject, as compared to a control recombinant virus, e.g., a control recombinant virus comprising a nucleotide sequences encoding an IL-12 polypeptide that is not membrane bound. For example, body weight loss may be reduced, decreased, lowered, lessened, or abated in the subject by about 0.5%, about 1%, about 5%, about 10%, about 20%, about 30%, about 40%, about 50%, about 60%, about 70%, about 80%, about 90%, about 99%, or greater. In some embodiments, body weight loss may be reduced, decreased, lowered, lessened, or abated in the subject by from about 5% to about 10%, from about 10% to about 20%, from about 50% to about 60%, from about 50% to about 70%, from about 50% to about 80%, from about 50% to about 90%, more than 60%, from about 60% to about 70%, from about 60% to about 80%, from about 60% to about 90%, more than about 70%, from about 70% to about 80%, from about 70% to about 90%, more than about 80%, from about 80% to about 90%, more than 90%, from about 90% to about 95%, from about 90% to about 98%, more than 95%, from about 95% to about 98%, more than about 98%, or more than about 99%. In some embodiments, body weight loss may be reduced, decreased, lowered, lessened, or abated in the subject by about 1%, 2%, 3%, 4%, 5%,

6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, or 20% or more. In some embodiments, body weight loss in the subject is prevented. In some embodiments, the recombinant virus and/or recombinant polynucleotide, or the pharmaceutical composition thereof, comprises a nucleotide sequence encoding an IL-12 polypeptide, or fragment or derivative thereof, which is membrane bound.

[00856] In some embodiments, a recombinant virus and/or a recombinant polynucleotide, or a pharmaceutical composition thereof, disclosed herein may be used to treat different types of cancer such as, but not limited to, myeloma (e.g., multiple myeloma), melanoma, glioma, lymphoma, mesothelioma, and cancers of the lung, brain, stomach, colon, rectum, kidney, prostate, ovary, breast, pancreas, liver, and head and neck.

[00857] Non-limiting examples of cancers treatable by the compositions and/or methods described herein include, for example, carcinomas, lymphomas, sarcomas, blastomas, and leukemias. Non-limiting specific examples, include, for example, breast cancer, pancreatic cancer, liver cancer, lung cancer, prostate cancer, colon cancer, rectal cancer, colorectal cancer, renal cancer, bladder cancer, head and neck carcinoma, thyroid carcinoma, soft tissue sarcoma, ovarian cancer, primary or metastatic melanoma, squamous cell carcinoma, basal cell carcinoma, brain cancers of all histopathologic types, angiosarcoma, hemangiosarcoma, bone sarcoma, fibrosarcoma, myxosarcoma, liposarcoma, chondrosarcoma, osteogenic sarcoma, chordoma, angiosarcoma, endotheliosarcoma, lymphangiosarcoma, lymphangioendotheliosarcoma, synovioma, testicular cancer, uterine cancer, cervical cancer, gastrointestinal cancer, mesothelioma, Ewing's tumor, leiomyosarcoma, Ewing's sarcoma, rhabdomyosarcoma, carcinoma of unknown primary (CUP), squamous cell carcinoma, basal cell carcinoma, adenocarcinoma, sweat gland carcinoma, sebaceous gland carcinoma, papillary carcinoma, Waldenstroom's macroglobulinemia, papillary adenocarcinomas, cystadenocarcinoma, bronchogenic carcinoma, bile duct carcinoma, choriocarcinoma, seminoma, embryonal carcinoma, Wilms' tumor, lung carcinoma, epithelial carcinoma, cervical cancer, testicular tumor, glioma, glioblastoma, astrocytoma, medulloblastoma, craniopharyngioma, ependymoma, pinealoma, hemangioblastoma, acoustic neuroma, oligodendroglioma, meningioma, retinoblastoma, leukemia, neuroblastoma, small cell lung carcinoma, bladder carcinoma, lymphoma, multiple myeloma, medullary carcinoma, B cell lymphoma, T cell lymphoma, NK cell lymphoma, large granular lymphocytic lymphoma or leukemia, gamma-delta T cell lymphoma or

gamma-delta T cell leukemia, mantle cell lymphoma, myeloma, leukemia, chronic myeloid leukemia, acute myeloid leukemia, chronic lymphocytic leukemia, acute lymphocytic leukemia, hairy cell leukemia, hematopoietic neoplasias, thymoma, sarcoma, non-Hodgkin's lymphoma, Hodgkin's lymphoma, Epstein-Barr virus (EBV) induced malignancies of all types including but not limited to EBV-associated Hodgkin's and non-Hodgkin's lymphoma, all forms of post-transplant lymphomas including post-transplant lymphoproliferative disorder (PTLD), uterine cancer, renal cell carcinoma, hepatoma, hepatoblastoma, Cancers that may treated by methods and compositions described herein include, but are not limited to, cancer cells from the bladder, blood, bone, bone marrow, brain, breast, colon, esophagus, gastrointestine, gum, head, kidney, liver, lung, nasopharynx, neck, ovary, prostate, skin, stomach, testis, tongue, or uterus. In addition, the cancer may specifically be of the following histological type, though it is not limited to these: neoplasm, malignant; carcinoma; carcinoma, undifferentiated; giant and spindle cell carcinoma; small cell carcinoma; papillary carcinoma; squamous cell carcinoma; lymphoepithelial carcinoma; basal cell carcinoma; pilomatrix carcinoma; transitional cell carcinoma; papillary transitional cell carcinoma; adenocarcinoma; gastrinoma, malignant; cholangiocarcinoma; hepatocellular carcinoma; combined hepatocellular carcinoma and cholangiocarcinoma; trabecular adenocarcinoma; adenoid cystic carcinoma; adenocarcinoma in adenomatous polyp; adenocarcinoma, familial polyposis coli; solid carcinoma; carcinoid tumor, malignant; branchiolo-alveolar adenocarcinoma; papillary adenocarcinoma; chromophobe carcinoma; acidophil carcinoma; oxyphilic adenocarcinoma; basophil carcinoma; clear cell adenocarcinoma; granular cell carcinoma; follicular adenocarcinoma; papillary and follicular adenocarcinoma; nonencapsulating sclerosing carcinoma; adrenal cortical carcinoma; endometroid carcinoma; skin appendage carcinoma; apocrine adenocarcinoma; sebaceous adenocarcinoma; ceruminous adenocarcinoma; mucoepidermoid carcinoma; cystadenocarcinoma; papillary cystadenocarcinoma; papillary serous cystadenocarcinoma; mucinous cystadenocarcinoma; mucinous adenocarcinoma; signet ring cell carcinoma; infiltrating duct carcinoma; medullary carcinoma; lobular carcinoma; inflammatory carcinoma; Paget's disease, mammary; acinar cell carcinoma; adenosquamous carcinoma; adenocarcinoma w/squamous metaplasia; thymoma, malignant; ovarian stromal tumor, malignant; thecoma, malignant; granulosa cell tumor, malignant; and roblastoma, malignant; sertoli cell carcinoma; Leydig cell tumor, malignant; lipid cell tumor, malignant; paraganglioma, malignant; extra-mammary paraganglioma, malignant;

pheochromocytoma; glomangiosarcoma; malignant melanoma; amelanotic melanoma; superficial spreading melanoma; malignant melanoma in giant pigmented nevus; epithelioid cell melanoma; blue nevus, malignant; sarcoma; fibrosarcoma; fibrous histiocytoma, malignant; myxosarcoma; liposarcoma; leiomyosarcoma; rhabdomyosarcoma; embryonal rhabdomyosarcoma; alveolar rhabdomyosarcoma; stromal sarcoma; mixed tumor, malignant; Mullerian mixed tumor; nephroblastoma; hepatoblastoma; carcinosarcoma; mesenchymoma, malignant; Brenner tumor, malignant; phyllodes tumor, malignant; synovial sarcoma; mesothelioma, malignant; dysgerminoma; embryonal carcinoma; teratoma, malignant; struma ovarii, malignant; choriocarcinoma; mesonephroma, malignant; hemangiosarcoma; hemangioendothelioma, malignant; Kaposi's sarcoma; hemangiopericytoma, malignant; lymphangiosarcoma; osteosarcoma; juxtacortical osteosarcoma; chondrosarcoma; chondroblastoma, malignant; mesenchymal chondrosarcoma; giant cell tumor of bone; Ewing's sarcoma; odontogenic tumor, malignant; ameloblastic odontosarcoma; ameloblastoma, malignant; ameloblastic fibrosarcoma; pinealoma, malignant; chordoma; glioma, malignant; ependymoma; astrocytoma; protoplasmic astrocytoma; fibrillary astrocytoma; astroblastoma; glioblastoma; oligodendroglioma; oligodendroblastoma; primitive neuroectodermal; cerebellar sarcoma; ganglioneuroblastoma; neuroblastoma; retinoblastoma; olfactory neurogenic tumor; meningioma, malignant; neurofibrosarcoma; neurilemmoma, malignant; granular cell tumor, malignant; malignant lymphoma; Hodgkin's disease; Hodgkin's lymphoma; paragranuloma; malignant lymphoma, small lymphocytic; malignant lymphoma, large cell, diffuse; malignant lymphoma, follicular; mycosis fungoides; other specified non-Hodgkin's lymphomas; malignant histiocytosis; multiple myeloma; mast cell sarcoma; immunoproliferative small intestinal disease; leukemia; lymphoid leukemia; plasma cell leukemia; erythroleukemia; lymphosarcoma cell leukemia; myeloid leukemia; basophilic leukemia; eosinophilic leukemia; monocytic leukemia; mast cell leukemia; megakaryoblastic leukemia; myeloid sarcoma; and hairy cell leukemia.

[00858] In some embodiments, the cancer treatable by the compositions and/or methods described herein can be a head and neck cancer. In some embodiments, the head and neck cancer can be a squamous cell carcinoma. In some embodiments, the head and neck cancer can develop from various head and neck tissues, e.g., in the oral cavity, lip, pharynx, larynx, nose, salivary glands, skin of the face, and/or sinuses. In some embodiments, the head and neck cancer can comprise

oropharyngeal cancer, also known as oropharyngeal squamous cell carcinoma, which can comprise cancers, e.g., of the base of the tongue, tonsils, uvula, and/or soft palate.

[00859] In certain embodiments, a head and neck cancer of the present disclosure can be an oral cavity cancer, a pharyngeal cancer, a nasopharyngeal cancer, an oropharyngeal cancer, a hypopharyngeal cancer, a laryngeal cancer, a paranasal sinus cancer, a nasal cavity cancer, or a salivary gland cancer.

[00860] In some embodiments, a cancer described herein can be recurrent, advanced, persistent, incurable, refractory, metastatic, and/or unresectable. In some embodiments, a cancer described herein can still be responsive to prior treatments or may not, or may no longer be responsive to prior treatments. The subject may have had one, two, three, four, or more prior treatments for the same indication. The subject may have never achieved a complete response or remission from any prior therapeutic treatment or may have never achieved even a partial response or remission from any prior therapeutic treatment.

[00861] In some embodiments, the cancers treatable by the compositions and/or methods described herein may be head and neck cancer, colon cancer, lung cancer, prostate cancer, ovarian cancer, hepatocellular carcinoma, pancreatic cancer, kidney cancer, melanoma, brain cancer, lymphoma, myeloma, lymphocytic leukemia, myelogenous leukemia, and/or breast cancer.

[00862] It is contemplated that when used to treat various diseases, e.g., cancer, the compositions and/or methods disclosed herein can be combined with other therapeutic agents suitable for the same or similar diseases, for example, a second anti-cancer treatment. Also, two or more embodiments described herein may be also co-administered to generate additive or synergistic effects. When co-administered with a second therapeutic agent, the embodiment described herein, and the second therapeutic agent may be administered simultaneously or sequentially (in any order). Suitable therapeutically effective dosages for each agent may be lowered due to the additive action or synergy.

[00863] As a non-limiting example, the compositions and/or methods described herein can be combined with other therapies that block inflammation (e.g., via blockage of IL1, INFα/β, IL6, TNF, IL13, IL23, etc.).

[00864] In some embodiments, the methods described herein can further comprise administering to the subject a therapeutically effective amount of a second anti-cancer treatment. Non-limiting examples of a second anti-cancer treatment include an agent targeting an immune

co-inhibitory or immune co-stimulatory pathway, radiation, chemotherapy, an agent that targets a specific genetic mutation which occurs in tumors, an agent intended to induce an immune response to one or more tumor antigen(s) or neoantigen(s), a cellular product of T cells or NK cells, an agent that facilitates viral replication and spread within cancer cells, an agent that protects non-cancer cells from viral toxicity, an agent intended to stimulate the STING, cGAS, TLR or other innate immune response and/or inflammatory pathway, or a second virus, or any combinations thereof.

[00865] In some embodiments, the compositions and/or methods disclosed herein are useful to enhance the efficacy of vaccines directed to tumors or infections. Thus, the compositions described herein can be administered to a subject either simultaneously with or before (e.g., 1-30 days before) a reagent (including but not limited to small molecules, antibodies, or cellular reagents) that acts to elicit an immune response (e.g., to treat cancer or an infection) is administered to the subject.

[00866] The compositions and methods described herein can be also administered in combination with an anti-tumor antibody or an antibody directed at a pathogenic antigen or allergen.

[00867] The compositions and methods described herein can be combined with immunomodulatory treatments such as, e.g., therapeutic vaccines (including but not limited to GVAX, DC-based vaccines, etc.), checkpoint inhibitors (including but not limited to agents that block CTLA-4, PD-1, LAG3, TIM3, etc.) or activators (including but not limited to agents that enhance 41BB, OX40, etc.). The inhibitory treatments described herein can be also combined with other treatments that possess the ability to modulate immune cell function or stability.

[00868] Therapeutic methods described herein can be combined with additional immunotherapies and therapies. For example, when used for treating cancer, the recombinant viruses or pharmaceutical compositions comprising such viruses described herein may be used in combination with conventional cancer therapies, such as, e.g., surgery, radiotherapy, chemotherapy or combinations thereof, depending on type of the tumor, patient condition, other health issues, and a variety of factors. In certain aspects, other therapeutic agents useful for combination cancer therapy with the inhibitors described herein include anti-angiogenic agents. Many anti-angiogenic agents have been identified and are known in the art, including, e.g., TNP-470, platelet factor 4, thrombospondin-1, tissue inhibitors of metalloproteases (TIMP1 and TIMP2), prolactin (16-Kd fragment), angiostatin (38-Kd fragment of plasminogen), endostatin, bFGF soluble receptor, transforming growth factor beta, interferon alpha, soluble KDR and FLT-

1 receptors, placental proliferin-related protein, as well as those listed by Carmeliet and Jain (2000). In some embodiments, the inhibitors described herein can be used in combination with a VEGF antagonist or a VEGF receptor antagonist such as anti-VEGF antibodies, VEGF variants, soluble VEGF receptor fragments, aptamers capable of blocking VEGF or VEGFR, neutralizing anti-VEGFR antibodies, inhibitors of VEGFR tyrosine kinases and any combinations thereof (e.g., anti-hVEGF antibody A4.6.1, bevacizumab, ranibizumab, or aflibercept, see U.S. Patent No. 7,396,664, hereby incorporated by reference in its entirety). In some embodiments, the inhibitors described herein can be used in combination with an EGF antagonist or an EGFR antagonist such as anti-EGF antibodies, EGF variants, soluble EGFR fragments, aptamers capable of blocking EGF or EGFR, neutralizing anti-EGFR antibodies, inhibitors of EGFR tyrosine kinases and any combinations thereof (e.g., anti-EGFR antibody cetuximab).

[00869] In some embodiments, the therapeutic methods disclosed herein may comprise administering to a subject an effective amount of a second anti-cancer treatment. In some embodiments, the second anti-cancer treatment may be an agent targeting an immune co-inhibitory or immune co-stimulatory pathway, radiation, chemotherapy, an agent that targets a specific genetic mutation which occurs in tumors, an agent intended to induce an immune response to one or more tumor antigen(s) or neoantigen(s), a cellular product of T cells or NK cells, an agent intended to stimulate the STING, cGAS, TLR or other innate immune response and/or inflammatory pathway, a second virus, and any combinations thereof.

[00870] Non-limiting examples of chemotherapeutic compounds which can be used in combination treatments include, for example, aminoglutethimide, amsacrine, anastrozole, asparaginase, bcg, bicalutamide, bleomycin, buserelin, busulfan, campothecin, capecitabine, carboplatin, carmustine, chlorambucil, cisplatin, cladribine, clodronate, colchicine, cyclophosphamide, cyproterone, cytarabine, dacarbazine, dactinomycin, daunorubicin, dienestrol, diethylstilbestrol, docetaxel, doxorubicin, epirubicin, estradiol, estramnustine, etoposide, exemestane, filgrastim, fludarabine, fludrocortisone, fluorouracil, fluoxymesterone, flutamide, gemcitabine, genistein, goserelin, hydroxyurea, idarubicin, ifosfamide, imatinib, interferon, irinotecan, 182 rednisolo, letrozole, leucovorin, leuprolide, levamisole, lomustine, mechlorethamine, medroxyprogesterone, megestrol, melphalan, mercaptopurine, mesna, methotrexate, mitomycin, mitotane, mitoxantrone, nilutamide, nocodazole, octreotide, oxaliplatin, paclitaxel, pamidronate, pentostatin, plicamycin, porfimer, procarbazine, raltitrexed, rituximab,

streptozocin, suramin, tamoxifen, temozolomide, teniposide, testosterone, thioguanine, thiotepa, titanocene dichloride, topotecan, trastuzumab, tretinoin, vinblastine, vincristine, vindesine, and vinorelbine.

[00871] These chemotherapeutic compounds may be categorized by their mechanism of action into, for example, following groups: anti-metabolites/anti-cancer agents, such as pyrimidine analogs (5-fluorouracil, floxuridine, capecitabine, gemcitabine and cytarabine) and purine analogs, folate antagonists and related inhibitors (mercaptopurine, thioguanine, pentostatin and 2-chlorodeoxyadenosine (cladribine)); antiproliferative/antimitotic agents including natural products such as vinca alkaloids (vinblastine, vincristine, and vinorelbine), microtubule disruptors such as taxane (paclitaxel, docetaxel), vincristin, vinblastin, nocodazole, epothilones and navelbine, epidipodophyllotoxins (etoposide, teniposide), DNA damaging agents (actinomycin, amsacrine, anthracyclines, bleomycin, busulfan, camptothecin, carboplatin, chlorambucil, cisplatin, cyclophosphamide, cytoxan, dactinomycin, daunorubicin, doxorubicin, epirubicin, hexamethyhnelamineoxaliplatin, iphosphamide, melphalan, merchlorehtamine, mitomycin, mitoxantrone, nitrosourea, plicamycin, procarbazine, taxol, taxotere, teniposide, triethylenethiophosphoramide and etoposide (VP16)); antibiotics such as dactinomycin (actinomycin D), daunorubicin, doxorubicin (adriamycin), idarubicin, anthracyclines, mitoxantrone, bleomycins, plicamycin (mithramycin) and mitomycin; enzymes (L-asparaginase which systemically metabolizes L-asparagine and deprives cells which do not have the capacity to synthesize their own asparagine); antiplatelet agents; antiproliferative/antimitotic alkylating agents such as nitrogen mustards (mechlorethamine, cyclophosphamide and analogs, melphalan, chlorambucil), ethylenimines and methylmelamines (hexamethylmelamine and thiotepa), alkyl sulfonates-busulfan, nitrosoureas (carmustine (BCNU) and analogs, streptozocin), trazenes-dacarbazinine (DTIC); antiproliferative/antimitotic antimetabolites such as folic acid analogs (methotrexate); platinum coordination complexes (cisplatin, carboplatin), procarbazine, hydroxyurea, mitotane, aminoglutethimide; hormones, hormone analogs (estrogen, tamoxifen, goserelin, bicalutamide, nilutamide) and aromatase inhibitors (letrozole, anastrozole); anticoagulants (heparin, synthetic heparin salts and other inhibitors of thrombin); fibrinolytic agents (such as tissue plasminogen activator, streptokinase and urokinase), aspirin, dipyridamole, ticlopidine, clopidogrel, abciximab; antimigratory agents; antisecretory agents (breveldin); immunosuppressives (cyclosporine, tacrolimus (FK-506), sirolimus (rapamycin), azathioprine,

mycophenolate mofetil); anti-angiogenic compounds (e.g., TNP-470, genistein, bevacizumab) and growth factor inhibitors (e.g., fibroblast growth factor (FGF) inhibitors); angiotensin receptor blocker; nitric oxide donors; anti-sense oligonucleotides; antibodies (trastuzumab); cell cycle inhibitors and differentiation inducers (tretinoin); mTOR inhibitors, topoisomerase inhibitors (doxorubicin (adriamycin), amsacrine, camptothecin, daunorubicin, dactinomycin, eniposide, epirubicin, etoposide, idarubicin and mitoxantrone, topotecan, irinotecan), corticosteroids (cortisone, dexamethasone, hydrocortisone, methylpednisolone, prednisone, and prenisolone); growth factor signal transduction kinase inhibitors; mitochondrial dysfunction inducers and caspase activators; and chromatin disruptors.

[00872] In some embodiments of any of the methods of treating a cancer in a subject in need thereof described above, the method may further comprise administering to the subject an effective amount of one or more immune checkpoint inhibitors. In some embodiments, the one or more immune checkpoint inhibitors comprise anti-CTLA-4 antibodies and/or anti-PD-1 antibodies. In some embodiments, the one or more immune checkpoint inhibitors may include anti-PD-L1 antibodies and/or PD-L2 antibodies. In some embodiments, the one or more immune checkpoint inhibitors may include an anti-CD28 antibody.

[00873] In some embodiments, the method may further comprise administering to the subject an effective amount of an immune checkpoint inhibitor. In some embodiments, the immune checkpoint inhibitor is an anti-PD-1 antibody. In some embodiments, the method may further comprise administering to the subject an effective amount of an anti-PD-1 antibody. In some embodiments, the anti-PD-1 antibody is cemiplimab (Libtayo®), nivolumab (Opdivo®), pembrolizumab (Keytruda®), durvalumab (Imfinzi®), atezolizumab (Tecentriq®), avelumab (Bavencio®), toripalimab (Loqtorzi®), tislelizumab (Tevimbra®), retifanlimab (Zynyz®), dostarlimab (Jemperli®), or camrelizumab/rivoceranib.

[00874] In one example, the recombinant viral composition dose can be about $1x10^7$, about $3x10^7$, about $1x10^8$, about $3x10^8$, about $1x10^9$, about $3x10^9$, and about $1x10^{10}$ $TCID_{50}$/mL. For example, the anti-PD-1 antibody dose can be about 350 mg. In some embodiments, the recombinant viral composition can be administered via intratumoral (IT) delivery. In some embodiments, the anti-PD-1 antibody can be administered via intravenous (IV) delivery.

[00875] In some embodiments, the recombinant viral composition dose is about $1x10^7$ $TCID_{50}$/mL, and the anti-PD-1 antibody is about 350 mg. In some embodiments, the recombinant

viral composition dose is about $3x10^7$ $TCID_{50}$/mL, and the anti-PD-1 antibody is about 350 mg. In some embodiments, the recombinant viral composition dose is about $1x10^8$ $TCID_{50}$/mL, and the anti-PD-1 antibody is about 350 mg. In some embodiments, the recombinant viral composition dose is about $3x10^8$ $TCID_{50}$/mL, and the anti-PD-1 antibody is about 350 mg. In some embodiments, the recombinant viral composition dose is about $1x10^9$ $TCID_{50}$/mL, and the anti-PD-1 antibody is about 350 mg. In some embodiments, the recombinant viral composition dose is about $3x10^9$ $TCID_{50}$/mL, and the anti-PD-1 antibody is about 350 mg. In some embodiments, the recombinant viral composition dose is about $1x10^{10}$ $TCID_{50}$/mL, and the anti-PD-1 antibody is about 350 mg.

[00876] In some embodiments, the anti-PD-1 antibody described herein can be administered at a dose such as, but not limited to, 25, 50, 75, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, and 1000 mg. Further examples of anti-PD-1 antibody doses include about 25, about 50, about 75, about 100, about 150, about 200, about 250, about 300, about 350, about 400, about 450, about 500, about 550, about 600, about 650, about 700, about 750, about 800, about 850, about 900, about 950, and about 1000 mg, or between about 25 to about 1000, between about 25 to about 950, between about 25 to about 900, between about 25 to about 850, between about 25 to about 800, between about 25 to about 750, between about 25 to about 700, between about 25 to about 650, between about 25 to about 600, between about 25 to about 550, between about 25 to about 500, between about 25 to about 450, between about 25 to about 400, between about 25 to about 350, between about 25 to about 300, between about 25 to about 250, between about 25 to about 200, between about 25 to about 150, between about 25 to about 100, between about 25 to about 75, between about 25 to about 50 mg, between about 50 to about 1000, between about 50 to about 950, between about 50 to about 900, between about 50 to about 850, between about 50 to about 800, between about 50 to about 750, between about 50 to about 700, between about 50 to about 650, between about 50 to about 600, between about 50 to about 550, between about 50 to about 500, between about 50 to about 450, between about 50 to about 400, between about 50 to about 350, between about 50 to about 300, between about 50 to about 250, between about 50 to about 200, between about 50 to about 150, between about 50 to about 100, between about 50 to about 75, between about 75 to about 1000, between about 75 to about 950, between about 75 to about 900, between about 75 to about 850, between about 75 to about 800, between about 75 to about 750, between about 75 to about 700, between about 75 to about

650, between about 75 to about 600, between about 75 to about 550, between about 75 to about 500, between about 75 to about 450, between about 75 to about 400, between about 75 to about 350, between about 75 to about 300, between about 75 to about 250, between about 75 to about 200, between about 75 to about 150, between about 75 to about 100, between about 100 to about 1000, between about 100 to about 950, between about 100 to about 900, between about 100 to about 850, between about 100 to about 800, between about 100 to about 750, between about 100 to about 700, between about 100 to about 650, between about 100 to about 600, between about 100 to about 550, between about 100 to about 500, between about 100 to about 450, between about 100 to about 400, between about 100 to about 350, between about 100 to about 300, between about 100 to about 250, between about 100 to about 200, between about 100 to about 150, between about 150 to about 1000, between about 150 to about 950, between about 150 to about 900, between about 150 to about 850, between about 150 to about 800, between about 150 to about 750, between about 150 to about 700, between about 150 to about 650, between about 150 to about 600, between about 150 to about 550, between about 150 to about 500, between about 150 to about 450, between about 150 to about 400, between about 150 to about 350, between about 150 to about 300, between about 150 to about 250, between about 150 to about 200, between about 200 to about 1000, between about 200 to about 950, between about 200 to about 900, between about 200 to about 850, between about 200 to about 800, between about 200 to about 750, between about 200 to about 700, between about 200 to about 650, between about 200 to about 600, between about 200 to about 550, between about 200 to about 500, between about 200 to about 450, between about 200 to about 400, between about 200 to about 350, between about 200 to about 300, between about 200 to about 250, between about 250 to about 1000, between about 250 to about 950, between about 250 to about 900, between about 250 to about 850, between about 250 to about 800, between about 250 to about 750, between about 250 to about 700, between about 250 to about 650, between about 250 to about 600, between about 250 to about 550, between about 250 to about 500, between about 250 to about 450, between about 250 to about 400, between about 250 to about 350, between about 250 to about 300, between about 300 to about 1000, between about 300 to about 950, between about 300 to about 900, between about 300 to about 850, between about 300 to about 800, between about 300 to about 750, between about 300 to about 700, between about 300 to about 650, between about 300 to about 600, between about 300 to about 550, between about 300 to about 500, between about 300 to about 450, between about 300 to about 400, between about 300 to about 350, between about

350 to about 1000, between about 350 to about 950, between about 350 to about 900, between about 350 to about 850, between about 350 to about 800, between about 350 to about 750, between about 350 to about 700, between about 350 to about 650, between about 350 to about 600, between about 350 to about 550, between about 350 to about 500, between about 350 to about 450, between about 350 to about 400, between about 400 to about 1000, between about 400 to about 950, between about 400 to about 900, between about 400 to about 850, between about 400 to about 800, between about 400 to about 750, between about 400 to about 700, between about 400 to about 650, between about 400 to about 600, between about 400 to about 550, between about 400 to about 500, between about 400 to about 450, between about 450 to about 1000, between about 450 to about 950, between about 450 to about 900, between about 450 to about 850, between about 450 to about 800, between about 450 to about 750, between about 450 to about 700, between about 450 to about 650, between about 450 to about 600, between about 450 to about 550, between about 450 to about 500, between about 500 to about 1000, between about 500 to about 950, between about 500 to about 900, between about 500 to about 850, between about 500 to about 800, between about 500 to about 750, between about 500 to about 700, between about 500 to about 650, between about 500 to about 600, between about 500 to about 550, between about 550 to about 1000, between about 550 to about 950, between about 550 to about 900, between about 550 to about 850, between about 550 to about 800, between about 550 to about 750, between about 550 to about 700, between about 550 to about 650, between about 550 to about 600, between about 600 to about 1000, between about 600 to about 950, between about 600 to about 900, between about 600 to about 850, between about 600 to about 800, between about 600 to about 750, between about 600 to about 700, between about 600 to about 650, between about 650 to about 1000, between about 650 to about 950, between about 650 to about 900, between about 650 to about 850, between about 650 to about 800, between about 650 to about 750, between about 650 to about 700, between about 700 to about 1000, between about 700 to about 950, between about 700 to about 900, between about 700 to about 850, between about 700 to about 800, between about 700 to about 750, between about 750 to about 1000, between about 750 to about 950, between about 750 to about 900, between about 750 to about 850, between about 750 to about 800, between about 800 to about 1000, between about 800 to about 950, between about 800 to about 900, between about 800 to about 850, between about 850 to about 1000, between about 850 to about 950, between about 850 to about 900, about

900 to about 1000, between about 900 to about 950, about between about 950 to about 1000 mg. Values and ranges intermediate to the recited values are also intended to be part of this disclosure.

[00877] If a particular subject fails to respond to a particular dosage amount, then the dosage amount of a recombinant viral composition and/or an anti-PD-1 antibody can be increased (e.g., by two fold). After receiving an increased dosage amount, the subject may be monitored for both responsiveness to the treatment and/or toxicity symptoms, and adjustments may be made accordingly. The effective amount may remain constant or may be adjusted as a sliding scale or variable dose dependent on the subject's response to treatment. Various factors can influence the actual effective amount used for a particular application. For example, the duration of treatment, the frequency of administration, route of administration, severity of the condition (e.g., cancer), and use of multiple treatment agents, may require an increase or decrease in the actual effective amount administered.

[00878] In some embodiments, the recombinant viral composition may be administered only in one dose. In some embodiments, the recombinant viral composition may be administered in accordance with a repeat dosing regimen wherein the recombinant viral composition may be administered a first time (e.g., in an initial dose) and then re-administered any number of subsequent times thereafter at any amount over the time course of treatment of a subject. For example, the recombinant viral composition may be re-administered once, twice, three times, four times, five times, six times, seven times, eight times, nine times, ten times, or more, over the time course of the treatment of a subject, which can occur over any number of days, weeks, or years. In some embodiments, the anti-PD-1 antibody may be administered only in one dose. In some embodiments, the anti-PD-1 antibody may be administered in accordance with a repeat dosing regimen wherein the anti-PD-1 antibody may be administered a first time (e.g., in an initial dose) and then re-administered any number of subsequent times thereafter at any amount over the time course of treatment of a subject. For example, the anti-PD-1 antibody may be re-administered once, twice, three times, four times, five times, six times, seven times, eight times, nine times, ten times, or more, over the time course of the treatment of a subject, which can occur over any number of days, weeks, or years.

[00879] When co-administered with a recombinant viral composition, the anti-PD-1 antibody may be administered prior to, simultaneously with, or after the recombinant viral composition. In certain embodiments, the anti-PD-1 antibody is administered after the recombinant viral

composition. In certain embodiments, the anti-PD-1 antibody is administered prior to and after the recombinant viral composition. In certain embodiments, the anti-PD-1 antibody is administered simultaneously with the recombinant viral composition. In some embodiments, when the anti-PD-1 antibody is administered prior to, simultaneously with, and/or after the recombinant viral composition, the anti-PD-1 antibody is administered once, twice, three times, four times, five times, six times, seven times, eight times, nine times, ten times, eleven times, twelve times, thirteen times, fourteen times, fifteen times, sixteen times, seventeen times, eighteen times, nineteen times, or twenty times or more, prior to, simultaneously with, and/or after the administration of the recombinant viral composition. In some embodiments, when a recombinant viral composition is administered in accordance with a repeat dosing regimen, an anti-PD-1 antibody may be administered any number of times prior to, simultaneously with, and/or after a first and/or second administration of the recombinant viral composition, and/or any number of subsequent administrations of the recombinant viral composition thereafter. According to certain embodiments of the present disclosure, an anti-PD-1 antibody may be administered to a subject separately from a recombinant viral composition described herein.

[00880] In some embodiments, a recombinant viral composition and an anti-PD-1 antibody may be administered separately over a defined time course. In certain embodiments, multiple doses of a recombinant viral composition and/or an anti-PD-1 antibody described herein may be administered to a subject over a defined time course. The methods according to such aspects of the disclosure may comprise sequentially administering to a subject multiple doses of a recombinant viral composition and/or an anti-PD-1 antibody of the disclosure. In some embodiments, when the recombinant viral composition and the anti-PD-1 antibody are administered sequentially, the recombinant viral composition can be administered before and/or in between each of the administrations of the anti-PD-1 antibody. In some embodiments, when the recombinant viral composition and the anti-PD-1 antibody are administered sequentially, the anti-PD-1 antibody can be administered before and/or in between each of the administrations of the recombinant viral composition. As used herein, "sequentially administering" means that each dose of the recombinant viral composition and/or the anti-PD-1 antibody, is administered to the subject at a different point in time, e.g., on different days or on the same day separated by a predetermined interval (e.g., hours, days, weeks, months, or years). In some embodiments, the methods of the disclosure comprise sequentially administering to the subject a single initial dose of the

recombinant viral composition and/or the anti-PD-1 antibody, followed by one or more secondary doses of the recombinant viral composition and/or the anti-PD-1 antibody, and optionally followed by one or more tertiary doses of the recombinant viral composition and/or the anti-PD-1 antibody.

[00881] The terms "initial dose," "secondary dose(s)," and "tertiary dose(s)" refer to the temporal sequence of administration of the recombinant viral composition and/or the anti-PD-1 antibody. Thus, the "initial dose" is the dose which is administered at the beginning of the treatment regimen (also referred to as the "loading dose"); the "secondary doses" are the doses which are administered after the initial dose; and the "tertiary doses" are the doses which are administered after the secondary doses. In some embodiments, the initial, secondary, and tertiary doses may all contain the same amount of the recombinant viral composition and/or the anti-PD-1 antibody, but may differ from one another in terms of frequency of administration. In some embodiments, the amount of the recombinant viral composition and/or the anti-PD-1 antibody contained in the initial, secondary and/or tertiary doses varies from one another (e.g., adjusted up or down as appropriate) during the course of treatment. In certain embodiments, one or more (e.g., 1, 2, 3, 4, or 5) doses are administered at the beginning of the treatment regimen as "loading doses" followed by subsequent doses that are administered on a less frequent basis (e.g., "maintenance doses"). In some embodiments, the initial dose and the one or more secondary doses each contain the same amount of the recombinant viral composition and/or the anti-PD-1 antibody. In other embodiments, the initial dose comprises a first amount of the recombinant viral composition and/or the anti-PD-1 antibody and the one or more secondary doses each comprise a second amount of the recombinant viral composition and/or the anti-PD-1 antibody. For example, the first amount of the recombinant viral composition and/or the anti-PD-1 antibody can be 1.5x, 2x, 2.5x, 3x, 3.5x, 4x, 5x or more than the second amount of the recombinant viral composition and/or the anti-PD-1 antibody.

[00882] In some embodiments, each secondary and/or tertiary dose is administered 1 to 14 (e.g., 1, 1½, 2, 2½, 3, 3½, 4, 4½, 5, 5½, 6, 6½, 7, 7½, 8, 8½, 9, 9½, 10, 10½, 11, 11½, 12, 12½, 13, 13½, 14, 14½, or more) weeks after the immediately preceding dose. The phrase "the immediately preceding dose," as used herein, means, in a sequence of multiple administrations, the dose of the recombinant viral composition and/or the anti-PD-1 antibody that is administered to a subject prior to the administration of the very next dose in the sequence with no intervening doses.

[00883] The methods of the disclosure may comprise administering to a subject any number of secondary and/or tertiary doses of a recombinant viral composition and/or an anti-PD-1 antibody. For example, in certain embodiments, only a single secondary dose is administered to the subject. In other embodiments, two or more (e.g., 2, 3, 4, 5, 6, 7, 8, or more) secondary doses are administered to the subject. Likewise, in certain embodiments, only a single tertiary dose is administered to the subject. In other embodiments, two or more (e.g., 2, 3, 4, 5, 6, 7, 8, or more) tertiary doses are administered to the subject.

[00884] In some embodiments involving multiple secondary doses, each secondary dose is administered at the same frequency as the other secondary doses. For example, each secondary dose may be administered to the subject 1, 2, 3, or 4 weeks after the immediately preceding dose. Similarly, in some embodiments involving multiple tertiary doses, each tertiary dose is administered at the same frequency as the other tertiary doses. Alternatively, the frequency at which the secondary and/or tertiary doses are administered to a subject can vary over the course of the treatment regimen. The frequency of administration may also be adjusted during the course of treatment by a physician depending on the needs of the individual subject following clinical examination.

[00885] In some embodiments, the subsequently administered anti-PD-1 antibody is administered via the same administration route as the originally administered anti-PD-1 antibody. In some embodiments, the subsequently administered recombinant viral composition is administered via the same administration route as the originally administered recombinant viral composition. In some embodiments, the subsequently administered anti-PD-1 antibody is administered via a different administration route as the originally administered anti-PD-1 antibody. In some embodiments, the subsequently administered recombinant viral composition is administered via a different administration route as the originally administered recombinant viral composition.

[00886] In various embodiments, the first dose of the anti-PD-1 antibody may be delayed as compared to the first dose of the recombinant viral composition. In some embodiments, the first dose of the anti-PD-1 antibody is delayed by about 1 to about 21 days as compared to first dose of the recombinant viral composition. In some embodiments, the first dose of the anti-PD-1 antibody is delayed by about 1 to about 14 days as compared to first dose of the recombinant viral

composition. In some embodiments, the first dose of the anti-PD-1 antibody is delayed by about 1 to about 7 days as compared to first dose of the recombinant viral composition.

[00887] In some embodiments, when a recombinant viral composition and/or an anti-PD-1 antibody are sequentially administered, the recombinant viral composition may be administered as a first component of the dosing regimen and the anti-PD-1 antibody may be administered as a second component of the dosing regimen. In some embodiments, an anti-PD-1 antibody and a recombinant viral composition may be sequentially administered, in either order, with variable time intervals between administrations. For example, the time interval between administration of the recombinant viral composition and the anti-PD-1 antibody may be at least about 30 seconds, at least about 35 seconds, at least about 40 seconds, at least about 45 seconds, at least about 50 seconds, at least about 55 seconds, at least about 1 minute, at least about 2 minutes, at least about 5 minutes, at least about 10 minutes, at least about 20 minutes, at least about 30 minutes, at least about 40 minutes, at least about 50 minutes, at least about 1 hour, at least about 2 hours, at least about 3 hours, at least about 4 hours, at least about 5 hours, at least about 6 hours, at least about 7 hours, at least about 8 hours, at least about 9 hours, at least about 10 hours, at least about 10 to 12 hours, at least about 12 to 14 hours, at least about 14 to 16 hours, at least about 16 to 18 hours, at least about 18 to 20 hours, at least about 20 to 22 hours, at least about 22 to 24 hours, at least about 1 day, at least about 2 days, at least about 3 days, at least about 4 days, at least about 5 days, at least about 6 days, at least about 7 days, at least about 8 days, at least about 9 days, at least about 10 days, at least about 10 to 12 days, at least about 12 to 14 days, at least about 14 to 16 days, at least about 16 to 18 days, at least about 18 to 20 days, at least about 20 to 22 days, at least about 22 to 24 days, at least about 24 to 26 days, at least about 28 days, at least about 29 days, at least about 30 days, at least about 31 days, at least about 1 month, at least about 2 months, at least about 3 months, at least about 4 months, at least about 5 months, at least about 6 months, at least about 7 months, at least about 8 months, at least about 9 months, at least about 10 months, at least about 11 months, at least about 1 year, at least about 2 years, at least about 3 years, at least about 4 years, at least about 5 years, at least about 6 years, at least about 7 years, at least about 8 years, at least about 9 years, at least about 10 years, or more.

[00888] In some embodiments, the anti-PD-1 antibody can be administered to a subject about 0.5 hour to about 48 hours, about 0.5 hour to about 24 hours, about 0.5 hour to about 12 hours, about 0.5 hour to about 6 hours, about 0.5 hour to about 2 hours, about 0.5 hour to about 1 hour,

about 1 hour to about 48 hours, about 1 hour to about 24 hours, about 1 hour to about 12 hours, about 1 hour to about 6 hours, about 2 hours to about 48 hours, about 6 hours to about 48 hours, about 12 hours to about 48 hours, or about 24 hours to about 48 hours prior to and/or subsequent to administration of the recombinant viral composition.

[00889] In some embodiments, the anti-PD-1 antibody is administered the same day as the administration of the recombinant viral composition. In some embodiments, the anti-PD-1 antibody is administered at least 30 minutes after administration of the recombinant viral composition. In some embodiments, the anti-PD-1 antibody is administered about 30 minutes, about 45 minutes, about 1 hour, about 1.5 hours, about 2 hours, about 2.5 hours, about 3 hours, about 3.5 hours, about 4 hours, about 4.5 hours, about 5 hours, about 6 hours, about 7 hours, about 8 hours, about 10 hours, about 12 hours, about 14 hours, about 16 hours, about 18 hours, about 20 hours, about 22 hours, or about 24 hours after administration of the recombinant viral composition. In some embodiments, the anti-PD-1 antibody may be re-administered once in each 21-day cycle for up to 2 years. In some embodiments, the anti-PD-1 antibody may be re-administered once in each 14-day cycle, once in each 18-day cycle, once in each 21-day cycle, once in each 25-day cycle, once in each 30-day cycle, or once in each 45-day cycle. In some embodiments, the anti-PD-1 antibody is administered to a subject at a dosing frequency of about four times a week, twice a week, once a week, once every two weeks, once every three weeks, once every four weeks, once every five weeks, once every six weeks, once every eight weeks, once every twelve weeks, or less frequently so long as a therapeutic response is achieved. In some embodiments, the anti-PD-1 antibody may be re-administered for up to 1 month, 2 months, 3 months, 4 months, 5 months, 6 months, 8 months, 10 months, 1 year, 1.5 years, 2 years, 2.5 years, 3 years, 3.5 years, 4 years, 4.5 years, 5 years, or more. In some embodiments, the anti-PD-1 antibody is administered at least 30 minutes after administration of the recombinant viral composition, the recombinant viral composition is administered only once, and the anti-PD-1 antibody is re-administered up to once in each 21-day cycle for up to 2 years.

[00890] In some embodiments, a subsequent dose of an anti-PD-1 antibody described herein may be higher than a first dose of an anti-PD-1 antibody described herein. In some embodiments, a subsequent dose of an anti-PD-1 antibody described herein may be lower than a first dose of an anti-PD-1 antibody described herein. In some embodiments, a subsequent dose of an anti-PD-1 antibody described herein may be the same as a first dose of an anti-PD-1 antibody described

herein. In some embodiments, a subsequent dose of a recombinant viral composition described herein may be higher than a first dose of a recombinant viral composition described herein. In some embodiments, a subsequent dose of a recombinant viral composition described herein may be lower than a first dose of a recombinant viral composition described herein. In some embodiments, a subsequent dose of a recombinant viral composition described herein may be the same as a first dose of a recombinant viral composition described herein.

[00891] Any of the above methods can further comprise any of various subsequent administration steps described herein. The subsequent administration step can comprise, for example, administering the anti-PD-1 antibody and/or the recombinant viral composition to the subject one or more subsequent times until a desired level of therapeutic effect, expression, and/or activity is achieved in the subject.

[00892] The subsequent administration step can be, for example, at least about 1 week, at least about 2 weeks, at least about 3 weeks, at least about 4 weeks, at least about 5 weeks, at least about 6 weeks, at least about 7 weeks, at least about 8 weeks, at least about 9 weeks, at least about 10 weeks, at least about 11 weeks, or at least about 12 weeks after the initial dosing, or about 4 weeks to about 12 weeks, about 4 weeks to about 13 weeks, about 4 weeks to about 14 weeks, about 4 weeks to about 15 weeks, about 4 weeks to about 16 weeks, about 1 week to about 12 weeks, about 2 weeks to about 12 weeks, about 3 weeks to about 12 weeks, about 1 week to about 15 weeks, about 2 week to about 14 weeks, or about 3 weeks to about 13 weeks after the initial dosing.

[00893] The frequency of administration of the anti-PD-1 antibody and/or the recombinant viral composition can be any amount that treats the subject without producing significant toxicity to the subject. The frequency of administration of the anti-PD-1 antibody and/or the recombinant viral composition can remain constant or can be variable during the duration of treatment. A course of treatment with a composition containing the anti-PD-1 antibody and/or the recombinant viral composition can include rest periods. As with the effective amount, various factors can influence the actual frequency of administration used for a particular application. For example, the effective amount, use of multiple treatment agents, duration of treatment, severity of the condition (e.g., cancer), and route of administration, may require an increase or decrease in administration frequency.

[00894] In some embodiments, the recombinant rhabdovirus or composition is administered before the administration of the immune checkpoint inhibitor to the subject.

[00895] In some embodiments, the recombinant rhabdovirus or composition is administered simultaneously with the administration of the immune checkpoint inhibitor to the subject.

[00896] In some embodiments, the recombinant rhabdovirus or composition is administered after the administration of the immune checkpoint inhibitor to the subject.

[00897] In some embodiments, the recombinant rhabdovirus or composition is administered once and the immune checkpoint inhibitor is administered two or more times to the subject.

[00898] In some embodiments, the immune checkpoint inhibitor and/or the recombinant rhabdovirus are administered two or more times.

[00899] In some embodiments, the recombinant rhabdovirus or composition is administered before and/or between each of the administrations of the immune checkpoint inhibitor.

Example Recombinant Viruses and Polynucleotides Comprising a Transmembrane Domain

[00900] In one aspect, provided herein is a recombinant rhabdovirus comprising a nucleotide sequence encoding a recombinant protein, wherein the recombinant protein comprises:

i. an IL-12 polypeptide, or a functional fragment or derivative thereof; and
ii. a transmembrane domain.

[00901] In some embodiments, the nucleotide sequence encoding the recombinant protein is a template for a positive sense transcript encoding said recombinant protein.

[00902] In some embodiments, the recombinant protein is membrane bound.

[00903] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

[00904] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00905] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[00906] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[00907] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[00908] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[00909] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[00910] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[00911] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[00912] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[00913] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[00914] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[00915] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[00916] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[00917] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[00918] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a first linker.

[00919] In some embodiments, the first linker is from about 5 amino acids to about 30 amino acids in length.

[00920] In some embodiments, the first linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00921] In some embodiments, the first linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00922] In some embodiments, the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

[00923] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

[00924] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[00925] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[00926] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[00927] In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

[00928] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

[00929] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

[00930] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, is connected to the transmembrane domain via a second linker.

[00931] In some embodiments, the second linker is from about 5 amino acids to about 50 amino acids in length.

[00932] In some embodiments, the second linker is a flexible linker, a rigid linker, or a cleavable linker.

[00933] In some embodiments, the second linker is a flexible linker.

[00934] In some embodiments, the second linker comprises the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[00935] In some embodiments, the second linker consists of the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[00936] In some embodiments, the second linker is a rigid linker.

[00937] In some embodiments, the second linker comprises the amino acid sequence of SEQ ID NO: 73.

[00938] In some embodiments, the second linker consists of the amino acid sequence of SEQ ID NO: 73.

[00939] In some embodiments, the second linker comprises the amino acid sequence of SEQ ID NO: 74.

[00940] In some embodiments, the second linker consists of the amino acid sequence of SEQ ID NO: 74.

[00941] In some embodiments, the transmembrane domain is derived from a B7.1 antigen.

[00942] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23, or an amino acid sequence which has at least 80% sequence identity thereto.

[00943] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23.

[00944] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 23.

[00945] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26, or an amino acid sequence which has at least 80% sequence identity thereto.

[00946] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26.

[00947] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 26.

[00948] In some embodiments, a topological domain is operably linked to the transmembrane domain.

[00949] In some embodiments, the topological domain is derived from a B7.1 antigen.

[00950] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21, or an amino acid sequence which has at least 80% sequence identity thereto, or SEQ ID NO: 22, or an amino acid sequence which has at least 80% sequence identity thereto.

[00951] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[00952] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[00953] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25, or an amino acid sequence which has at least 80% sequence identity thereto.

[00954] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25.

[00955] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 25.

[00956] In some embodiments, the transmembrane domain is derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[00957] In some embodiments, the transmembrane domain is operably linked to a topological domain.

[00958] In some embodiments, the topological domain is derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[00959] In another aspect, provided herein is a recombinant rhabdovirus comprising a nucleotide sequence encoding a recombinant protein, wherein the recombinant protein comprises:

i. an IL-12 polypeptide comprising an IL-12 p35 subunit, or a functional fragment or derivative thereof;
ii. a signal peptide operably linked the IL-12 polypeptide; and
iii. a transmembrane domain derived from a B7.1 antigen.

[00960] In some embodiments, the nucleotide sequence encoding the recombinant protein is a template for a positive sense transcript encoding said recombinant protein.

[00961] In some embodiments, the recombinant protein is membrane bound.

[00962] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

[00963] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[00964] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[00965] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[00966] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[00967] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[00968] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[00969] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[00970] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[00971] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[00972] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[00973] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[00974] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[00975] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a first linker.

[00976] In some embodiments, the first linker is from about 5 amino acids to about 30 amino acids in length.

[00977] In some embodiments, the first linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00978] In some embodiments, the first linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[00979] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

[00980] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[00981] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[00982] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[00983] In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

[00984] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

[00985] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

[00986] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23, or an amino acid sequence which has at least 80% sequence identity thereto.

[00987] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23.

[00988] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 23.

[00989] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26, or an amino acid sequence which has at least 80% sequence identity thereto.

[00990] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26.

[00991] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 26.

[00992] In some embodiments, a topological domain is operably linked to the transmembrane domain.

[00993] In some embodiments, the topological domain is derived from a B7.1 antigen.

[00994] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22, or an amino acid sequence which has at least 80% sequence identity thereto.

[00995] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[00996] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[00997] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25, or an amino acid sequence which has at least 80% sequence identity thereto.

[00998] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25.

[00999] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 25.

[001000] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, is connected to the B7.1 antigen transmembrane domain via a second linker.

[001001] In some embodiments, the second linker is from about 5 amino acids to about 50 amino acids in length.

[001002] In some embodiments, the second linker is a flexible linker, a rigid linker, or a cleavable linker.

[001003] In some embodiments, the second linker is a flexible linker.

[001004] In some embodiments, the second linker comprises the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001005] In some embodiments, the second linker consists of the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001006] In some embodiments, the second linker is a rigid linker.

[001007] In some embodiments, the second linker comprises the amino acid sequence of SEQ ID NO: 73.

[001008] In some embodiments, the second linker consists of the amino acid sequence of SEQ ID NO: 73.

[001009] In some embodiments, the second linker comprises the amino acid sequence of SEQ ID NO: 74.

[001010] In some embodiments, the second linker consists of the amino acid sequence of SEQ ID NO: 74.

[001011] In some embodiments, the recombinant protein further comprises one or more of the following additional polypeptides:

a) a cluster of differentiation 4 (CD4) polypeptide, or a functional fragment or derivative thereof;

b) a cluster of differentiation 46 (CD46) polypeptide, or a functional fragment or derivative thereof;

c) an IgG2a polypeptide, or a functional fragment or derivative thereof;

d) an IgG1 polypeptide, or a functional fragment or derivative thereof; and/or

e) an IgG4 polypeptide, or a functional fragment or derivative thereof.

[001012] In some embodiments, the one or more additional polypeptides are positioned between the IL-12 p35 subunit, or the functional fragment or derivative thereof, and the transmembrane domain.

[001013] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, is connected to the one or more additional polypeptides via a second linker, and the one more additional polypeptides are connected to the transmembrane domain via a third linker.

[001014] In some embodiments, the second linker and/or the third linker is from about 5 amino acids to about 50 amino acids in length.

[001015] In some embodiments, the second linker and/or the third linker is a flexible linker, a rigid linker, or a cleavable linker.

[001016] In some embodiments, the second linker and/or the third linker is a flexible linker.

[001017] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001018] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001019] In some embodiments, the second linker and/or the third linker is a rigid linker.

[001020] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence of SEQ ID NO: 73.

[001021] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence of SEQ ID NO: 73.

[001022] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence of SEQ ID NO: 74.

[001023] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence of SEQ ID NO: 74.

[001024] In some embodiments, the one or more additional polypeptides comprise a CD4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 153, or an amino acid sequence which has at least 80% sequence identity thereto.

[001025] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 153.

[001026] In some embodiments, the one or more additional polypeptides comprise a CD4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 96, or an amino acid sequence which has at least 80% sequence identity thereto.

[001027] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 96.

[001028] In some embodiments, the one or more additional polypeptides comprise a CD46 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 98, or an amino acid sequence which has at least 80% sequence identity thereto.

[001029] In some embodiments, the CD46 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 98.

[001030] In some embodiments, the one or more additional polypeptides comprise an IgG2a polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 102, or an amino acid sequence which has at least 80% sequence identity thereto.

[001031] In some embodiments, the IgG2a polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 102.

[001032] In some embodiments, the IgG2a polypeptide or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 102.

[001033] In some embodiments, the one or more additional polypeptides comprise an IgG1 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 151, or an amino acid sequence which has at least 80% sequence identity thereto.

[001034] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 151.

[001035] In some embodiments, the one or more additional polypeptides comprise an IgG1 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 104, or an amino acid sequence which has at least 80% sequence identity thereto.

[001036] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 104.

[001037] In some embodiments, the IgG1 polypeptide or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 104.

[001038] In some embodiments, the one or more additional polypeptides comprise an IgG4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 106, or an amino acid sequence which has at least 80% sequence identity thereto.

[001039] In some embodiments, the IgG4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 106.

[001040] In some embodiments, the rhabdovirus is a vesiculovirus.

[001041] In some embodiments, the vesiculovirus is a vesicular stomatitis virus (VSV).

[001042] In some embodiments, the rhabdovirus genome comprises a gene encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof.

[001043] In some embodiments, the rhabdovirus genome comprises a gene encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof.

[001044] In some embodiments, the rhabdovirus genome comprises a gene encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof.

[001045] In some embodiments, the rhabdovirus genome comprises a gene encoding a fusogenic polypeptide, or a functional fragment or derivative thereof.

[001046] In some embodiments, the rhabdovirus genome comprises a gene encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof.

[001047] In some embodiments, the rhabdovirus genome comprises one or more genes encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof, a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof, a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof.

[001048] In some embodiments, the recombinant rhabdovirus comprises an RNA molecule, wherein the RNA molecule comprises a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein.

[001049] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned in one of the following positions:

a. between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or a functional fragment or derivative thereof;

b. between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or a functional fragment or derivative thereof;
c. at the 5' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof;
d. at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof;
e. between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof; or
f. between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[001050] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or a functional fragment or derivative thereof.

[001051] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or a functional fragment or derivative thereof.

[001052] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 5' end of the nucleotide sequence

that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[001053] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof.

[001054] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof.

[001055] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[001056] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence:

a. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding VSV L polypeptide, or a functional fragment or derivative thereof;

b. a nucleotide sequence that is a template for a positive sense transcript encoding a

VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein;

c. the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof;

d. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a

VSV L polypeptide, or a functional fragment or derivative thereof; or

e. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001057] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is the template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001058] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a

nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein.

[001059] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is the template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001060] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001061] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript

encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, the nucleotide sequence that is a template for the positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001062] In some embodiments, the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

[001063] In some embodiments, upon infection of a cell with the recombinant rhabdovirus, the cell expresses the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof.

[001064] In some embodiments, the cell is a human cell.

[001065] In some embodiments, the cell is a cancer cell.

[001066] In some embodiments, the recombinant rhabdovirus is a replication-competent virus.

[001067] In some embodiments, the recombinant rhabdovirus is non-replicative.

[001068] In some embodiments, the recombinant rhabdovirus is an oncolytic virus.

[001069] In some embodiments, the VSV M polypeptide is a wild-type VSV M polypeptide.

[001070] In some embodiments, the VSV M polypeptide is a mutant VSV M polypeptide.

[001071] In some embodiments, the mutant VSV M polypeptide comprises a mutation at methionine (M) 51.

[001072] In some embodiments, the mutation at methionine (M) 51 is a substitution from methionine (M) to arginine (R).

[001073] In some embodiments, the VSV M polypeptide comprises an amino acid sequence that comprises of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

[001074] In a further aspect, provided herein is a recombinant polynucleotide comprising:

i. a nucleotide sequence encoding a vesicular stomatitis virus (VSV) nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

ii. a nucleotide sequence encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

iii. a nucleotide sequence encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

iv. a nucleotide sequence encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

v. a nucleotide sequence encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and

vi. a nucleotide sequence encoding a recombinant protein comprising (i) an IL-12 polypeptide, or a functional fragment or derivative thereof, (ii) a transmembrane domain.

[001075] In some embodiments, the recombinant protein is membrane bound.

[001076] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

[001077] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[001078] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[001079] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[001080] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[001081] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[001082] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[001083] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[001084] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[001085] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[001086] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[001087] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[001088] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[001089] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[001090] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[001091] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a first linker.

[001092] In some embodiments, the first linker is from about 5 amino acids to about 30 amino acids in length.

[001093] In some embodiments, the first linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[001094] In some embodiments, the first linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[001095] In some embodiments, the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

[001096] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

[001097] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[001098] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[001099] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[001100] In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

[001101] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

[001102] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

[001103] In some embodiments, the transmembrane domain is derived from a B7.1 antigen.

[001104] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23, or an amino acid sequence which has at least 80% sequence identity thereto.

[001105] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23.

[001106] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 23.

[001107] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26, or an amino acid sequence which has at least 80% sequence identity thereto.

[001108] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26.

[001109] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 26.

[001110] In some embodiments, a topological domain is operably linked to the transmembrane domain.

[001111] In some embodiments, the topological domain is derived from a B7.1 antigen.

[001112] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22, or an amino acid sequence which has at least 80% sequence identity thereto.

[001113] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[001114] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[001115] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25, or an amino acid sequence which has at least 80% sequence identity thereto.

[001116] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25.

[001117] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 25.

[001118] In some embodiments, the transmembrane domain is derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[001119] In some embodiments, the transmembrane domain is operably linked to a topological domain.

[001120] In some embodiments, the topological domain is derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[001121] In some embodiments, the recombinant protein further comprises one or more of the following additional polypeptides:

a. a cluster of differentiation 4 (CD4) polypeptide, or a functional fragment or derivative thereof;
b. a cluster of differentiation 46 (CD46) polypeptide, or a functional fragment or derivative thereof;
c. an IgG2a polypeptide, or a functional fragment or derivative thereof;
d. an IgG1 polypeptide, or a functional fragment or derivative thereof; and/or
e. an IgG4 polypeptide, or a functional fragment or derivative thereof.

[001122] In some embodiments, the one or more additional polypeptides are positioned between the IL-12 p35 subunit, or the functional fragment or derivative thereof, and the transmembrane domain.

[001123] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, is connected to the one or more additional polypeptides via a second linker, and the one more additional polypeptides are connected to the transmembrane domain via a third linker.

[001124] In some embodiments, the second linker and/or the third linker is from about 5 amino acids to about 50 amino acids in length.

[001125] In some embodiments, the second linker and/or the third linker is a flexible linker, a rigid linker, or a cleavable linker.

[001126] In some embodiments, the second linker and/or the third linker is a flexible linker.

[001127] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001128] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001129] In some embodiments, the second linker and/or the third linker is a rigid linker.

[001130] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence of SEQ ID NO: 73.

[001131] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence of SEQ ID NO: 73.

[001132] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence of SEQ ID NO: 74.

[001133] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence of SEQ ID NO: 74.

[001134] In some embodiments, the one or more additional polypeptides comprise a CD4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 153, or an amino acid sequence which has at least 80% sequence identity thereto.

[001135] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 153.

[001136] In some embodiments, the one or more additional polypeptides comprise a CD4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 96, or an amino acid sequence which has at least 80% sequence identity thereto.

[001137] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 96.

[001138] In some embodiments, the one or more additional polypeptides comprise a CD46 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 98, or an amino acid sequence which has at least 80% sequence identity thereto.

[001139] In some embodiments, the CD46 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 98.

[001140] In some embodiments, the one or more additional polypeptides comprise an IgG2a polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 102, or an amino acid sequence which has at least 80% sequence identity thereto.

[001141] In some embodiments, the IgG2a polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 102.

[001142] In some embodiments, the IgG2a polypeptide or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 102.

[001143] In some embodiments, the one or more additional polypeptides comprise an IgG1 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 151, or an amino acid sequence which has at least 80% sequence identity thereto.

[001144] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 151.

[001145] In some embodiments, the one or more additional polypeptides comprise an IgG1 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 104, or an amino acid sequence which has at least 80% sequence identity thereto.

[001146] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 104.

[001147] In some embodiments, the IgG1 polypeptide or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 104.

[001148] In some embodiments, the one or more additional polypeptides comprise an IgG4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 106, or an amino acid sequence which has at least 80% sequence identity thereto.

[001149] In some embodiments, the IgG4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 106.

[001150] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned in one of the following positions:

a. between the nucleotide sequence encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof;
b. between the nucleotide sequence encoding the VSV M polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the fusogenic polypeptide, or a functional fragment or derivative thereof;
c. at the 3' end of the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof;
d. at the 5' end of the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof;
e. between the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof; or
f. between the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[001151] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[001152] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the VSV M polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the fusogenic polypeptide, or a functional fragment or derivative thereof.

[001153] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned at the 3' end of the nucleotide sequence encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[001154] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned at the 5' end of the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof.

[001155] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof.

[001156] In some embodiments, the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[001157] In some embodiments, the recombinant polynucleotide comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence:

a. a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, the recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof;

b. a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, a VSV L polypeptide, or a functional fragment or derivative thereof, and the recombinant protein;

c. the recombinant protein, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or

derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof;

d. a VSV N polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof; or

e. a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[001158] In some embodiments, the recombinant polynucleotide comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, the recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[001159] In some embodiments, the recombinant polynucleotide comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, a VSV L polypeptide, or a functional fragment or derivative thereof, and the recombinant protein.

[001160] In some embodiments, the recombinant polynucleotide comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, the recombinant protein, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or

derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[001161] In some embodiments, the recombinant polynucleotide comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[001162] In some embodiments, the recombinant polynucleotide comprises a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, the recombinant protein, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a VSV L polypeptide, or a functional fragment or derivative thereof.

[001163] In some embodiments, the VSV M polypeptide is a wild-type VSV M polypeptide.

[001164] In some embodiments, the VSV M polypeptide is a mutant VSV M polypeptide.

[001165] In some embodiments, the mutant VSV M polypeptide comprises a mutation at methionine (M) 51.

[001166] In some embodiments, the mutation at methionine (M) 51 is a substitution from methionine (M) to arginine (R).

[001167] In some embodiments, the VSV M polypeptide comprises an amino acid sequence that comprises of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

[001168] In some embodiments, the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

[001169] In some embodiments, the polynucleotide is DNA.

[001170] In some embodiments, the polynucleotide is RNA.

[001171] In another aspect, provided herein is a recombinant polynucleotide, wherein the recombinant polynucleotide is an RNA molecule comprising:

i. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

ii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

iii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

iv. a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

v. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and

vi. a nucleotide sequence that is a template for a positive sense transcript encoding a recombinant protein comprising (i) an IL-12 polypeptide, or a functional fragment or derivative thereof, (ii) a transmembrane domain.

[001172] In some embodiments, the recombinant protein is membrane bound.

[001173] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

[001174] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[001175] In some embodiments, the IL-12 polypeptide, or the functional fragment or derivative thereof comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

[001176] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

[001177] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

[001178] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

[001179] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

[001180] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

[001181] In some embodiments, the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

[001182] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

[001183] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

[001184] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

[001185] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

[001186] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

[001187] In some embodiments, the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

[001188] In some embodiments, the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a first linker.

[001189] In some embodiments, the first linker is from about 5 amino acids to about 30 amino acids in length.

[001190] In some embodiments, the first linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[001191] In some embodiments, the first linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

[001192] In some embodiments, the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

[001193] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

[001194] In some embodiments, the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

[001195] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

[001196] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

[001197] In some embodiments, the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

[001198] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

[001199] In some embodiments, the signal peptide comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

[001200] In some embodiments, the transmembrane domain is derived from a B7.1 antigen.

[001201] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23, or an amino acid sequence which has at least 80% sequence identity thereto.

[001202] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 23.

[001203] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 23.

[001204] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26, or an amino acid sequence which has at least 80% sequence identity thereto.

[001205] In some embodiments, the B7.1 antigen transmembrane domain comprises the amino acid sequence of SEQ ID NO: 26.

[001206] In some embodiments, the B7.1 antigen transmembrane domain consists of the amino acid sequence of SEQ ID NO: 26.

[001207] In some embodiments, a topological domain is operably linked to the transmembrane domain.

[001208] In some embodiments, the topological domain is derived from a B7.1 antigen

[001209] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22, or an amino acid sequence which has at least 80% sequence identity thereto.

[001210] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[001211] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 21 or SEQ ID NO: 22.

[001212] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25, or an amino acid sequence which has at least 80% sequence identity thereto.

[001213] In some embodiments, the topological domain comprises the amino acid sequence of SEQ ID NO: 25.

[001214] In some embodiments, the topological domain consists of the amino acid sequence of SEQ ID NO: 25.

[001215] In some embodiments, the transmembrane domain is derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[001216] In some embodiments, the transmembrane domain is operably linked to a topological domain.

[001217] In some embodiments, the topological domain is derived from tumor necrosis factor (TNF) alpha (TNFα), platelet-derived growth factor receptor (PDGFR), or cluster of differentiation 4 (CD4).

[001218] In some embodiments, the recombinant protein further comprises one or more of the following additional polypeptides:

a. a cluster of differentiation 4 (CD4) polypeptide, or a functional fragment or derivative thereof;
b. a cluster of differentiation 46 (CD46) polypeptide, or a functional fragment

or derivative thereof;

c. an IgG2a polypeptide, or a functional fragment or derivative thereof;
d. an IgG1 polypeptide, or a functional fragment or derivative thereof; and/or
e. an IgG4 polypeptide, or a functional fragment or derivative thereof.

[001219] In some embodiments, the one or more additional polypeptides are positioned between the IL-12 p35 subunit, or the functional fragment or derivative thereof, and the transmembrane domain.

[001220] In some embodiments, the IL-12 p35 subunit, or the functional fragment or derivative thereof, is connected to the one or more additional polypeptides via a second linker, and the one more additional polypeptides are connected to the transmembrane domain via a third linker.

[001221] In some embodiments, the second linker and/or the third linker is from about 5 amino acids to about 50 amino acids in length.

[001222] In some embodiments, the second linker and/or the third linker is a flexible linker, a rigid linker, or a cleavable linker.

[001223] In some embodiments, the second linker and/or the third linker is a flexible linker.

[001224] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001225] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence $(G_4S)_3$ (SEQ ID NO: 18).

[001226] In some embodiments, the second linker and/or the third linker is a rigid linker.

[001227] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence of SEQ ID NO: 73.

[001228] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence of SEQ ID NO: 73.

[001229] In some embodiments, the second linker and/or the third linker comprises the amino acid sequence of SEQ ID NO: 74.

[001230] In some embodiments, the second linker and/or the third linker consists of the amino acid sequence of SEQ ID NO: 74.

[001231] In some embodiments, the one or more additional polypeptides comprise a CD4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 153, or an amino acid sequence which has at least 80% sequence identity thereto.

[001232] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 153.

[001233] In some embodiments, the one or more additional polypeptides comprise a CD4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 96, or an amino acid sequence which has at least 80% sequence identity thereto.

[001234] In some embodiments, the CD4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 96.

[001235] In some embodiments, the one or more additional polypeptides comprise a CD46 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 98, or an amino acid sequence which has at least 80% sequence identity thereto.

[001236] In some embodiments, the CD46 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 98.

[001237] In some embodiments, the one or more additional polypeptides comprise an IgG2a polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 102, or an amino acid sequence which has at least 80% sequence identity thereto.

[001238] In some embodiments, the IgG2a polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 102.

[001239] In some embodiments, the IgG2a polypeptide or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 102.

[001240] In some embodiments, the one or more additional polypeptides comprise an IgG1 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 151, or an amino acid sequence which has at least 80% sequence identity thereto.

[001241] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 151.

[001242] In some embodiments, the one or more additional polypeptides comprise an IgG1 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 104, or an amino acid sequence which has at least 80% sequence identity thereto.

[001243] In some embodiments, the IgG1 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 104.

[001244] In some embodiments, the IgG1 polypeptide or functional fragment or derivative thereof, comprises an alanine (A) substitution at position D265 with reference to the amino acid sequence of SEQ ID NO: 104.

[001245] In some embodiments, the one or more additional polypeptides comprise an IgG4 polypeptide, or a functional fragment or derivative thereof, comprising the amino acid sequence of SEQ ID NO: 106, or an amino acid sequence which has at least 80% sequence identity thereto.

[001246] In some embodiments, the IgG4 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 106.

[001247] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned in one of the following positions:

a. between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof;
b. between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof;
c. at the 5' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof;
d. at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof;
e. between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof; or
f. between the nucleotide sequence that is a template for a positive sense transcript

encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[001248] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[001249] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof.

[001250] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 5' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

[001251] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned at the 3' end of the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof.

[001252] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV N polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof.

[001253] In some embodiments, the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the VSV P polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV M polypeptide, or the functional fragment or derivative thereof.

[001254] In some embodiments, the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide:

a. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof;

b. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein;

c. a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a

functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof;

d. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof; or

e. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001255] In some embodiments, the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001256] In some embodiments, the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein.

[001257] In some embodiments, the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide

sequence that is a template for a positive sense transcript encoding VSV L polypeptide, or a functional fragment or derivative thereof.

[001258] In some embodiments, the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001259] In some embodiments, the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

[001260] In some embodiments, the VSV M polypeptide is a wild-type VSV M polypeptide.

[001261] In some embodiments, the VSV M polypeptide is a mutant VSV M polypeptide.

[001262] In some embodiments, the mutant VSV M polypeptide comprises a mutation at methionine (M) 51.

[001263] In some embodiments, the mutation at methionine (M) 51 is a substitution from methionine (M) to arginine (R).

[001264] In some embodiments, the VSV M polypeptide comprises an amino acid sequence that comprises SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

[001265] In some embodiments, the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

[001266] In a further aspect, provided herein is a vector comprising any one of the recombinant polynucleotides as described herein.

[001267] In another aspect, provided herein is a recombinant vesicular stomatitis virus (VSV) comprising any one of the recombinant polynucleotides as described herein.

[001268] In a further aspect, provided herein is a composition comprising any one of the recombinant rhabdoviruses as described herein, and a carrier and/or excipient.

[001269] In another aspect, provided herein is a composition comprising any one of the recombinant polynucleotides as described herein, and a pharmaceutically acceptable carrier and/or a pharmaceutically acceptable excipient

[001270] In a further aspect, provided herein is a host cell comprising any one of the recombinant rhabdoviruses as described herein.

[001271] In another aspect, provided herein is a host cell comprising any one of the recombinant polynucleotides as described herein.

[001272] In a further aspect, provided herein is a method of treating a cancer in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of any one of the recombinant rhabdoviruses as described herein or the composition comprising any one of the recombinant rhabdoviruses as described herein, and a carrier and/or excipient.

[001273] In some embodiments, the administration of the recombinant rhabdovirus or composition to the subject is under conditions wherein the recombinant rhabdovirus infects cancer cells of the subject to form infected cancer cells, wherein the infected cancer cells express the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and wherein the number of cancer cells within the subject is reduced following the administration.

[001274] In some embodiments, the administration of the recombinant rhabdovirus or composition to the subject is under conditions wherein the recombinant rhabdovirus infects cancer cells of the subject to form infected cancer cells, wherein the infected cancer cells express the

recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and wherein the number of cancer cells within the subject does not increase following the administration.

[001275] In another aspect, provided herein is a method for inducing a cancer regression in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of any one of the recombinant rhabdoviruses as described herein or the composition comprising any one of the recombinant rhabdoviruses as described herein, and a carrier and/or excipient

[001276] In some embodiments, the cancer regression produces a reduced tumor size.

[001277] In some embodiments, the recombinant rhabdovirus or composition is administered via local delivery.

[001278] In some embodiments, the local delivery is intratumoral delivery.

[001279] In some embodiments, the recombinant rhabdovirus or composition is administered via systemic delivery.

[001280] In some embodiments, the recombinant rhabdovirus or composition is administered via parenteral delivery.

[001281] In some embodiments, the parenteral delivery is subcutaneous, intraperitoneal, intradermal, intramuscular, or intravenous delivery.

[001282] In some embodiments, the parenteral delivery is intravenous delivery.

[001283] In some embodiments, the administration of the recombinant rhabdovirus to the subject produces a reduced serum interferon gamma (IFNγ) release in the subject as compared to a control recombinant rhabdovirus comprising a nucleotide sequence encoding a wild-type IL-12 polypeptide that is not membrane bound.

[001284] In some embodiments, the cancer is selected from head and neck cancer, colon cancer, lung cancer, prostate cancer, ovarian cancer, hepatocellular carcinoma, pancreatic cancer, kidney cancer, melanoma, brain cancer, lymphoma, myeloma, lymphocytic leukemia, myelogenous leukemia, and breast cancer.

[001285] In some embodiments, the subject is human.

EXAMPLES

[001286] The following examples are provided to further describe some of the embodiments disclosed herein. The examples are intended to illustrate, not to limit, the disclosed embodiments.

Example 1. Membrane-tethered interleukin-12 (IL-12) encoded by Vesicular Stomatitis Virus (VSV) does not induce toxicity when delivered intravenously

[001287] This Example describes the lack of toxicity observed using VSV encoding a membrane-tethered version of IL-12 p70 when delivered intravenously (i.v.). The VSV used in this study was engineered to genetically encode a membrane-tethered version of IL-12 p70 in a following sequence: IL-12p40-linker-IL-12p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated in amino acid position 51 (M51R) named VSV-M51R-IL-12p70_TM. This study used other VSV viruses as a control encoding for soluble version of IL-12 p70: VSV-Mwt (wild type)-IL-12p70 (that encodes for IL-12p40-linker-IL-12p35) or VSV-M51R-IL-12p70 (that encodes for IL-12p40-linker-IL-12p35 and viral M protein mutated) and a membrane-tethered version of IL-12 p35: IL-12p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated in position 51 (M51R) named VSV-M51-IL-12p35_TM (see, e.g., **Figure 1**).

[001288] C57BL/6 strain background mice were injected intravenously at day 0 with the viruses (VSV-M51R-mIL-12p70_TM, VSV-M51R-mIL-12p35_TM, VSV-M51R-mIL-12p70 or VSV-Mwt-mIL-12p70) at $1x10^9$ $TCID_{50}$ (median tissue culture infectious dose) dose resuspended in phosphate buffered saline (PBS), or PBS as control (**Figure 2**). A schematic of the dosing regimen is shown in **Figure 2**. The body weight of the mice was monitored post-infection. Serum was collected to measure serum cytokine release 24 hours post-infection. The average body weight change over time for each group showed that VSV-Mwt-mIL12p70 and VSV-M51R-mIL12p70 treatment induced body weight loss within the first day post-infection as compared to PBS control, with enhanced toxicity for the Mwt version compared to M51R backbone (**Figure 3**). Individual body weight loss graphs (**Figures 4A-4E**) show that two out of five and one out of five mice lost more than 20% of their initial weight respectively for VSV-Mwt-mIL12p70 (**Figure 4B**) and VSV-M51R-mIL12p70 (**Figure 4C**) treated mice, causing them to be euthanized at day 7 after treatment initiation. Strikingly, mice treated with VSV-M51R-mIL12p70_TM (**Figure 4E**) had no body weight loss compared to the soluble versions of IL-12 encoding VSV (**Figure 3** and **Figures 4B-4C**). Serum levels of IL-12 p70 and interferon gamma (IFNγ) 24 hours post-infection were measured and showed large amounts of both cytokines in groups treated with VSV-Mwt-

mIL12p70 and VSV-M51R-mIL12p70 compared to PBS control. However, mice treated with the membrane-tethered forms IL-12 p70 and IL-12 p35 encoding viruses did not induce serum release of these cytokines (**Figure 5**). In summary, intravenous delivery of a VSV encoding for a membrane-tethered form of IL-12 p70 demonstrated less toxicity than the IL-12 p70 soluble version.

Example 2. Anti-tumor efficacy of membrane-tethered IL-12 p70 encoded by VSV when delivered intratumorally

[001289] This Example describes the anti-tumor efficacy of VSV encoding for a membrane-tethered version of IL-12 p70 such as one that encodes for IL-12p40-linker-IL-12p35-linker-B7.1 transmembrane/intracellular domain VSV-M51R-mIL-12p70_TM when delivered intratumorally. C57BL/6 strain background mice were implanted subcutaneously with MC38 cells ($3x10^5$ cells/mouse) at day 0. Tumors were measured using a caliper and tumor volumes were calculated with the formula $(L^2xW)/2$ where L is the smallest size. Mice were randomized evenly into four treatment groups when the average tumor size reached 135-140 mm^3 which was at day 10. Mice were injected intratumorally with 50 µL of VSV-M51R-mIL-12p70, VSV-M51R-mIL-12p70_TM, VSV-M51R-mIL-12p35_TM virus at $5x10^8$ $TCID_{50}$ dose resuspended in PBS, or PBS as control (**Figure 6**). Tumor volumes were monitored by caliper measurements twice per week until the end of the study.

[001290] Treatment with VSV-M51R-mIL-12p70_TM and VSV-M51R-mIL-12p70 induced strong anti-tumor efficacy compared to PBS and VSV-M51R-mIL-12p35_TM with IL-12 p70 soluble form having a stronger effect than the membrane-tethered form (**Figure 7** and **Figure 8**). Day 14 corresponds to the day when all mice from all groups were alive (**Figure 8**) and statistical significance was determined by one-way ANOVA with Dunnett's multiple comparisons post-test (* $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$, **** $p< 0.0001$). The average tumor growth was strongly reduced in VSV-M51R-mIL-12p70_TM and VSV-M51R-mIL-12p70 treated groups with IL-12 p70 soluble form being the strongest and membrane-tethered IL-12 p70 having a better efficacy than membrane-tethered IL-12 p35. By Day 20, four out of seven mice became tumor free in the VSV-M51R-mIL-12p70 treated group, and VSV-M51R-mIL-12p70_TM also extended the survival compared to PBS and VSV-M51R-mIL-12p35_TM groups (**Figure 9**). Moreover, serum levels of IL-12 p70 and IFNγ were detected at low levels in mice treated with VSV-M51R-mIL-

12p70 but mice treated with VSV-M51R-mIL-12p70_TM did not have any detectable levels of IL-12 p70 and very low levels of IFNγ (**Figure 10**). In summary, intratumoral delivery of a VSV encoding for a membrane-tethered form of IL-12 p70 demonstrates anti-tumor efficacy in MC38 tumor model albeit to a lesser extent to a VSV encoding for a soluble form of IL-12 p70.

Example 3. Anti-tumor efficacy of membrane-tethered IL-12 encoded by VSV does not induce toxicity when delivered intravenously

[001291] This Example describes the anti-tumor efficacy of VSV encoding for a membrane-tethered version of IL-12 p70 such as one that encodes for IL-12p40-linker-p35-linker-B7.1 transmembrane/intracellular domain VSV-M51R-mIL-12p70_TM when delivered intravenously. C57BL/6 strain background mice were implanted subcutaneously with B16F10 cells ($3x10^5$ cells/mouse) at day 0. Tumors were measured using a caliper and tumor volumes were calculated with the formula $(L^2xW)/2$ where L is the smallest size. Mice were randomized evenly into three treatment groups when the average tumor size reached 100 mm^3 which was at day 9. Mice received 200 µL intravenous injection of VSV-M51R-mIL-12p70, VSV-M51R-mIL-12p70_TM virus at $1x10^9$ TCID50 dose resuspended in PBS, or PBS as control (**Figure 11**). Tumor volumes were monitored by caliper measurements twice per week until the end of the study.

[001292] Treatment with VSV-M51R-mIL-12p70_TM and VSV-M51R-mIL-12p70 induced strong anti-tumor efficacy compared to PBS, with the IL-12 p70 soluble form having similar efficacy as the membrane-tethered form (**Figure 12** and **Figure 13**). Day 11 corresponds to the day when all mice from all groups were alive (**Figure 13**) and statistical significance was determined by one-way ANOVA with Dunnett's multiple comparisons post-test (* $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$, **** $p< 0.0001$, n.s.: non-significant). The average tumor growth was strongly reduced VSV-M51R-mIL-12p70_TM and VSV-M51R-mIL-12p70 treated groups with IL-12 p70 soluble form and membrane-tethered IL-12 p70 having a similar efficacy. VSV-M51R-mIL-12p70 and VSV-M51R-mIL-12p70_TM treated groups also extended the survival compared to PBS (**Figure 14**). Body weight change was monitored, and groups treated with VSV-M51R-mIL-12p70 had a drop in their weight within the first three days post-virus administration. Interestingly, mice treated with VSV-M51R-mIL-12p70_TM did not lose body weight (**Figure 15**). Moreover, serum levels of IL-12 p70 and IFNγ were high in mice treated with VSV-M51R-mIL-12p70 but mice treated with VSV-M51R-mIL-12p70_TM did not have any detectable levels of IL12 p70 and very

low levels of IFNγ (**Figure 16**). In summary, intravenous delivery of a VSV encoding for a membrane-tethered form of IL-12 p70 demonstrated less toxicity than the IL-12 p70 soluble version and has equal anti-tumor efficacy in a B16F10 tumor model.

Example 4. *In vivo* effects of the oncolytic virus Vesicular Stomatitis Virus (VSV) encoding membrane-tethered IL-12 p70

[001293] To determine the effect of VSV encoding membrane-tethered IL-12 p70 in a relevant *in vivo* model, three *in vivo* studies were performed. One experiment involved wild type (WT) mice to test intravenous delivery of the viruses to assess toxicity and cytokine levels released in the bloodstream. The other experiments involved subcutaneous injection of tumor cells. All experiments were conducted in C57BL/6 strain background mice. For the tumor studies, mice were divided evenly according to the tumor size that averaged 135-140 mm^3 for MC38 and 100 mm^3 for B16F10 (measured by caliper with the calculation formula: $(L^2xW)/2$ where L is the smallest size).

[001294] Study 1 involved four groups with five mice per group. At day 0, mice were injected intravenously into the tail vein with different viruses: VSV-Mwt-mIL-12p70 (that encodes for IL-12p40-linker-IL-12p35) or VSV-M51R-mIL-12p70 (that encodes for IL-12p40-linker-IL-12p35 and viral M protein mutated) or VSV-M51-mIL-12p70_TM (that encodes for IL-12p40-linker-IL-12p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated) or VSV-M51-mIL-12p35_TM (that encodes for IL-12p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated) at $1x10^9$ $TCID_{50}$ dose resuspended in PBS, or PBS as control. Experimental dosing and treatment protocol for groups of mice are shown in **Table 4**.

Table 4. Study 1 experimental dosing and treatment protocol for groups of mice

Group	Route	Compound	$TCID_{50}$	Treatment day	n #
1	Intravenous	PBS	-	D0	5
2	Intravenous	VSV-M51R-mIL-12p70	$1x10^9$ $TCID_{50}$	D0	5
3	Intravenous	VSV-M51R-mIL-12p70_TM	$1x10^9$ $TCID_{50}$	D0	5
4	Intravenous	VSV-M51R-mIL-12p35_TM	$1x10^9$ $TCID_{50}$	D0	5

[001295] Study 2 involved four groups with seven to eight mice per group. At day 0, mice were anesthetized by isoflurane inhalation and then injected subcutaneously into the right flank with $3x10^5$ MC38 cells in suspension of 100 µL of Dulbecco's Modified Eagle Medium (DMEM). At day 10, mice were randomized evenly within the four groups according to the tumor size to average 135 mm^3, and mice received either 50 µL intra-tumor injection of different viruses: VSV-M51R-mIL-12p70 (that encodes for IL-12p40-linker-IL-12p35 and viral M protein mutated) or VSV-M51R-mIL-12p70_TM (that encodes for IL-12p40-linker-IL-12p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated) VSV-M51R-mIL-12p35_TM (that encodes for IL-12p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated) at $5x10^8$ $TCID_{50}$ dose resuspended in PBS, or PBS as control. Experimental dosing and treatment protocol for groups of mice are shown in **Table 5**.

Table 5. Study 2 experimental dosing and treatment protocol for groups of mice

Group	Route	Compound	$TCID_{50}$	Treatment day	n #
1	Intra-tumor	PBS	-	D10	8
2	Intra-tumor	VSV-M51R-mIL-12p70	$5x10^8$ $TCID_{50}$	D10	7
3	Intra-tumor	VSV-M51R-mIL-12p70_TM	$5x10^8$ $TCID_{50}$	D10	8
4	Intra-tumor	VSV-M51R-mIL-12p35_TM	$5x10^8$ $TCID_{50}$	D10	8

[001296] Study 3 involved three groups with seven mice per group. At day 0, mice were anesthetized by isoflurane inhalation and then injected subcutaneously into the right flank with $3x10^5$ B16F10 cells in suspension of 100 µL of DMEM. At day 9, mice were randomized evenly within three groups according to the tumor size to average 100 mm^3, and mice received 200 µL intravenous injection of VSV-M51R-mIL-12p70 (that encodes for IL-12p40-linker-IL-12p35, and viral M protein mutated) or VSV-M51R-mIL-12p70_TM (that encodes for IL-12p40-linker-IL-12p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated) at $1x10^9$ $TCID_{50}$ dose resuspended in PBS, or PBS as control. Experimental dosing and treatment protocol for groups of mice are shown in **Table 6**.

Table 6. Study 3 experimental dosing and treatment protocol for groups of mice

Group	Route	Compound	$TCID_{50}$	Treatment day	n #

1	Intravenous	PBS	-	D9	7
2	Intravenous	VSV-M51R-mIL-12p70	$1x10^9$ $TCID_{50}$	D9	7
3	Intravenous	VSV-M51R-mIL-12p70_TM	$1x10^9$ $TCID_{50}$	D9	7

[001297] For the studies, average tumor volumes determined by caliper measurements and percent survival at least twice a week in each experiment for each treatment group were recorded. In addition, the number of tumor-free mice was also assessed at the end of the study. Results, expressed as percentage of body weight loss or mean tumor volume (mm^3 ± SEM), percent survival, and/or number of tumor-free mice are shown in **Table 7** for Study 1, **Table 8** for Study 2, and **Table 9** for Study 3.

Table 7. Mean tumor volume, percent survival and numbers of tumor free mice in each treatment group from in vivo tumor Study 1

Treatment group (n=5)		Body weight change, % (±SD)			Survival, %	
		Day 3	Day 5	Day 7	Day 5	Day 11
1	PBS	0.6 (±3.3)	4.0 (±3.7)	3.1 (±3.0)	100%	100%
2	VSV-mIL-12p70	-13.6 (±1.7)	-18.7 (±2.8)	-16.8 (±6.0)	100%	60%
3	VSV-M51R-mIL-12p70	-13 (±1.4)	-12.7 (±5.5)	-10.5 (±8.8)	100%	80%
4	VSV-M51R-mIL-12p70_TM	-2.7 (±2.2)	2.8 (±1.4)	5.5 (±1.6)	100%	100%
5	VSV-M51R-mIL-12p35_TM	-9.5 (±2.4)	-3.6 (±2.0)	-1.5 (±2.7)	100%	100%

[001298] As shown in **Table 6** for Study 1, mice treated with either VSV-mIL-12p70 or VSV-M51R-mIL12p70 started to lose body weight shortly after the virus administration. By day 7, two out of five and one out of five mice treated respectively with VSV-mIL-12p70 or VSV-M51R-mIL12p70 needed to be euthanized due to body weight loss exceeding 20% of their original weight pre-treatment. In contrast, mice treated with VSV-M51R-mIL12p70_TM did not lose any body weight. Mice treated with VSV-M51R-mIL12p35_TM had a very mild body weight loss.

Table 8. Mean tumor volume, percent survival and numbers of tumor free mice in each treatment group from in vivo tumor Study 2

Treatment group (n=7-8)	Tumor Volume, mm^3	Tumor-Free Mice	Survival, %

		mean (±SD)					
		Day 14	Day 17	Day 20	Day 14	Day 17	Day 20
1	PBS	3198 (±582)	0/8	0/8	100%	0%	0%
2	VSV-M51R-mIL-12p70	101 (±120)	0/7	4/7	100%	100%	100%
3	VSV-M51R-mIL-12p70_TM	1273 (±255)	0/8	0/8	100%	100%	62.5%
4	VSV-M51R-mIL-12p35_TM	2586 (±542)	0/8	0/8	100%	0%	0%

[001299] As shown in **Table 7** for Study 2, mice treated intratumorally with VSV-M51R-mIL12p70 had strong anti-tumor efficacy compared to control and VSV-M51R-mIL12p35_TM treated tumors. VSV-M51R-mIL12p70_TM treated tumors had added anti-tumor efficacy and extended survival compared to PBS treated and VSV-M51R-mIL12p35_TM treated groups, with a lower efficacy compared to VSV-M51R-mIL12p70. This suggests that VSV-M51R-mIL12p70_TM contributes to local anti-tumor efficacy.

Table 9. Mean tumor volume, percent survival and numbers of tumor free mice in each treatment group from *in vivo* tumor Study 3

Treatment group (n=7-8)		Tumor Volume, mm^3 mean (±SD)	Survival, %		
		Day 11	Day 11	Day 18	Day 21
1	PBS	1544 (±520)	100%	57%	0%
2	VSV-M51R-mIL-12p70	478 (±173)	100%	85%	85%
3	VSV-M51R-mIL-12p70_TM	637 (±223)	100%	100%	57%

[001300] As shown in **Table 8** for Study 3, mice treated intravenously with VSV-M51R-mIL12p70 had strong anti-tumor efficacy compared to control. VSV-M51R-mIL12p70_TM treated tumors had added anti-tumor efficacy and extended survival compared to PBS treated groups, with similar efficacy compared to VSV-M51R-mIL12p70. This suggests that VSV-M51R-mIL12p70_TM contributes to local anti-tumor efficacy.

Example 5. Functional assessment of all VSV-12p70TM (rigid linker)

[001301] The aims of the present Example were as follows:

1. To verify the expression of IL-12p70 in the cell membrane using flow cytometry; and

2. To functionally assess the IL-12p70 membrane variants to induce interferon gamma (IFNγ) in a splenocyte co-culture system,

[001302] The materials used in the present Example are listed below:

- 5TGM1 cells
- 5TGM1 media (Iscove's Modified Dulbecco's Medium (IMDM) media + 10% Heat inactivated fetal bovine serum (FBS) +1% SP)
- Murine splenocytes
- Roswell Park Memorial Institute (RPMI) 1640 complete media (10% Heat inactivated FBS +1% SP)
- IL-12/IL-23 p40 monoclonal antibody (C17.8), eFluor™ 450, eBioscience
- Hanks' Balanced Salt Solution (HBSS)
- Fluorescence-activated cell sorting (FACS) buffer: phosphate-buffered saline (PBS)+ 2% Heat inactivated FBS
- Mouse IFNγ ELISA kit
- optiMEM media for virus dilution
- Viruses

[001303] A description of the viruses used in the present Example is shown in **Table 10**. A virus description, and a median tissue culture infectious dose per milliliter ($TCID_{50}$/ml) value are included for each of virus.

Table 10. Description of viruses

Virus description	$TCID_{50}$/ml
VSV-M51R-GFP (Negative control)	1.40E+11
VSV-M51R-mIL12p70TM (positive control)	1.63E+11
VSV-M51R-mIL12p70-H4-2TM	1.24e+11
VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM	1.07e+11
VSV-mIL12p70TM-N-M51R-GFP	8.91E+07
VSV-N-mIL12p70TM-P-M51R-GFP	1.69E+10
VSV-M51R-mIL12p70-mCD4-d1-4TM	1.95e+10
VSV-M51R-mIL12p70-D265A_mIgG1TM	4.02e+10
VSV-M51R-mIL12p70-mIgG2aTM	2.94e+10
VSV-M51R-mIL12 (Negative control for Flow cytometry)	1.75E+09

[001304] The assay design used in the present Example is shown **Figure 43**. A 12-well plate was prepared with 1 x 10^6 5TGM1 cells/ml/well. Viruses were diluted to 1 x 10^7/ml using optiMEM media and 10 µl of diluted virus was added to the cells. Infection was performed using a multiplicity of infection (MOI) of 0.1 and 4 hours later, the samples were split for the flow cytometry-based expression analysis and for the IFNγ functional assay as described herein.

[001305] The IFNγ functional assay was performed as follows:

- 4 x 10^5 cells (400 µl) were collected in Eppendorf tubes and washed twice with PBS
- Remaining cells on the 12-well plate were used for flow cytometry-based expression analysis as described herein
- The cells were re-suspended in 400 µl RPMI 1640 complete media and 100 µl of the cells were plated in 96-well U bottom plate.
- For co-incubation:
    - 5 x 10^5 splenocytes (1:5 ratio) were added to 100 µl of infected 5TGM1 cells
    - IL-2 was added at 5 ng/ml
    - The cells were co-incubated at 37°C for 48 hours
- The plate was spun at 1500 revolutions per minute (RPM) and the supernatants were collected to assay using the IFNγ ELISA described herein
- As a positive control recombinant IL-12 was added to splenocytes along with IL-2

[001306] The flow cytometry-based expression analysis was performed as follows:

- To the remaining 600 µl of cells, 400 µl of media was added and allowed to incubate at 37°C for a total of 24 hours
- After completion of incubation, the cells were observed for cytopathic effects (CPE) and collected in 1.6 ml Eppendorf tubes
- Cells were washed in HBSS 2 times and resuspended in 400 µl of HBSS
- 100 µl of the cell suspension was then added to a 96-well plate and proceeded with flow staining
- For live dead staining: A working solution (1:100) of Live/Dead (L/D) dye was prepared by adding 5 µl of stock Tonbo Biosciences Ghost Dye Red 780 Viability Dye (stored at -20°C) to 0.5 ml of PBS

- 10 µL of the L/D working solution was added to cells re-suspended in PBS (1:10) and mixed well. The sample was then incubated in the dark at room temperature for 15 minutes

- For preparation of the antibody working solution: 0.5 µg of IL-12/IL-23 p40 monoclonal antibody was added to each sample
  - 2.5 µl times the number of samples (14) = 35 µl
  - 35 µl of IL-12/IL-23 p40 monoclonal antibody was mixed with 665 µl of FACS buffer and mixed well
  - 50 µl of the antibody mix was added to each well
- Samples were mixed and allowed to incubate at room temperature (RT) for 30 minutes in dark
- After incubation, the plate was spun at 1500 RPM for 5 minutes and supernatants were discarded.
- Cells were then washed with FACS buffer twice (200 µl/ well)
- Cells were finally resuspended in 200 µl of FACS buffer and analyzed for IL-12 expression on the cell surface
- Appropriate isotype and unstained controls were used

[001307] For the flow cytometry-based expression analysis, results indicated that all of the VSV transmembrane IL-12 variants tested expressed IL-12 on the cell surface. Cells infected with VSV-M51R-mIL12 and VSV-M51R-GFP (negative controls) did not express IL-12 on the cell surface. Isotype controls and unstained controls were negative for IL-12 expression (see, e.g., **Figure 44**).

[001308] For the IFNγ functional assay, results indicated that all of the IL-12 variants test induced IFNγ production from splenocytes. The highest expression level was seen for the VSV-M51R-mIL12p70-H4-2TM, followed by VSV-M51R-mIL12p70-mCD4-d1-4TM and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM co-incubated conditions. Except for VSV-M51R-mIL12p70-D265A_mIgG1TM, all IL-12p70TM constructs induced higher levels of IFNγ compared to VSV-M51R-mIL12p70TM (see e.g., **Figure 45**).

Example 6. Flow cytometry-based validation and ELISA for IL-12 (Rigid linker payloads)

[001309] The aims of the present Examples were as follows:

1. To verify the expression of IL-12p70 in the cell membrane using flow cytometry; and

2. To assess the cleavage of IL-12p70 membrane variants by measuring the IL-12 levels in the supernatants.

[001310] The materials used in the present Example are listed below:

- 5TGM1 cells
- 5TGM1 media (IMDM media + 10% Heat inactivated FBS +1% SP)
- IL-12/IL-23 p40 monoclonal antibody (C17.8), eFluor™ 450, eBioscience
- HBSS
- FACS buffer: PBS+ 2% Heat inactivated FBS
- optiMEM media for virus dilution
- IL-12 ELISA kit (Duoset)
- Viruses

[001311] A description of the viruses used in the present Example is shown in **Table 11**. A virus description, and a median tissue culture infectious dose per milliliter ($TCID_{50}$/ml) value are included for each of virus.

Table 11. Description of viruses

Virus description	$TCID_{50}$/ml
VSV-M51R-mIL12p70-H4-2TM	1.24e+11
VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM	1.07e+11
VSV-M51R-GFP (negative control)	1.40E+11
VSV-M51R-mIL12 (positive control for ELISA)	1.89E+10
VSV-M51R-mIL12p70-mCD4-d1-4TM	1.95e+10
VSV-M51R-mIL12p70-D265A_mIgG1TM	4.02e+10
VSV-M51R-mIL12p70-mIgG2aTM	2.94e+10
VSV-M51R-mIL12p70TM (positive control for Flow)	1.63e+11

[001312] The assay design used in the present Example is shown **Figure 46**. A 48-well plate was prepared with 1 x 10^6 5TGM1 cells/ml/well. Viruses were diluted to 1 x 10^7/ml using optiMEM media and 10 µl of diluted virus was added to the cells. Infection was performed using a MOI of 0.1 or 0.01 and the samples were incubated at 37°C for 20 hours. After incubation, the samples were collected and spun at 1500 RPM. Cellular supernatants were collected and frozen down at -80°C and the cell pellet was used for flow cytometry-based expression analysis as described herein.

[001313] The flow cytometry-based expression analysis was performed as follows:

- Cells were washed two times in HBSS and resuspended in 400 µl of HBSS
- 100 µl of the cell suspension was then added to a 96-well plate and proceeded with flow staining
- Live dead staining: A working solution (1:100) of Live/Dead (L/D) dye was prepared by adding 5 µl of stock Tonbo Biosciences Ghost Dye Red 780 Viability Dye (stored at -20°C) to 0.5 ml of PBS
    - 10 µL of L/D working solution was added to cells re-suspended in PBS (1:10), and mixed well. The sample was then incubated in the dark at room temperature for 15 minutes.
- For preparation of the antibody working solution: 0.5 ug of IL-12/IL-23 p40 monoclonal antibody was added to each sample.
    - 2.5 µl times the number of samples (18) = 45 µl
    - 45 µl of IL-12/IL-23 p40 monoclonal antibody was mixed with 855 µl of FACS buffer and mixed well
    - 50 µl of the antibody mix was added to each well
- Samples were mixed and allowed to incubate at RT for 30 minutes in dark
- After incubation, the plate was spun at 1500 RPM for 5 minutes and supernatants were discarded
- Cells were then washed with FACS buffer twice (200 µl/ well)
- Cells were finally resuspended in 200 µl of FACS buffer and analyzed for IL-12 expression on cell surface
- Appropriate Isotype and unstained control were used

[001314] Analysis of supernatants for IL-12 levels was performed using an R&D Systems Mouse IL-12 p70 DuoSet ELISA kit.

[001315] For the flow cytometry-based expression analysis, results indicated that all of the VSV transmembrane IL-12 variants expressed IL-12 on the cell surface. Median fluorescence intensity of the IL-12 expression on cell surface was lower in VSV-M51R-mIL12p70-H4-2TM, VSV-M51R-mIL12p70-mCD4-d1-4TM and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM, which can suggest cleavage and shedding of IL-12 from the membrane. Cells infected with VSV-M51R-mIL12 and VSV-M51R-GFP (negative controls) did not express IL-12 on the cell surface.

Isotype controls and unstained controls were negative for IL-12 expression (see, e.g., **Figures 47-48**).

[001316] For IL-12 expression analysis in supernatants, the highest expression level of IL-12 was seen in conditions treated with VSV-M51R-mIL12p70 (positive control). A substantial amount of IL-12 was observed in the conditions treated with VSV-M51R-mIL12p70-H4-2TM, VSV-M51R-mIL12p70-mCD4-d1-4TM and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM. These data show that a portion of the IL-12 from the samples infected with VSV-M51R-mIL12p70-H4-2TM, VSV-M51R-mIL12p70-mCD4-d1-4TM and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM viruses was cleaved from the membrane and found in a soluble form in the supernatants (see, e.g., **Figure 49**).

Example 7. VSV encoding membrane-tethered form of IL-12 p70 with various linkers

[001317] The objective of these studies was to determine the effect of the oncolytic virus Vesicular Stomatitis Virus (VSV) encoding membrane-tethered IL-12p70 with various linkers inserted between the transmembrane domain and IL-12p70 in relevant *in vivo* models. Two experiments were conducted using WT mice to test the intratumoral and intravenous delivery of the viruses, with the aim of assessing their efficacy, toxicity, and the levels of cytokines released into the bloodstream. All experiments were carried out using WT C57BL/6 or C3H/Hej strain background mice.

[001318] For the tumor study (Study 1), C57BL/6 mice were subcutaneously inoculated with tumor cells. Once the tumors reached an appropriate size, the mice were divided evenly according to tumor size, which averaged 130 mm^3 for MC38. Tumor size was measured by caliper using the calculation formula: $(L^2xW)/2$, where L is the smallest size. The mice were monitored for tumor kinetics and body weight twice per week.

[001319] Study 1 involved eight groups, each containing seven mice. On day 0, the mice were anesthetized using isoflurane inhalation and then injected subcutaneously into the right flank with a 100 µL suspension of $3x10^5$ MC38 cells in DMEM. On day 10 (day 0 post-infection), the mice were evenly randomized into the eight groups based on an average tumor size of 130 mm^3. The mice then received a 50 µl intratumor injection of different viruses, each encoded with various flexible, rigid, or extended linkers. The mice received a 50 µl intratumor injection of different viruses, each encoded with various flexible, rigid, or extended linkers. These viruses were

administered at a dose of $5x10^8$ TCID50, resuspended in PBS. The control group received PBS only. The experimental dosing and treatment protocol for the groups of mice are detailed in **Table 12**.

Table 12. Study 1 experimental dosing and treatment protocol for groups of mice.

Group	Route	Compound	$TCID_{50}$	Treatment day	n #
1	Intratumor	PBS	-	D10 (D0 post infection)	7
2	Intratumor	VSV-M51R-mIL-12p70	$5x10^8$ $TCID^{50}$	D10 (D0 post infection)	7
3	Intratumor	VSV-M51R-mIL-12p70_TM	$5x10^8$ $TCID^{50}$	D10 (D0 post infection)	7
4	Intratumor	VSV-M51R-mIL12p70-mCD4-d1-4TM	$5x10^8$ $TCID^{50}$	D10 (D0 post infection)	7
5	Intratumor	VSV-M51R-mIL12p70-H4-2TM	$5x10^8$ $TCID^{50}$	D10 (D0 post infection)	7
6	Intratumor	VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM	$5x10^8$ $TCID^{50}$	D10 (D0 post infection)	7
7	Intratumor	VSV-M51R-mIL12p70-D265A_mIgG1TM	$5x10^8$ $TCID^{50}$	D10 (D0 post infection)	7
8	Intratumor	VSV-M51R-mIL12p70-mIgG2aTM	$5x10^8$ $TCID^{50}$	D10 (D0 post infection)	7

[001320] The viruses used were as follows:

[001321] 1. VSV-M51R-mIL-12p70: Encodes for IL-12p40-linker-p35 and a mutated viral M protein.

2. VSV-M51R-mIL-12p70_TM: Encodes for IL-12p40-linker-p35-linker((G4S)x3)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

3. VSV-M51R-mIL12p70-mCD4-d1-4TM: Encodes for IL-12p40-linker-p35-linker(mCD4-d1-4)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

4. VSV-M51R-mIL12p70-H4-2TM: Encodes for IL-12p40-linker-p35-linker(H4-2)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

5. VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM: Encodes for IL-12p40-linker-p35-linker(AEAAKEAAAKEAAAKATM)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

6. VSV-M51R-mIL12p70-D265A_mIgG1TM: Encodes for IL-12p40-linker-p35-linker(D265A_mIgG1)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

7. VSV-M51R-mIL12p70-mIgG2aTM: Encodes for IL-12p40-linker-p35-linker(D265A_mIgG2a)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

[001322] Study 2, which focused on safety (mice were not injected with tumor cells), involved nine groups, each containing five C3H/Hej mice. On day 0, the mice were injected intravenously into the tail vein with 200 µl of different viruses, each encoded with various flexible, rigid, or extended linkers.

[001323] The viruses used were as follows:

[001324] 1. VSV-M51R-GFP: Encodes for GFP and a mutated viral M protein.

2. VSV-M51R-mIL-12p70: Encodes for IL-12p40-linker-p35 and a mutated viral M protein.

3. VSV-M51R-mIL-12p70_TM: Encodes for IL-12p40-linker-p35-linker((G4S)x3)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

4. VSV-M51R-mIL12p70-mCD4-d1-4TM: Encodes for IL-12p40-linker-p35-linker(mCD4-d1-4)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

5. VSV-M51R-mIL12p70-H4-2TM: Encodes for IL-12p40-linker-p35-linker(H4-2)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

6. VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM: Encodes for IL-12p40-linker-p35-linker(AEAAKEAAAKEAAAKATM)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

7. VSV-M51R-mIL12p70-D265A_mIgG1TM: Encodes for IL-12p40-linker-p35-linker(D265A_mIgG1)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

8. VSV-M51R-mIL12p70-mIgG2aTM: Encodes for IL-12p40-linker-p35-linker(D265A_mIgG2a)-B7.1 transmembrane/intracellular domain and a mutated viral M protein.

[001325] The viruses were administered at a dose of $1x10^9$ TCID50, resuspended in PBS. The control group received PBS only. The experimental dosing and treatment protocol for the groups of mice are detailed in **Table 13**.

Table 13. Study 2 experimental dosing protocol for non-tumor bearing groups of mice.

Group	Route	Compound	$TCID_{50}$	Treatment day	n #
1	Intravenous	PBS	-	D0	5
2	Intravenous	VSV-M51R-GFP	$1x10^9$ $TCID^{50}$	D0	5
3	Intravenous	VSV-M51R-mIL-12p70	$1x10^9$ $TCID^{50}$	D0	5
4	Intravenous	VSV-M51R-mIL-12p70_TM	$1x10^9$ $TCID^{50}$	D0	5

5	Intravenous	VSV-M51R-mIL12p70-mCD4-d1-4TM	$1x10^9$ $TCID^{50}$	D0	5
6	Intravenous	VSV-M51R-mIL12p70-H4-2TM	$1x10^9$ $TCID^{50}$	D0	5
7	Intravenous	VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM	$1x10^9$ $TCID^{50}$	D0	5
8	Intravenous	VSV-M51R-mIL12p70-D265A_mIgG1TM	$1x10^9$ $TCID^{50}$	D0	5
9	Intravenous	VSV-M51R-mIL12p70-mIgG2aTM	$1x10^9$ $TCID^{50}$	D0	5

[001326] For these studies, several parameters were recorded at least twice a week for each treatment group in each experiment. These parameters included average tumor volumes, determined by caliper measurements, body weight, and percent survival. Additionally, the number of tumor-free mice was assessed at the conclusion of the tumor study. The results, expressed as a percentage of body weight loss or mean tumor volume (mm^3)(±SD), percent survival, and/or the number of tumor-free mice, are presented in **Table 14** for Study 1 and **Table 15** for Study 2.

Table 14. Mean tumor volume, percent survival and numbers of tumor-free mice in each treatment group from *in vivo* tumor Study 1.

		Tumor Volume, mm^3 mean (±SD)	Tumor-Free Mice		Survival, %		
		Day 14	Day 17	Day 28	Day 14	Day 28	Day 40
1	PBS	1953.9 (±778.1)	0/7	0/7	42%	0%	0%
2	VSV-M51R-mIL-12p70	29.1 (±34.1)	6/7	6/7	100%	100%	100%
3	VSV-M51R-mIL-12p70_TM	1209.7 (±434.4)	0/7	0/7	85.7%	0%	0%
4	VSV-M51R-mIL12p70-mCD4-d1-4TM	380.4 (±398.1)	1/7	1/7	100%	14.2%	0%
5	VSV-M51R-mIL12p70-H4-2TM	66.2 (±73.8)	4/7	5/7	100%	85.7%	71.4%
6	VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM	366.2 (±295.3	1/7	1/7	100%	42.8%	14.2%
7	VSV-M51R-mIL12p70-D265A_mIgG1TM	1075.1 (±655.7)	0/7	0/7	100%	0%	0%
8	VSV-M51R-mIL12p70-mIgG2aTM	1134.3 (±403.6)	0/7	0/7	100%	0%	0%

[001327] Table 14 demonstrates that tumors dosed with VSV expressing rigid linkers, specifically VSV-M51R-mIL12p70-H4-2TM and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM, exhibited significant anti-tumor efficacy by Day 14 post-infection, compared to PBS. Although not as potent as VSV-M51R-mIL-12p70, both viruses resulted in extended survival by Day 40.

VSV-M51R-mIL12p70-H4-2TM and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM led to tumor-free mice (4 out of 7 and 1 out of 7, respectively). VSV-M51R-mIL12p70-mCD4-d1-4TM, which contains an extended linker, resulted in one tumor-free mouse and a survival rate of 14.2% by Day 40.

Table 15. Mean body weight change and percent survival of mice in each treatment group from non-tumor Study 2.

Treatment group (n=5)		Body weight change, % (±SD)			Survival, %		
		Day 1	Day 3	Day 4	Day1	Day 4	Day 20
1	PBS	-.09 (±1.7)	-3.0 (±1.3)	-2.8 (±1.8)	100%	100%	100%
2	VSV-M51R-GFP	-5.3 (±1.2)	-7.0 (±2.0)	-3.2 (±3.3)	100%	100%	100%
3	VSV-M51R-mIL-12p70	-2.5 (±1.7)	-16.8(±2.5)	-20.0 (±5.5)	100%	66%	50%
4	VSV-M51R-mIL-12p70_TM	-4.5 (±1.0)	-8.0(±2.2)	-5.55 (±2.4)	100%	100%	100%
5	VSV-M51R-mIL12p70-mCD4-d1-4TM	-5.0 (±1.7)	-13.1(±2.2)	-11.7 (±5.2)	100%	100%	100%
6	VSV-M51R-mIL12p70-H4-2TM	-4.8 (±1.8)	-15.6(±2.7)	-16.0 (±5.8)	100%	83%	66.7%
7	VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM	-6.1 (±0.8)	-12.8(±1.3)	-9.8 (±4.9)	100%	100%	100%
8	VSV-M51R-mIL12p70-D265A_mIgG1TM	-6.1 (±1.8)	-12.7(±1.4)	-8.41 (±2.0)	100%	100%	100%
9	VSV-M51R-mIL12p70-mIgG2aTM	-5.2 (±1.2)	-11.8(±5.0)	-1.79 (±1.6)	100%	100%	100%

[001328] Table 15 illustrates the body weight loss in C3H/Hej mice that were intravenously dosed through the tail vein with VSV expressing GFP, soluble IL-12p70, or VSV expressing membrane-bound IL-12p70 with various linker sequences. It was observed that in mice that regained body weight, the peak of body weight loss occurred around the third or fourth day post-infection. Sustained body weight loss was noted in mice dosed with VSV-M51R-mIL12p70 and VSV-M51R-mIL12p70-H4-2TM. Mice that experienced a body weight loss of 20% or more were euthanized as per the protocol. C3H/Hej mice are notably sensitive to IL-12, and a few mice dosed with VSV-M51R-mIL12 and VSV-M51R-mIL12p70-H4-2TM succumbed to infection. This is reflected in the survival section of the table, where 50% of mice survived after being dosed with VSV-M51R-mIL12p70 and 66.7% survived after being dosed with VSV-M51R-mIL12p70-H4-2TM. Interestingly, the other linkers, specifically VSV-M51R-mIL12p70-mCD4-d1-4TM and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM, which demonstrated anti-tumor efficacy

in the previous experiment, did not result in body weight loss in this experiment. In the background strain C57BL/6, all viruses dosed intratumorally did not cause significant body weight loss (Study 1) (data not shown).

Example 8. Membrane-tethered IL-12 encoded by VSV with rigid linkers display significant anti-tumor efficacy and no toxicity dosed intratumorally in C57BL/6 mice

[001329] Study 1 aimed to evaluate the anti-tumor efficacy and potential toxicity of the oncolytic virus Vesicular Stomatitis Virus (VSV) encoding a membrane version of IL-12p70 with various linkers when delivered intratumorally. The VSV used in this study was engineered to genetically encode a membrane-tethered version of IL-12p70 in the following sequence: IL-12p40-linker-p35-linker-B7.1 transmembrane/intracellular domain and viral M protein mutated at position 51 (M51R), named VSV-M51-mIL-12p70_TM. This study compared various rigid, extended, or flexible linkers. VSV encoding for the soluble version of IL-12p70: VSV-M51R-mIL-12p70 (that encodes for IL-12p40-linker-p35 and viral M protein mutated) was used as a control, along with PBS (vehicle).

[001330] C57BL/6 strain background mice from Jackson Laboratories were implanted subcutaneously with MC38 cells ($3x10^5$ cells/mouse) at day 0. Tumors were measured using a caliper, and tumor volumes were calculated with the formula $(L^2xW)/2$, where L is the smallest size. Mice were randomized evenly into four treatment groups when the average tumor size reached 130 mm^3, which was at day 10. Mice were injected intratumorally with 50 µl of PBS or VSV expressing soluble IL-12p70 or VSV expressing membrane-tethered IL-12p70 at a $5x10^8$ TCID50 dose resuspended in PBS. Tumor volumes were monitored by caliper measurements twice per week until the end of the study.

[001331] The treatment with VSV-M51R-mIL12p70-H4-2TM, VSV-M51R-mIL12p70-mCD4-d1-4TM, and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM resulted in significant anti-tumor efficacy compared to day 14 post-infection, as shown in **Figure 50**. The statistical significance was determined by one-way ANOVA with Dunnett's multiple comparisons post-test (* $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$, **** $p< 0.0001$). The efficacy of VSV-M51R-mIL12p70-H4-2TM, VSV-M51R-mIL12p70-mCD4-d1-4TM, and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM ($p<.0001$) was similar to that of VSV-M51R-mIL-12p70 ($p<.0001$), which also induced strong anti-tumor efficacy.

[001332] By Day 35, six out of seven mice became tumor-free in the VSV-M51R-mIL-12p70 treated group, five out of seven mice became tumor-free in the VSV-M51R-mIL12p70-H4-2TM group, and one out of seven mice were tumor-free in the VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM treated groups, as shown in **Figure 51**. The VSV-mIL12TM linkers H4-2, $A(EAAAK)_3A$ (SEQ ID NO: 74), and CD4-d1-4 resulted in tumor-free mice. Survival was also extended in groups dosed with VSV-M51R-mIL12-p70, VSV-M51R-mIL12p70-H4-2TM, VSV-M51R-mIL12p70-mCD4-d1-4TM, and VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM, as shown in **Figure 52**.

[001333] The mice of this experiment did not experience significant body weight loss, as shown in **Figure 53**. This suggests that these VSV viruses encoding for membrane bound IL-12 are safe for these mice when administered intratumorally. No treated mouse needed to be euthanized in the study due to excessive body weight loss (>20%). However, VSV-M51R-mIL12p70-H4-2TM is comparable to VSV-M51R-mIL12-p70. This trend could potentially be explained by higher levels of circulating IFNγ at 24 hours post-infection, as detected by ELISA (**Figure 54**). Serum levels of IL-12p70 were lower or undetectable compared to VSV expressing soluble IL-12, indicating that the membrane-tethered versions may be much safer in comparison. While some IFNγ was detected in all groups, levels were lower than VSV expressing soluble IL-12, except for the previously mentioned VSV-M51R-mIL12p70-H4-2TM, which resulted in similar but lower levels.

Example 9. Selective membrane-tethered IL-12 encoded by VSV with rigid linkers induces body weight loss in IL-12-sensitive C3H/Hej mice following intravenous injection

[001334] Study 2 involved the use of C3H/Hej strain mice from Jackson Laboratories. These mice were intravenously injected (via the tail vein) on day 0 with the viruses at a dose of $1x10^9$ TCID50, resuspended in PBS, or with PBS as a control. The mice's body weight was monitored following the virus infection. Serum was collected 24 hours post-infection to measure cytokine release. The average body weight change over time for each group indicates that all viruses led to some initial body weight loss, peaking within the first three days (**Figure 55**).

[001335] Upon detailed examination of each individual mouse, it was found that VSV-M51R-mIL-12p70 and VSV-M51R-mIL12p70-H4-2TM caused the most significant body weight loss, with three out of five and two out of five mice, respectively, succumbing to the virus (body weight loss >20%) (**Figure 56**). C3H/Hej mice recovered body weight over time. While all other viruses also

resulted in some transient body weight change, recovery was observed by Day 20, as also reflected in the survival data (**Figure 57**).

[001336] The observed changes in body weight may be attributed to the serum cytokine levels 24 hours post-infection, as assessed via the LEGENDPlex assay (**Figure 58**). While all membrane-tethered IL-12p70 viruses exhibited much lower serum levels of IL-12p70, the groups treated with VSV-M51R-mIL12p70-H4-2TM expressed the highest levels compared to all other membrane-tethered IL-12p70 viruses. Rigid linkers resulted in low serum levels of IL-12 but largely reduced compared to soluble IL-12 (sIL12). However, H4-2 showed serum IL-12. $A(EAAAK)_3A$ (SEQ ID NO: 74) has reduced serum IL-12 compared to H4-2: $A(EAAAK)_4ALEA(EAAAK)_4A$ (SEQ ID NO: 73). This could potentially explain the toxicity observed in mice dosed with this virus. All virus-treated groups exhibited relatively high levels of IFNγ. However, most virus-dosed groups of mice were able to tolerate these levels. It is important to note that C3H/Hej mice are particularly sensitive to IL-12p70 induced toxicity.

Example 10. VSV-M51R-IL12p70 virus (soluble form), murine tumor efficacy, and toxicity studies

[001337] The components of the VSV-mIFNb-NIS virus and the VSV-M51R-IL12p70 virus (soluble form) tested in the present Example are shown in **Figure 59**.

[001338] Single dose VSV encoding IL-12 (VSV-M51R-mIL12p70) administered intratumorally (IT) showed markedly increased anti-tumor efficacy compared to the VSV-mIFNb-NIS virus (**Figures 60-63**). Further, it was found that IT delivery of VSV-mIL12 did not result in weight loss and resulted in limited IL12p70 serum levels. No toxicity was observed in mice treated IT with VSV-M51R-mIL12p70 (**Figure 64**) and low serum levels of IL-12 were detected 24 hours post infection (**Figure 65**). VSV-M51R-mIL12p70 was more efficacious when dosed IT compared to IV in the CMT64 therapeutic model (**Figures 66-67**). VSV-M51R-mIL12p70 was less toxic when dosed IT compared to IV in the CMT64 therapeutic model (**Figure 68**). The lower efficacy of the IV dosage of VSV-mIL-12 inversely correlated to the levels of IL-12p70 in serum after 24 hours post infection (**Figure 69**). Single dose IT VSV-M51R-mIL12p70 had robust anti-tumor efficacy compared to the VSV-mIFNb-NIS virus on treated and contralateral non-treated tumors in MC38 and CMT64 tumors (**Figures 70-72**).

[001339] Additional data indicated that for IT administration, a single dose of VSV encoding IL-12 (VSV-M51R-mIL12p70) led to strong anti-tumor efficacy or tumor clearance (compared to the VSV-mIFNb-NIS virus) in large tumors (~150-200 mm^3). The models tested were MC38, CMT64, B16F10, MBT2, and EMT6. Dose dependent anti-tumor efficacy was established. Tumor control was demonstrated in the contralateral non-treated tumor in dual tumor models. No toxicity was observed with IT administration, but was seen with IV administration. Combination with anti-PD-1 treatment enhanced anti-tumor efficacy and survival. Long-lasting T cell memory, increased T cell numbers, cytokine production, and strongly boosted cytotoxic T lymphocyte (CTL) and natural killer (NK) cell responses were demonstrated. Specifically, polyclonal tumor specific T cell numbers were increased within the tumors. Regarding the hypersensitive IL-12 toxicity model (C3H/HeJ), toxicity was seen at 1e9 $TCID_{50}$ IV administration. This was associated with very high serum levels of IL-12 and IFNγ. Further, 2e8 $TCID_{50}$ IV administration and 5e8 $TCID_{50}$ subcutaneous (SC) administration were well tolerated.

Example 11. Transcript variants with IL-12 positioned downstream of L in the VSV genome retain similar efficacy as compared to the VSV-M51R-mIL12p70 virus (soluble form) which has IL-12 positioned between G and L in the VSV genome

[001340] An example of a toxicity mitigation strategy for VSV-mIL12p70 transcript variants tested in the present Example is shown in **Figure 73A**. A schematic representation of a dosing regimen is shown in **Figure 73B**. Briefly, C57BL/6 strain background mice were implanted subcutaneously (SC) with MC38 cells. When the average tumor size reached approximately 150 mm^3, mice were injected intratumorally at day 0 with VSV-M51R-mIL12p70 or VSV-M51R-GFP-L-mIL12p70 virus resuspended in PBS, or PBS as control (**Figure 73B**). Tumor volumes (**Figure 73C**) and body weights (**Figure 73D**) were measured twice per week until the end of the study. VSV-M51R-GFP-L-mIL12p70 results in similar efficacy to VSV-M51R-mIL12p70.

[001341] The results show that transcript variants with IL-12 positioned downstream of L in the VSV genome retain similar efficacy as compared to the VSV-M51R-mIL12p70 virus which has IL-12 positioned between G and L in the VSV genome, when tested as a one dose IT. Reduced leakage of IL-12 in circulation and lower serum expression levels of IFNγ were observed in the transcript variant with IL-12 positioned downstream of L in the VSV genome as compared to the VSV-M51R-mIL12p70 virus (see, e.g., **Figure 74**). When IL-12 is positioned downstream of L in

the VSV genome, fewer copies of IL-12 can be expected to be encoded (see, e.g., **Figure 73A**); however, in the present case, while the transcript still encoded sufficient IL-12 to fully obtain the efficacy of the VSV-M51R-mIL12p70 virus, IL-12 was not present in an excess amount which can lead to systemic release.

Example 12. *In vitro* analysis of IL-12 expression and IL-12 functional assay

[001342] For analysis of IL-12 expression, 5e5 BHK21 cells were infected with VSVs VSV-M51R-GFP, VSV-M51R-mIL12p70, VSV-M51R-GFP-L-mIL12p70, or VSV-M51R-GFP-mIL12p70.P2A.L at a MOI of 0.1. Twenty-two hours post infection, cell supernatants were collected and assayed for mouse IL-12 using ELISA. The results showed there was no significant difference in the production of IL-12 from VSV-M51R-mIL-12 and VSV-M51R-GFP-L-mIL-12. However, VSV-M51R-GFP-mIL-12. P2A.L produced significantly less IL-12 (**Figure 75**).

[001343] For the IL-12 functional assay (**Figure 76A**), 5TGM1 cells were infected with VSVs VSV-M51R-mIL12p70, VSV-M51R-GFP-L-mIL12p70 or VSV-M51R-GFP-mIL12p70.P2A.L at a MOI of 0.1. Four hours later, 5TGM1 cells were washed in PBS and counted. 1e5 of the 5TGM1 cells were co-incubated with 5e5 of splenocytes isolated from C57Bl/Ka mice. 5 ng/ml of IL-2 was added to all wells. As a positive control, recombinant mouse IL-12 was added at 2 ng/ml, and as negative control, 5TGM1 infected with VSV-M51R-GFP was used. Cells were incubated at 37°C for 48 hours. Cell supernatants were collected and analyzed for IFNγ levels by ELISA. The results showed that IFNγ induction from VSV-M51R-mIL-12 was higher than the other VSVs encoding IL-12 test in the present Example (**Figure 76B**).

Example 13. Anti-tumor efficacy of VSV-M51R-mIL12 encoding murine single chain IL-12 (soluble form) alone and in combination with anti-PD-1 antibody in mice bearing syngeneic MC38 tumors

[001344] *In vivo* experiments were conducted to assess the anti-tumor efficacy of administration of VSV-M51R-mIL12 encoding murine single chain IL-12 (soluble form) (also referred to as VSV-M51R-mIL12p70 herein; see, e.g., SEQ ID NO: 50) in combination with anti-PD-1 antibody in mice. C57BL/6J (Jackson Laboratory) mice were subcutaneously (SC) implanted in both hind flanks with murine MC38 colorectal adenocarcinoma cells (National Cancer Institute Lab of Tumor Immunology and Biology; #ACL8874) to establish two tumors per mouse. Fourteen days

post-tumor implantation (PTI) (Day 0), when average tumor size reached approximately 150 mm^3, mice were randomized based on tumor size into 4 groups and dosed as indicated in **Table 16**. On Day 0, one out of the two tumors on each mouse was injected intratumorally (IT) with PBS or VSV-M51R-mIL12 (5×10^8 $TCID_{50}$). The contralateral tumor was not administered any reagent, but the volume of the tumor was measured throughout the study to assess potential systemic anti-tumor immune response from IT administration of VSV-M51R-mIL12 in the dosed tumor. Additionally, beginning on Day 0, mice were administered either anti-PD-1 antibody (mouse PD-1 IgG1 isotype antibody; REGN4232) or an isotype control antibody (a mouse IgG1 non-binding isotype control for anti-PD-1; REGN653) (10 mg/kg, IP, twice weekly) through Day 57 (i.e., the end of the study). Dual-flank tumor volumes (measured via caliper measurement) and survival were monitored through Day 57. Mice were sacrificed before study termination if tumors reached ≥2000 mm^3 in total volume. Data were analyzed using GraphPad Prism software.

Table 16. Dosing Regimen

Group	Dosing		n	Parameters Measured (through Day 57)
	Single IT Dose (1 Tumor per Mouse)	Twice Weekly SC Dose (10 mg/kg)		
1	PBS	Isotype control antibody	8	Tumor volume via caliper measurement Survival
2	PBS	Anti-PD-1		
3	VSV-M51R-mIL12 (5×10^8 $TCID_{50}$)	Isotype control antibody		
4	VSV-M51R-mIL12 (5×10^8 $TCID_{50}$)	Anti-PD-1		

[001345] Administration of a single IT dose of VSV-M51R-mIL12 as a monotherapy and in combination with repeated IP dosing with anti-PD-1 resulted in tumor volume reduction in both the dosed tumor (**Figure 77A**) and in the contralateral, non-dosed tumor (**Figure 77B**). However, administration of VSV-M51R-mIL12 in combination with anti-PD-1 prolonged survival relative to administration of PBS + isotype control antibody, anti-PD-1 alone, or VSV-M51R-mIL12 alone, and therefore enhanced the long-term response to test article administration (**Figure 78**). Together, these data demonstrated that VSV-M51R-mIL12 and anti-PD-1 had synergistic anti-tumor activity in mice bearing syngeneic MC38 tumors.

Example 14. Examples and sequences of the VSV-IL-12 constructs described and used herein

[001346] Examples of the VSV-IL-12 constructs described herein are exhibited in **Figures 17A-17K**. VSV-M51R-hIL12p70 is shown in **Figure 17A**. VSV-M51R-hIL12p40-hIL12p35 is shown in **Figure 17B**. VSV-M51R-L-hIL12p70 is shown in **Figure 17C**. VSV-M51R-hIL12p70.P2A.L is shown in **Figure 17D**. VSV-M51R-hIL12p70TM is shown in **Figure 17E**. VSV-M51R-hIL12p70_hCD4 is shown in **Figure 17F**. VSV-M51R-hIL12p70_hCD46 is shown in **Figure 17G**. VSV-M51R-hIL12p70_G_4Sx3_CBD is shown in **Figure 17H**. VSV-M51R-hIL12p70_(G_4Sx3_CBD)x2 is shown in **Figure 17I**. VSV-M51R-hIL12p70_hIgG1 is shown in **Figure 17J**. VSV-M51R-hIL12p70_hIgG4 is shown in **Figure 17K**.

[001347] Sequences of secreted VSV-M51R-hIL12p70 are exhibited in **Figures 18A-18K**; the nucleic acid sequence (SEQ ID NO: 112) is shown in **Figures 18A-18H** and the amino acid sequence (SEQ ID NO: 113) is shown in **Figures 18I-18K.** A vector map of VSV-M51R-hIL12p70 is exhibited in **Figures 79A-79LL**. Sequences of secreted VSV-M51R-hIL12p40-hIL12p35 are exhibited in **Figures 19A-19K**; the nucleic acid sequence (SEQ ID NO: 114) is shown in **Figures 19A-19H** and the amino acid sequence (SEQ ID NO: 115) is shown in **Figures 19I-19K**. Sequences of secreted VSV-M51R-L-hIL12p70 are exhibited in **Figures 20A-20K**; the nucleic acid sequence (SEQ ID NO: 116) is shown in **Figures 20A-20H** and the amino acid sequence (SEQ ID NO: 117) is shown in **Figures 20I-20K**. Sequences of secreted VSV-M51R-hIL12p70.P2A.L are exhibited in **Figures 21A-21K**; the nucleic acid sequence (SEQ ID NO: 118) is shown in **Figures 21A-21H** and the amino acid sequence (SEQ ID NO: 119) is shown in **Figures 21I-21K**. Sequences of human transmembrane VSV-M51R-hIL12p70TM are exhibited in **Figures 22A-22J**; the nucleic acid sequence (SEQ ID NO: 120) is shown in **Figures 22A-22H** and the amino acid sequence (SEQ ID NO: 121) is shown in **Figures 22I-22J**. Sequences of human transmembrane VSV-M51R-hIL12p70_hCD4 are exhibited in **Figures 23-23L**; the nucleic acid sequence (SEQ ID NO: 122) is shown in **Figures 23A-23I** and the amino acid sequence (SEQ ID NO: 123) is shown in **Figures 23J-23L**. Sequences of human transmembrane VSV-M51R-hIL12p70_hCD46 are exhibited in **Figures 24A-24K**; the nucleic acid sequence (SEQ ID NO: 124) is shown in **Figures 24A-24H** and the amino acid sequence (SEQ ID NO: 125) is shown in **Figures 24I-24K**. Sequences of human transmembrane VSV-M51R-hIL12p70_hIgG1 are exhibited in **Figures 25A-25K**; the nucleic acid sequence (SEQ ID NO: 132) is shown in **Figures 25A-25H** and the amino acid sequence (SEQ ID NO: 133) is shown in **Figures 25I-25K**.

Sequences of human transmembrane VSV-M51R-hIL12p70_hIgG4 are exhibited in **Figures 26A-26K**; the nucleic acid sequence (SEQ ID NO: 130) is shown in **Figures 26A-26H** and the amino acid sequence (SEQ ID NO: 131) is shown in **Figures 26I-26K**. Sequences of secreted VSV-M51R-hIL12p70_CBD1 are exhibited in **Figures 27A-27K**; the nucleic acid sequence (SEQ ID NO: 126) is shown in **Figures 27A-27H** and the amino acid sequence (SEQ ID NO: 127) is shown in **Figures 27I-27K**. Sequences of secreted VSV-M51R-hIL12p70_CBD2 are exhibited in **Figures 28A-28L**; the nucleic acid sequence (SEQ ID NO: 128) is shown in **Figures 28A-28I** and the amino acid sequence (SEQ ID NO: 129) is shown in **Figures 28J-28L**. Sequences of secreted VSV-M51R-mIL12p40-mIL12p35 are exhibited in **Figures 29A-29J**; the nucleic acid sequence (SEQ ID NO: 110) is shown in **Figures 29A-29H** and the amino acid sequence (SEQ ID NO: 111) is shown in **Figures 29I-29J**. Sequences of mouse transmembrane VSV-M51R-mIL12p70TM are exhibited in **Figures 30A-30J**; the nucleic acid sequence (SEQ ID NO: 56) is shown in **Figures 30A-30H** and the amino acid sequence (SEQ ID NO: 55) is shown in **Figures 30I-30J**. Sequences of mouse transmembrane VSV-M51R-mIL12p35TM are exhibited in **Figures 31A-31I**; the nucleic acid sequence (SEQ ID NO: 58) is shown in **Figures 31A-31G** and the amino acid sequence (SEQ ID NO: 57) is shown in **Figures 31H-31I**. Sequences of mouse secreted VSV-M51R-mIL12p70woSP are exhibited in **Figures 32A-32J**; the nucleic acid sequence (SEQ ID NO: 60) is shown in **Figures 32A-32H** and the amino acid sequence (SEQ ID NO: 59) is shown in **Figures 32I-32J**. Sequences of mouse secreted (mutein) VSV-M51R-mIL12p70_2xAla are exhibited in **Figures 33A-33J**; the nucleic acid sequence (SEQ ID NO: 52) is shown in **Figures 33A-33H** and the amino acid sequence (SEQ ID NO: 51) is shown in **Figures 33I-33J**. Sequences of mouse secreted (mutein) VSV-M51R-mIL12p70_3xAla are exhibited in **Figures 34A-34J**; the nucleic acid sequence (SEQ ID NO: 54) is shown in **Figures 34A-34H** and the amino acid sequence (SEQ ID NO: 53) is shown in **Figures 34I-34J**. Sequences of mouse secreted VSV-M51R-mIL12p70 are exhibited in **Figures 35A-35J**; the nucleic acid sequence (SEQ ID NO: 50) is shown in **Figures 35A-35H** and the amino acid sequence (SEQ ID NO: 49) is shown in **Figures 35I-35J**. Sequences of mouse transmembrane VSV-M51R-mIL12p70-mCD4-d1-4TM are exhibited in **Figures 36A-36K**; the nucleic acid sequence (SEQ ID NO: 134) is shown in **Figures 36A-36H** and the amino acid sequence (SEQ ID NO: 135) is shown in **Figures 36I-36K**. Sequences of mouse transmembrane VSV-M51R-mIL12p70-H4-2TM are exhibited in **Figures 37A-37J**; the nucleic acid sequence (SEQ ID NO: 136) is shown in **Figures 37A-37H** and the

amino acid sequence (SEQ ID NO: 137) is shown in **Figures 37I-37J**. Sequences of mouse transmembrane VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM are exhibited in **Figures 38A-38K**; the nucleic acid sequence (SEQ ID NO: 138) is shown in **Figures 38A-38H** and the amino acid sequence (SEQ ID NO: 139) is shown in **Figures 38I-38K**. Sequences of mouse transmembrane VSV-M51R-mIL12p70-D265A_mIgG1TM are exhibited in **Figures 39A-39K**; the nucleic acid sequence (SEQ ID NO: 140) is shown in **Figures 39A-39H** and the amino acid sequence (SEQ ID NO: 141) is shown in **Figures 39I-39K**. Sequences of mouse transmembrane VSV-M51R-mIL12p70-mIgG2aTM are exhibited in **Figures 40A-40K**; the nucleic acid sequence (SEQ ID NO: 142) is shown in **Figures 40A-40H** and the amino acid sequence (SEQ ID NO: 143) is shown in **Figures 40I-40K**. Sequences of mouse transmembrane VSV-mIL12p70TM-N-M51R-GFP are exhibited in **Figures 41A-41K**; the nucleic acid sequence (SEQ ID NO: 144) is shown in **Figures 41A-41H** and the amino acid sequence (SEQ ID NO: 145) is shown in **Figures 41I-41K**. Sequences of mouse transmembrane VSV-N-mIL12p70TM-P-M51R-GFP are exhibited in **Figures 42A-42K**; the nucleic acid sequence (SEQ ID NO: 146) is shown in **Figures 42A-42H** and the amino acid sequence (SEQ ID NO: 147) is shown in **Figures 42I-42K**.

Example 15. VSV-M51R-mIL12p70 is less toxic than VSV-Mwt-mIL12p70

[001348] A single intravenous injection of VSV-Mwt-GFP compared to VSV-Mwt-mIL12p70 or VSV-M51R-mIL12p70 was evaluated in naïve C57BL/6 mice. This experiment revealed higher serum levels of IL-12p70 (**Figure 80A**) and IFNγ (**Figure 80B**) 24 hours post-infection with wild-type M (Mwt) compared to M51R, correlating with greater body weight loss and delayed body weight recovery (**Figure 80C**).

Example 16. Induction of polyclonal T cell responses

[001349] Whether intratumoral administration of VSV-M51R-mIL12p70 resulted in polyclonal T cell responses was evaluated. Tumors from mice bearing CMT64 lung adenocarcinoma tumors treated with PBS, VSV-M51R-GFP or VSV-M51R-mIL12p70 were harvested and tested against previously published epitopes of CMT64 neoantigens, see Woller et al., 2015, *Mol Ther*, 23(10), 1630–1640 (**Figure 81**). VSV-nucleoprotein (52-59, H-Arg-Gly-Tyr-Val-Tyr-Gln-Gly-Leu-OH, labeled as VSV-NP) (**SEQ ID NO: 196**) and PMA/ionomycin served as positive controls as these two groups are expected to stimulate T-cells. Overall, VSV-M51R-mIL12p70 increased T-cell

receptor (TCR) polyclonality and resulted in greater IFNγ responses against all peptides than VSV-M51R-GFP. The most significant IFNγ response was against Ndufs1, a prominent CMT64 tumor neoantigen. VSV-M51R-mIL12p70 treatment boosted tumor-specific CD8 T cell responses to Ndufs1 (p=0.0002) compared to the response elicited by VSV-M51R-GFP (p=0.0207).

Example 17. Functional differences between VSV-M51R-hIL12p70 and VSV-P-hIL12p70-ΔM51

[001350] It was investigated whether the positioning of the IL-12 transgene in a VSV construct would affect certain key virus characteristics including the production of IL-12, toxicity to human cancer cells *in vitro*, and kinetics of viral growth. VSV-M51R-hIL12p70 positions the IL-12 transgene between the G and the L genes of the VSV genome, whereas VSV-P-hIL12p70-ΔM51 positions the IL-12 transgene more upstream, between the P and the M genes of the VSV genome.

[001351] The cell lines used for this study are shown in **Table 17**. Cells were maintained at 37°C/5% CO_2 in culture media for at least a week prior to being used herein.

Table 17. Details of cell lines used herein

Cell line (abbreviation)	Cell type
SCC-15	Head and neck squamous cell carcinoma
DLD-1	Colorectal adenocarcinoma
HT1080	Fibrosarcoma
LaSt293	Embryonic kidney
SCC-25	Head and neck squamous cell carcinoma
A375	Melanoma

[001352] The viruses used for this study are shown in **Table 18**.

Table 18. Viruses used herein

Virus	Titer ($TCID_{50}$/mL)
VSV-M51R-hIL12p70	$7.89x10^{10}$
VSV-P-hIL12p70-ΔM51	$2.65x10^{10}$

[001353] Cell lines were infected with either VSV-M51R-hIL12p70 or VSV-P-hIL12p70-ΔM51 and IL-12 levels were quantified from culture supernatants 24 hours post-infection (**Figure 82**). VSV-P-hIL12p70-ΔM51 drove significantly higher IL-12 expression than VSV-M51R-hIL12p70 in moderately susceptible (HT1080, SCC-15) and resistant (SCC-25) cell lines. In contrast, in highly susceptible lines (A375, DLD-1, LaSt293), both vectors led to robust IL-12 expression without clear statistical differences, though in both A375 and DLD-1 the vectors show the same trend, particularly at MOI 1.0.

[001354] The higher IL-12 expression from VSV-P-hIL12p70-ΔM51 can raise concerns about cytokine-mediated toxicity. In contrast, VSV-M51R-hIL12p70 could offer a more balanced profile, potentially maintaining therapeutic transgene expression while limiting the risk of IL-12 overproduction. VSV-M51R-hIL12p70 may have advantageous traits regarding safety in susceptible tumor types or systemic applications.

[001355] To test this, cell lines were infected with either VSV-M51R-hIL12p70 or VSV-P-hIL12p70-ΔM51 and cell viability was assessed 24 hours post-infection using a viability assay (**Figure 83**). Cell viability was assessed using a cell counting kit-8 (CCK-8) assay. The CCK-8 assay is a colorimetric assay that determines cell viability. In a CCK-8 assay, the metabolic activity of dehydrogenase enzymes in living cells leads to reduction of a highly water-soluble tetrazolium salt (e.g., WST-8 (5-(2,4-disulfophenyl)-3-(2-methoxy-4-nitrophenyl)-2-(4-nitrophenyl)-2H-tetrazolium)) into a yellow-orange colored formazan dye that is soluble in culture media, wherein the quantity of dye is directly proportional to the number of living cells. VSV variants caused a dose-dependent decrease in viability in the cancer cell lines, indicating efficient oncolytic killing. Comparing the two vectors, VSV-M51R-hIL12p70 demonstrated equal or slightly greater killing efficiency than VSV-P-hIL12p70-ΔM51 in most cases.

[001356] Virus growth as well as kinetics of hIL12p70 production were tested in LaSt293 and HT1080 cell lines. LaSt293 and HT1080 cell lines were infected with either VSV-M51R-hIL12p70 or VSV-P-hIL12p70-ΔM51, viral titer was quantified by $TCID_{50}$ assay (**Figures 84A-84B**), and hIL12p70 concentration was determined by ELISA assay (**Figures 85A-85B**).

[001357] VSV-M51R-hIL12p70 replicates faster and reaches higher titers in both LaSt293 (a producer line) (**Figure 84B**) and HT1080 (tumor) (**Figure 84A**) cell lines compared to VSV-P-hIL12p70-ΔM51, while maintaining lower production levels of hIL12p70 in cell supernatant of

both HT1080 (**Figure 85A**) and LaSt293 (**Figure 85B**) cell lines. Faster replication with lower production of payload may result in a more efficacious virus with less toxicity.

[001358] Taken together, the results shown in **Figures 82-85** demonstrate that VSV-M51R-hIL12p70, with the IL-12 transgene positioned more downstream between VSV G gene and VSV L gene, could have advantageous characteristics as compared to a VSV vector construct with the IL-12 transgene between VSV P gene and VSV M gene. These advantages can include maintaining therapeutic transgene expression while limiting IL-12 production, thereby potentially reducing toxicity, and demonstrating fast replication, high titer, low production levels of hIL-12p70, and high efficiency.

Example 18. Efficacy, safety, and biodistribution assessment of VSV-M51R-mIL12 following repeated intratumoral administration in a MBT2 syngeneic murine tumor model

[001359] C3H/HeJ mice were selected for this study for their heightened susceptibility to Interleukin 12 (IL-12) and interferon gamma (IFNγ) toxicity compared to other mouse strains (Leonard et al., Effects of single-dose interleukin-12 exposure on interleukin-12-associated toxicity and interferon-gamma production. Blood. 1997 Oct 1;90(7):2541-8. 1997). The use of a syngeneic tumor model, MBT2, combined with the surrogate tumor antigen (TA) encoding murine IL-12, allowed for the assessment of not only the direct tumor cell killing mediated by the VSV vector, but also the multifaceted immune response. The multifaceted immune response includes the recruitment of immune cells responding to release of pathogen-associated molecular patterns (PAMPs) and danger-associated molecular patterns (DAMPs) after oncolysis and release of virally encoded, biologically active IL-12 by infected cells. Release of murine IL-12 in this immunocompetent model activates T and natural killer (NK) cells, which produce IFNγ and boost antigen presenting cell (APC) activation, resulting in the generation of systemic polyclonal cellular antitumor immunity and the destruction of tumor cells.

[001360] A total of 323 C3H/HeJ mice (171 females, 96 males, and 56 spares (36 females, 20 males)) were subcutaneously injected with MBT2 syngeneic, bladder cancer cells on the left side of the dorsal abdomen on Day -13 or -12. Body weight, body condition scoring (BCS), tumor measurements, and detailed observations began on the day of engraftment and were repeated every three days until euthanasia. Prior to control or VSV-M51R-mIL12 administration, animals were randomized into study groups based on tumor size (target mean tumor volume of 150-250 mm^3,

which is the approximated tumor volume at intratumoral injection). For both efficacy and safety/biodistribution (BD) arms of the study, control or VSV-M51R-mIL12 was injected intratumorally on Day 1, 4, and 7. A three day dose interval allows the innate antiviral response to lessen in the tumor environment before the second or third dose are administered (before the tumor burden is too great in saline or low dose cohorts).

[001361] The efficacy arm of the study had 5 groups. Group 1 was dosed with saline, Groups 2-5 were dosed with $5x10^5$, $5x10^6$, $5x10^7$, or $5x10^8$ $TCID_{50}$ VSV-M51R-mIL12/dose. Blood was collected from selected animals on Day 2, 3, 5, 6, and 8 (i.e., one and two days after the first and second dose, and one day after the third dose). Tumor volumes were analyzed, and an animal survival curve was generated. Animals underwent necropsy on Day 45 or 46, with terminal body weight collection, gross necropsy, and blood and tumor collection for transgene product and cytokine analyses.

[001362] Treatment with VSV-M51R-mIL12 resulted in prolonged average survival time compared to animals in the saline control group (Group 1: 2.6 weeks, Group 2: 4.0 weeks, Group 3: 4.0 weeks, Group 4: 4.6 weeks, Group 5: 4.5 weeks). Amongst those animals that were treated, animals treated with $5x10^7$ $TCID_{50}$ (Group 4) or $5x10^8$ $TCID_{50}$ (Group 5) had longer average survival times than those treated with lower doses, indicating the improved survival in a VSV-M51R-mIL12 dose-dependent manner. Consistent with these results, VSV-M51R-mIL12 suppressed tumor growth in a dose-dependent manner. In addition, surviving animals at later time points gained body weight. Animals that survived until scheduled necropsy did not have any tumor- or treatment-related persisting clinical signs.

[001363] IL-12 was detected after the initial IT injection of VSV-M51R-mIL12 at all dose levels, with peak levels in blood at 24 hours post injection, declining by hour 48. All VSV-M51R-mIL12-treated mice were VSV seropositive at the end of the study.

[001364] Based on the VSV-M51R-mIL12-mediated anti-tumor activity and improved survival in this efficacy arm of the study, a therapeutic window up to VSV-M51R-mIL12 $5x10^7$ $TCID_{50}$/mouse with repeat administration can be established. A minimal tumor volume-based efficacy signal was observed at the $5x10^5$ dose level and efficacy increased dose-dependently with higher efficacy at higher doses.

[001365] The safety and biodistribution arm of the study had 5 groups. Group 6 was dosed with saline, Groups 7-10 were dosed with $5x10^6$, $5x10^7$, or $5x10^8$ $TCID_{50}$ VSV-M51R-mIL12/dose

(animals in Groups 9 and 10 received the same dose of $5x10^8$ $TCID_{50}$ and were used for assessing safety and biodistribution, respectively). Blood was collected from selected animals on Day 2 and 5 (i.e., one day after the first and second dose). Animals underwent necropsy on Day 8, 14, or 28 (i.e., 1, 7, or 21 days after the last control or last VSV-M51R-mIL12 administration), with terminal body weight collection, gross necropsy, and blood and tumor collection for various analyses.

[001366] Data obtained from tumor tissues of all groups of the efficacy arm at Day 45 or 46 indicated low/near baseline expression of mIL-12p70 and IFNγ protein within tumor homogenates. In the safety/BD arm of this study, a few animals, most notably male animals, showed increased levels of mIL-12p70 and IFNγ protein at Day 14 across the dosing groups and out to Day 28 mostly in the high dose group (Group 10). These data suggest that the tumor may have allowed for virus replication to occur. RNA tissue biodistribution analyses collectively showed that VSV-derived RNA is mostly limited to the tumor injection sites, and peaked around Day 14. In Group 10 (animals that received the highest dose level of VSV-M51R-mIL12), test article derived RNA was detected at a low frequency in the pancreas, spleen, adrenal gland, brain, spinal cord, heart, kidney, small intestines, and the draining lymph node.

[001367] Infectious virus recovery (IVR) showed 8 total samples. Five out of 8 samples were confirmed positive by cytopathic effect (CPE) upon a second plate, including 1/8 of brain samples, 2/8 of tumor samples, and 1/8 of each brain and tumor, at Day 8 or 14, all from the high dose group. There were no histopathology abnormalities in the brain with positive IVR.

[001368] Treatment with VSV-M51R-mIL12 induced a minimal to marked mononuclear infiltrate at the tumor injection site, which was absent in saline control animals, and a higher degree of tumor necrosis than in the control animals. Animals that were treated with VSV-M51R-mIL12 sometimes developed minimal mononuclear infiltrates, also seen in blood, or minimal hepatocellular proliferation, and changes which are infrequently or rarely seen in control mice and may reflect systemic cytokine increases associated with peritumoral infiltrates and tumor necrosis. Minimal to mild increased lymphocyte cellularity in splenic periarteriolar lymphoid sheaths (PALS) may also be associated with treatment, though age control mice were not available to confirm this finding, and may account for increases in splenic mass associated with treatment.

[001369] The anti-VSV antibody profile indicated that VSV-M51R-mIL12-treated groups (independent of dosing level) developed anti-VSV antibodies, and the saline-treated groups displayed no neutralizing activity in the cell-based neutralizing antibody assay.

[001370] Based on the data in the safety/BD arm of this study, systemic effects of VSV-M51R-mIL12 treatment appeared to be limited, VSV-derived RNA was mostly limited to the tissue injection sites, and serum cytokine release was transient. Safety parameters analyzed did not indicate adverse findings in the low- and mid-dose groups. A no-observed-adverse-effect-level (NOAEL) at VSV-M51R-mIL12 $5x10^7$ $TCID_{50}$/mouse is proposed.

* * *

[001371] The present disclosure is not to be limited in scope by the specific embodiments described herein. Indeed, various modifications of the disclosure in addition to those described herein will become apparent to those skilled in the art from the foregoing description. Such modifications are intended to fall within the scope of the appended claims.

[001372] All patents, applications, publications, test methods, literature, and other materials cited herein are hereby incorporated by reference in their entirety as if physically present in this specification.

List of Sequences

SEQ ID NO: 1 vesicular stomatitis virus nucleoprotein (N) , amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDK

SEQ ID NO: 2 vesicular stomatitis virus nucleoprotein (N) , nucleic acid sequence
ATGTCTGTTACAGTCAAGAGAATCATTGACAACACAGTCGTAGTTCCAAAACTTCCT
GCAAATGAGGATCCAGTGGAATACCCGGCAGATTACTTCAGAAAATCAAAGGAGAT
TCCTCTTTACATCAATACTACAAAAAGTTTGTCAGATCTAAGAGGATATGTCTACCA
AGGCCTCAAATCCGGAAATGTATCAATCATACATGTCAACAGCTACTTGTATGGAGC
ATTAAAGGACATCCGGGGTAAGTTGGATAAAGATTGGTCAAGTTTCGGAATAAACA
TCGGGAAAGCAGGGGATACAATCGGAATATTTGACCTTGTATCCTTGAAAGCCCTGG
ACGGCGTACTTCCAGATGGAGTATCGGATGCTTCCAGAACCAGCGCAGATGACAAA
TGGTTGCCTTTGTATCTACTTGGCTTATACAGAGTGGGCAGAACACAAATGCCTGAA
TACAGAAAAAAGCTCATGGATGGGCTGACAAATCAATGCAAAATGATCAATGAACA
GTTTGAACCTCTTGTGCCAGAAGGTCGTGACATTTTTGATGTGTGGGGAAATGACAG
TAATTACACAAAAATTGTCGCTGCAGTGGACATGTTCTTCCACATGTTCAAAAAACA
TGAATGTGCCTCGTTCAGATACGGAACTATTGTTTCCAGATTCAAAGATTGTGCTGC
ATTGGCAACATTTGGACACCTCTGCAAAATAACCGGAATGTCTACAGAAGATGTAA
CGACCTGGATCTTGAACCGAGAAGTTGCAGATGAAATGGTCCAAATGATGCTTCCA
GGCCAAGAAATTGACAAGGCCGATTCATACATGCCTTATTTGATCGACTTTGGATTG
TCTTCTAAGTCTCCATATTCTTCCGTCAAAAACCCTGCCTTCCACTTCTGGGGGCAAT
TGACAGCTCTTCTGCTCAGATCCACCAGAGCAAGGAATGCCCGACAGCCTGATGAC
ATTGAGTATACATCTCTTACTACAGCAGGTTTGTTGTACGCTTATGCAGTAGGATCCT
CTGCCGACTTGGCACAACAGTTTTGTGTTGGAGATAACAAATACACTCCAGATGATA
GTACCGGAGGATTGACGACTAATGCACCGCCACAAGGCAGAGATGTGGTCGAATGG
CTCGGATGGTTTGAAGATCAAAACAGAAAACCGACTCCTGATATGATGCAGTATGC
GAAAAGAGCAGTCATGTCACTGCAAGGCCTAAGAGAGAAGACAATTGGCAAGTATG
CTAAGTCAGAATTTGACAAATGA

SEQ ID NO: 3 vesicular stomatitis virus matrix (M) protein, wild-type, amino acid sequence
MSSLKKILGLKGKGKKSKKLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDEMDTYDPNQL
RYEKFFFTVKMTVRSNRPFRTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLK
ATPAVLADQGQPEYHAHCEGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTM
TIYDDESLEAAPMIWDHFNSSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFK

SEQ ID NO: 4 vesicular stomatitis virus matrix (M) protein, wild-type, nucleic acid sequence

Atgagttccttaaagaagattctcggtctgaaggggaaaggtaagaaatctaagaaattagggatcgcaccacccccttatgaagaggaca
ctagcatggagtatgctccgagcgctccaattgacaaatcctattttggagttgacgagatggacacctatgatccgaatcaattaagatatga
gaaattcttctttacagtgaaaatgacggttagatctaatcgtccgttcagaacatactcagatgtggcagccgctgtatcccattgggatcaca
tgtacatcggaatggcagggaaacgtcccttctacaaaatcttggctttttgggttcttctaatctaaaggccactccagcggtattggcagat
caaggtcaaccagagtatcacgctcactgcgaaggcagggcttatttgccacataggatggggaagacccctcccatgctcaatgtaccag
agcacttcagaagaccattcaatataggtctttacaagggaacgattgagctcacaatgaccatctacgatgatgagtcactggaagcagctc
ctatgatctgggatcatttcaattcttccaaattttctgatttcagagagaaggccttaatgtttggcctgattgtcgagaaaaaggcatctggagc
gtgggtcctggactctatcggccacttcaaatga

SEQ ID NO: 5 vesicular stomatitis virus matrix (M) protein, M51R mutant, amino acid sequence
MSSLKKILGLKGKGKKSKKLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQL
RYEKFFFTVKMTVRSNRPFRTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLK
ATPAVLADQGQPEYHAHCEGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTM
TIYDDESLEAAPMIWDHFNSSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFK

SEQ ID NO: 6 vesicular stomatitis virus matrix (M) protein, M51R mutant, nucleic acid sequence
Atgagttccttaaagaagattctcggtctgaaggggaaaggtaagaaatctaagaaattagggatcgcaccacccccttatgaagaggaca
ctagcatggagtatgctccgagcgctccaattgacaaatcctattttggagttgacgagcgagacacctatgatccgaatcaattaagatatga
gaaattcttctttacagtgaaaatgacggttagatctaatcgtccgttcagaacatactcagatgtggcagccgctgtatcccattgggatcaca
tgtacatcggaatggcagggaaacgtcccttctacaaaatcttggctttttgggttcttctaatctaaaggccactccagcggtattggcagat
caaggtcaaccagagtatcacgctcactgcgaaggcagggcttatttgccacataggatggggaagacccctcccatgctcaatgtaccag
agcacttcagaagaccattcaatataggtctttacaagggaacgattgagctcacaatgaccatctacgatgatgagtcactggaagcagctc
ctatgatctgggatcatttcaattcttccaaattttctgatttcagagagaaggccttaatgtttggcctgattgtcgagaaaaaggcatctggagc
gtgggtcctggactctatcggccacttcaaatga

SEQ ID NO: 7 vesicular stomatitis virus matrix (M) protein, ΔM51 mutant, amino acid sequence
MSSLKKILGLKGKGKKSKKLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDEDTYDPNQLR
YEKFFFTVKMTVRSNRPFRTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKA
TPAVLADQGQPEYHAHCEGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTI
YDDESLEAAPMIWDHFNSSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFK

SEQ ID NO: 8 vesicular stomatitis virus matrix (M) protein, ΔM51 mutant, nucleic acid sequence
atgagttccttaaagaagattctcggtctgaaggggaaaggtaagaaatctaagaaattagggatcgcaccacccccttatgaagaggacac
tagcatggagtatgctccgagcgctccaattgacaaatcctattttggagttgacgaggacacctatgatccgaatcaattaagatatgagaaa
ttcttctttacagtgaaaatgacggttagatctaatcgtccgttcagaacatactcagatgtggcagccgctgtatcccattgggatcacatgtac
atcggaatggcagggaaacgtcccttctacaaaatcttggctttttgggttcttctaatctaaaggccactccagcggtattggcagatcaagg
tcaaccagagtatcacgctcactgcgaaggcagggcttatttgccacataggatggggaagacccctcccatgctcaatgtaccagagcac
ttcagaagaccattcaatataggtctttacaagggaacgattgagctcacaatgaccatctacgatgatgagtcactggaagcagctcctatg
atctgggatcatttcaattcttccaaattttctgatttcagagagaaggccttaatgtttggcctgattgtcgagaaaaaggcatctggagcgtgg
gtcctggactctatcggccacttcaaatga

SEQ ID NO: 9 vesicular stomatitis virus phosphoprotein (P), amino acid sequence

MDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVEEHTKPSYFQAADD
SDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTSDWKQPELESDEH
GKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGEGVIMKERQITPDV
YKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDELFSSRGEFISVGGD
GRMSHKEAILLGLRYKKLYNQARVKYSL

SEQ ID NO: 10 vesicular stomatitis virus phosphoprotein (P), nucleic acid sequence
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAG

SEQ ID NO: 11 plasmid pVSVFL(+), nucleic acid sequence
CACCTAAATTGTAAGCGTTAATATTTTGTTAAAATTCGCGTTAAATTTTTGTTAAATC
AGCTCATTTTTTAACCAATAGGCCGAAATCGGCAAAATCCCTTATAAATCAAAAGAA
TAGACCGAGATAGGGTTGAGTGTTGTTCCAGTTTGGAACAAGAGTCCACTATTAAAG
AACGTGGACTCCAACGTCAAAGGGCGAAAAACCGTCTATCAGGGCGATGGCCCACT
ACGTGAACCATCACCCTAATCAAGTTTTTTGGGGTCGAGGTGCCGTAAAGCACTAAA
TCGGAACCCTAAAGGGAGCCCCCGATTTAGAGCTTGACGGGGAAAGCCGGCGAACG
TGGCGAGAAAGGAAGGGAAGAAAGCGAAAGGAGCGGGCGCTAGGGCGCTGGCAAG
TGTAGCGGTCACGCTGCGCGTAACCACCACACCCGCCGCGCTTAATGCGCCGCTACA
GGGCGCGTCCCATTCGCCATTCAGGCTGCGCAACTGTTGGGAAGGGCGATCGGTGC
GGGCCTCTTCGCTATTACGCCAGCTGGCGAAAGGGGGATGTGCTGCAAGGCGATTA
AGTTGGGTAACGCCAGGGTTTTCCCAGTCACGACGTTGTAAAACGACGGCCAGTGA
ATTGTAATACGACTCACTATAGGGCGAATTGGGTACCGGGCCCCCCCTCGAGTTGTA
ATACGACTCACTATAGGGACGAAGACAAACAAACCATTATTATCATTAAAAGGCTC
AGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTGACA
ACACAGTCATAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCGGCA
GATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGTTTG
TCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATCATA
CATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGATAA
AGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAATAT
TTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGATG
CTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATACA
GAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGACA

AATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTGAC
ATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGGAC
ATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTATT
GTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAATA
ACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCAGA
TGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATACA
TGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAAAA
CCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGAGC
AAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGTTT
GTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTGG
AGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCGC
CACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAAA
CCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCCT
AAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTATA
ATTCTCAGATCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATCA
TGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAGG
CGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGAG
TTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGCA
GATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGTTTGTATGC
ACCAGATCCAGAAGCTGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGACT
ATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTTG
AATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGGA
GAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAATA
CTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAGG
AGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCCGT
CCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTTCC
AACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTCAT
CTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGGCC
ATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATTCT
CTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTATCCCAATCCAT
TCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAATCT
AAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTATGC
TCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGATGGACACCTATGA
TCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGATC
TAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGATCA
CATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTGGG
TTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAGTA
TCACACTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCTC
CCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAGG
GAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCCT
ATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTAA
TGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGATTCTATCA
GCCACTTCAAATGAGCTAGTCTAACTTCTAGCTTCTGAACAATCCCCGGTTTACTCA
GTCTCTCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATGA
AAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACTT
AGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCAA

AAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGAT
TTAAATTGGCATAATGACTTAATAGGCACAGCCATACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACAGTCCATCCGATCCTTCAC
TCCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGC
TGAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAG
CAGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAAT
GGGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCC
ATAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACC
TCATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAA
AGGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCC
TGCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTC
GAGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGG
TCAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTT
GAGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGG
TCTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGG
TCCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAG
AGTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTAC
CACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGAC
CCAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGAC
ATGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATC
CTCACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGA
TACTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAA
AAGCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTC
TCCGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTT
ATACAGACATAGAGATGAACCGACTTGGAAAGTAACTCAAATCCTGCTAGCCAGAT
TCTTCATGTTTGGACCAAATCAACTTGTGATACCATGCTCAAAGAGGCCTCAATTAT
ATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCATGGAAGTCCACGATT
TTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTATGCCACAAGAGAATTCC
TGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATTACAATTTGAATTCTC
CTCTAATTAGTGATGATATTGACAATTTGATCAGGAAATTCAATTCTCTTCCGATTCC
CTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGATGTTAACATCATGTCA
AGCCAATCCCATCTCAACATCTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTC
TGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGC
AGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAA
TTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGT
GTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGG
TGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCAT
GGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAA
GGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGAAACTTTCTGTTAATG
GTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCCATGGTATGTAGAAT
AGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATATCTACAGAATTGG
AGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGA
ACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCC
CACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAA
TTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGTGAAAACAGTGGATC

TCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCCTTTTATAGATTATTA
CACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAAAGATATTGATGTGT
CATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCA
ATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTA
AAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGA
GATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACCCGACTTACTAGAC
CCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAA
CATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATG
TTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGG
CTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGT
TGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAATACTTTGTAATTAC
CGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGA
CGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAA
GTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGAAAAATGGAATAACC
ACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTT
ATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAAGTCTTATATACTACA
ATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGATCAATTCAACCTCCC
AACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGG
ATGGACTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAAAATCAGAAACACTGC
TGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCACACAGTATAAAACGAA
GAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAA
TGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAA
ATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTATGGAAAAATACCGATTT
TCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTC
ACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCT
CTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCATGATACAGTACAATTAT
TTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCTGCTCTTCGTCAATCAT
TGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCA
TGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTT
GATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCA
TGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCG
AGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGTAGAAGATCCAACCTCT
CTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAA
ATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGATTAAGGATGCAACCA
TATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTC
TGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACG
GGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGT
ATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATCCTCTTTGACACATT
TAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGACATGTTCAGCTACTC
ATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTATTGGGACAACTGTAC
CCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGACTCCTTGTGCACCAT
GTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGACGGGATCCATGACG
TCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAAAACATCTGAATCTAC
ATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTA
CACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGA
CTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGACCAAAAGGCAGCATG

GGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATCTCGGATGAGCCATG
GTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGATGGCAACTACAGAC
ACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTC
TATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCACCAGTTGTACAGAT
CATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGAGATCACCCTGGAC
TCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAAGACATGGAGGAA
TGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTTTAGAAGGGAATT
GGAAGAATTTAGCACCTGCTGAGCAATCCTATCAAGTCGGCAGATGTATAGGTTTTC
TATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGACAGTTCTCTATTTC
CTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACG
GATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGTCTGGCTCATTTG
AAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATTGATAAATTGAGT
GTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAGACGAATTAGAA
ACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGTGATATGGGGGT
GATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAGGGAAAATACA
GATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATAGACTTCATTGG
ACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCATTTTTATCTGGG
AAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCTAAGATCAGG
AGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATATTATTGTGTCC
AGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAATAATAAAGACA
TGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAACAATCCCTGTTT
ATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGAATCCAAAATC
CCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCATTATAAAATTC
GGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAGTTGTGGAGACG
GCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATAGCAGAGGAATA
TTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTCTCCTGAGCCC
CCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTAAATGGTGAAAC
ATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGACTATTTCCTCCG
ACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGATATGGAAGTTCG
GGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTATGTGCACCGGAT
TTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATATATTTGTGAGAG
CGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCGACTTAGTTCA
AACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGTAAAGGTTTGAA
GAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAATCCTGGAAAAA
CCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAGAAGGTTAGTA
CATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCTTTTGTAAACAT
TGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCATGCGGCTGCCTT
AAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTTATATGGCGATT
ATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTCCGAACCCCCCA
TCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATAAGCTTTTGGCTG
AGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCAGTTATCCAGCAA
TCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACAAGCAGAAGTG
GAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAACTTCAGACTCCTTGGCCC
CAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGTTCGTCTAAATC
CATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAATCATTTGAAAT
GGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATAGACGAATTTCA

AAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAGGAAAACTCTTG
GAGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAAAAAAACTTTGA
TCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCTTCGTGGGTCG
GCATGGCATCTCCACCTCCTCGCGGTCCGACCTGGGCATCCGAAGGAGGACGTCGTC
CACTCGGATGGCTAAGGGAGGGGCCCCCGCGGGGCTGCTAACAAAGCCCGAAAGG
AAGCTGAGTTGGCTGCTGCCACCGCTGAGCAATAACTAGCATAACCCCTTGGGGCCT
CTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATCCGGATCGAGAC
CTCGATACTAGTGCGGTGGAGCTCCAGCTTTTGTTCCCTTTAGTGAGGGTTAATTTCG
AGCTTGGCGTAATCATGGTCATAGCTGTTTCCTGTGTGAAATTGTTATCCGCTCACAA
TTCCACACAACATACGAGCCGGAAGCATAAAGTGTAAAGCCTGGGGTGCCTAATGA
GTGAGCTAACTCACATTAATTGCGTTGCGCTCACTGCCCGCTTTCCAGTCGGGAAAC
CTGTCGTGCCAGCTGCATTAATGAATCGGCCAACGCGCGGGGAGAGGCGGTTTGCG
TATTGGGCGCTCTTCCGCTTCCTCGCTCACTGACTCGCTGCGCTCGGTCGTTCGGCTG
CGGCGAGCGGTATCAGCTCACTCAAAGGCGGTAATACGGTTATCCACAGAATCAGG
GGATAACGCAGGAAAGAACATGTGAGCAAAAGGCCAGCAAAAGGCCAGGAACCGT
AAAAAGGCCGCGTTGCTGGCGTTTTTCCATAGGCTCCGCCCCCCTGACGAGCATCAC
AAAAATCGACGCTCAAGTCAGAGGTGGCGAAACCCGACAGGACTATAAAGATACCA
GGCGTTTCCCCCTGGAAGCTCCCTCGTGCGCTCTCCTGTTCCGACCCTGCCGCTTACC
GGATACCTGTCCGCCTTTCTCCCTTCGGGAAGCGTGGCGCTTTCTCATAGCTCACGCT
GTAGGTATCTCAGTTCGGTGTAGGTCGTTCGCTCCAAGCTGGGCTGTGTGCACGAAC
CCCCCGTTCAGCCCGACCGCTGCGCCTTATCCGGTAACTATCGTCTTGAGTCCAACC
CGGTAAGACACGACTTATCGCCACTGGCAGCAGCCACTGGTAACAGGATTAGCAGA
GCGAGGTATGTAGGCGGTGCTACAGAGTTCTTGAAGTGGTGGCCTAACTACGGCTAC
ACTAGAAGGACAGTATTTGGTATCTGCGCTCTGCTGAAGCCAGTTACCTTCGGAAAA
AGAGTTGGTAGCTCTTGATCCGGCAAACAAACCACCGCTGGTAGCGGTGGTTTTTTT
GTTTGCAAGCAGCAGATTACGCGCAGAAAAAAAGGATCTCAAGAAGATCCTTTGAT
CTTTTCTACGGGGTCTGACGCTCAGTGGAACGAAAACTCACGTTAAGGGATTTTGGT
CATGAGATTATCAAAAAGGATCTTCACCTAGATCCTTTTAAATTAAAAATGAAGTTT
TAAATCAATCTAAAGTATATATGAGTAAACTTGGTCTGACAGTTACCAATGCTTAAT
CAGTGAGGCACCTATCTCAGCGATCTGTCTATTTCGTTCATCCATAGTTGCCTGACTC
CCCGTCGTGTAGATAACTACGATACGGGAGGGCTTACCATCTGGCCCCAGTGCTGCA
ATGATACCGCGAGACCCACGCTCACCGGCTCCAGATTTATCAGCAATAAACCAGCC
AGCCGGAAGGGCCGAGCGCAGAAGTGGTCCTGCAACTTTATCCGCCTCCATCCAGT
CTATTAATTGTTGCCGGGAAGCTAGAGTAAGTAGTTCGCCAGTTAATAGTTTGCGCA
ACGTTGTTGCCATTGCTACAGGCATCGTGGTGTCACGCTCGTCGTTTGGTATGGCTTC
ATTCAGCTCCGGTTCCCAACGATCAAGGCGAGTTACATGATCCCCCATGTTGTGCAA
AAAAGCGGTTAGCTCCTTCGGTCCTCCGATCGTTGTCAGAAGTAAGTTGGCCGCAGT
GTTATCACTCATGGTTATGGCAGCACTGCATAATTCTCTTACTGTCATGCCATCCGTA
AGATGCTTTTCTGTGACTGGTGAGTACTCAACCAAGTCATTCTGAGAATAGTGTATG
CGGCGACCGAGTTGCTCTTGCCCGGCGTCAATACGGGATAATACCGCGCCACATAG
CAGAACTTTAAAAGTGCTCATCATTGGAAAACGTTCTTCGGGGCGAAAACTCTCAAG
GATCTTACCGCTGTTGAGATCCAGTTCGATGTAACCCACTCGTGCACCCAACTGATC
TTCAGCATCTTTTACTTTCACCAGCGTTTCTGGGTGAGCAAAAACAGGAAGGCAAAA
TGCCGCAAAAAAGGGAATAAGGGCGACACGGAAATGTTGAATACTCATACTCTTCC
TTTTTCAATATTATTGAAGCATTTATCAGGGTTATTGTCTCATGAGCGGATACATATT

TGAATGTATTTAGAAAAATAAACAAATAGGGGTTCCGCGCACATTTCCCCGAAAAG
TGC

SEQ ID NO: 12 hIL-12 p40 subunit precursor sequence, human, amino acid sequence
MCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLTCDTPEEDGI
TWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKEDGIWSTDIL
KDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGVTCGAATLS
AERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSFFIRDIIKPD
PPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKDRVFTDKT
SATVICRKNASISVRAQDRYYSSSWSEWASVPCS

SEQ ID NO: 13 hIL-12 p40 subunit precursor sequence, human, v1, nucleic acid sequence
ATGTGTCACCAGCAGTTGGTCATCTCTTGGTTTTCCCTGGTTTTTCTGGCATCTCCCCT
CGTGGCCATATGGGAACTGAAGAAAGATGTTTATGTCGTAGAATTGGATTGGTATCC
GGATGCCCCTGGAGAAATGGTGGTCCTCACCTGTGACACCCCTGAAGAAGATGGTA
TCACCTGGACCTTGGACCAGAGCAGTGAGGTCTTAGGCTCTGGCAAAACCCTGACC
ATCCAAGTCAAAGAGTTTGGAGATGCTGGCCAGTACACCTGTCACAAAGGAGGCGA
GGTTCTAAGCCATTCGCTCCTGCTGCTTCACAAAAAGGAAGATGGAATTTGGTCCAC
TGATATTTTAAAGGACCAGAAAGAACCCAAAAATAAGACCTTTCTAAGATGCGAGG
CCAAGAATTATTCTGGACGTTTCACCTGCTGGTGGCTGACGACAATCAGTACTGATT
TGACATTCAGTGTCAAAAGCAGCAGAGGCTCTTCTGACCCCCAAGGGGTGACGTGC
GGAGCTGCTACACTCTCTGCAGAGAGAGTCAGAGGGGACAACAAGGAGTATGAGTA
CTCAGTGGAGTGCCAGGAGGACAGTGCCTGCCCAGCTGCTGAGGAGAGTCTGCCCA
TTGAGGTCATGGTGGATGCCGTTCACAAGCTCAAGTATGAAAACTACACCAGCAGCT
TCTTCATCAGGGACATCATCAAACCTGACCCACCCAAGAACTTGCAGCTGAAGCCAT
TAAAGAATTCTCGGCAGGTGGAGGTCAGCTGGGAGTACCCTGACACCTGGAGTACT
CCACATTCCTACTTCTCCCTGACATTCTGCGTTCAGGTCCAGGGCAAGAGCAAGAGA
GAAAAGAAAGATAGAGTCTTCACGGACAAGACCTCAGCCACGGTCATCTGCCGCAA
AAATGCCAGCATTAGCGTGCGGGCCCAGGACCGCTACTATAGCTCATCTTGGAGCG
AATGGGCATCTGTGCCCTGCAGTTAG

SEQ ID NO: 14 hIL-12p40 subunit precursor sequence, human, v2, nucleic acid sequence
Atgtgtcaccagcagttggtcatctcttggttttccctggtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtc
gtagaattggattggtatccggatgcccctggagaaatggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttgga
ccagagcagtgaggtcttaggctctggcaaaaccctgaccatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaagga
ggcgaggttctaagccattcgctcctgctgcttcacaaaaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaa
aataagacctttctaagatgcgaggccaagaattattctggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgt
caaaagcagcagaggctcttctgacccccaaggggtgacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaag
gagtatgagtactcagtggagtgccaggaggacagtgcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttc
acaagctcaagtatgaaaactacaccagcagcttcttcatcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccatta
aagaattctcggcaggtggaggtcagctgggagtaccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtc
cagggcaagagcaagagagaaaagaaagatagagtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattag
cgtgcgggcccaggaccgctactatagctcatcttggagcgaatgggcatctgtgccctgcagttaa

SEQ ID NO: 15 hIL-12 p35 subunit precursor sequence, human, amino acid sequence

MCPARSLLLVATLVLLDHLSLARNLPVATPDPGMFPCLHHSQNLLRAVSNMLQKARQT
LEFYPCTSEEIDHEDITKDKTSTVEACLPLELTKNESCLNSRETSFITNGSCLASRKTSFM
MALCLSSIYEDLKMYQVEFKTMNAKLLMDPKRQIFLDQNMLAVIDELMQALNFNSETV
PQKSSLEEPDFYKTKIKLCILLHAFRIRAVTIDRVMSYLNAS

SEQ ID NO: 16 hIL-12 p35 subunit precursor sequence, human, nucleic acid sequence
Atgtgtccagcgcgcagcctcctccttgtggctaccctggtcctcctggaccacctcagtttggccagaaacctccccgtggccactccaga
cccaggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaatttt
acccttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaaga
atgagagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgcctt
agtagtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctag
atcaaaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccgg
atttttataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttcc
taa

SEQ ID NO: 17 $(VPGVG)_2$ linker, amino acid sequence
VPGVGVPGVG

SEQ ID NO: 18 $(G_4S)_3$ linker, amino acid sequence
GGGGSGGGGSGGGGS

SEQ ID NO: 19 mB7.1 (cd80) transmembrane full-length sequence (transmembrane domain + topological domain), "RR" version, mouse, amino acid sequence
NTLVLFGAGFGAVITVVVIVVIIKCFCKHRSCF**RR**NEASRETNNSLTFGPEEALAEQTVFL

SEQ ID NO: 20 mB7.1 (cd80) transmembrane full-length sequence (transmembrane domain + topological domain), "RRR" version, mouse, amino acid sequence
NTLVLFGAGFGAVITVVVIVVIIKCFCKHRSCF**RRR**NEASRETNNSLTFGPEEALAEQTV
FL

SEQ ID NO: 21 mB7.1 (cd80) topological domain, "RR" version, mouse, amino acid sequence
KCFCKHRSCF**RR**NEASRETNNSLTFGPEEALAEQTVFL

SEQ ID NO: 22 mB7.1 (cd80) topological domain, "RRR" version, mouse, amino acid sequence
KCFCKHRSCF**RRR**NEASRETNNSLTFGPEEALAEQTVFL

SEQ ID NO: 23 mB7.1 (cd80) transmembrane domain, mouse, amino acid sequence
NTLVLFGAGFGAVITVVVIVVII

SEQ ID NO: 24 hB7.1 (cd80) transmembrane full-length sequence (transmembrane domain + topological domain), human, amino acid sequence
NLLPSWAITLISVNGIFVICCLTYCFAPRCRERRRNERLRRESVRPV

SEQ ID NO: 25 hB7.1 (cd80) topological domain, human, amino acid sequence

TYCFAPRCRERRRNERLRRESVRPV

SEQ ID NO: 26 hB7.1 (cd80) transmembrane domain, human, amino acid sequence
NLLPSWAITLISVNGIFVICCL

SEQ ID NO: 27 mIL-12 p40 subunit precursor sequence, mouse, amino acid sequence
MCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLTCDTPEEDDI
TWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKENGIWSTEILK
NFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCGMASLSAEKV
TLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIRDIIKPDPPKN
LQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEGCNQKGAFLV
EKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRS

SEQ ID NO: 28 mIL-12 p40 subunit precursor sequence, mouse, nucleic acid sequence
ATGTGTCCTCAGAAGCTAACCATCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCAC
TCATGGCCATGTGGGAGCTGGAGAAAGACGTTTATGTTGTAGAGGTGGACTGGACT
CCCGATGCCCCTGGAGAAACAGTGAACCTCACCTGTGACACGCCTGAAGAAGATGA
CATCACCTGGACCTCAGACCAGAGACATGGAGTCATAGGCTCTGGAAAGACCCTGA
CCATCACTGTCAAAGAGTTTCTAGATGCTGGCCAGTACACCTGCCACAAAGGAGGC
GAGACTCTGAGCCACTCACATCTGCTGCTCCACAAGAAGGAAAATGGAATTTGGTCC
ACTGAAATTTTAAAAAATTTCAAAAACAAGACTTTCCTGAAGTGTGAAGCACCAAAT
TACTCCGGACGGTTCACGTGCTCATGGCTGGTGCAAAGAAACATGGACTTGAAGTTC
AACATCAAGAGCAGTAGCAGTTCCCCTGACTCTCGGGCAGTGACATGTGGAATGGC
GTCTCTGTCTGCAGAGAAGGTCACACTGGACCAAAGGGACTATGAGAAGTATTCAG
TGTCCTGCCAGGAGGATGTCACCTGCCCAACTGCCGAGGAGACCCTGCCCATTGAAC
TGGCGTTGGAAGCACGGCAGCAGAATAAATATGAGAACTACAGCACCAGCTTCTTC
ATCAGGGACATCATCAAACCAGACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAA
GAACTCACAGGTGGAGGTCAGCTGGGAGTACCCTGACTCCTGGAGCACTCCCCATTC
CTACTTCTCCCTCAAGTTCTTTGTTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGA
GACAGAGGAGGGGTGTAACCAGAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCG
AAGTCCAATGCAAAGGCGGGAATGTCTGCGTGCAAGCTCAGGATCGCTATTACAAT
TCCTCATGCAGCAAGTGGGCATGTGTTCCCTGCAGAGTCCGATCGTGA

SEQ ID NO: 29 mIL-12 p35 subunit precursor sequence, mouse, amino acid sequence
MCQSRYLLFLATLALLNHLSLARVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYS
CTAEDIDHEDITRDQTSTLKTCLPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCL
GSIYEDLKMYQTEFQAINAALQNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPV
GEADPYRVKMKLCILLHAFSTRVVTINRVMGYLSSA

SEQ ID NO: 30 mIL-12 p35 subunit precursor sequence, mouse, nucleic acid sequence
Atgtgtcaatcacgctacctcctcttttttggccacccttgccctcctaaaccacctcagtttggccagggtcattccagtctctggacctgccag
gtgtcttagccagtcccgaaacctgctgaagaccacagatgacatggtgaagacggccagagaaaaactgaaacattattcctgcactgct
gaagacatcgatcatgaagacatcacacgggaccaaaccagcacattgaagacctgtttaccactggaactacacaagaacgagagttgc
ctggctactagagagacttcttccacaacaagagggagctgcctgcccccacagaagacgtctttgatgatgaccctgtgccttggtagcat
ctatgaggacttgaagatgtaccagacagagttccaggccatcaacgcagcacttcagaatcacaaccatcagcagatcattctagacaag
ggcatgctggtggccatcgatgagctgatgcagtctctgaatcataatggcgagactctgcgccagaaacctcctgtgggagaagcagacc

cttacagagtgaaaatgaagctctgcatcctgcttcacgccttcagcacccgcgtcgtgaccatcaacagggtgatgggctatctgagctcc gcctga

SEQ ID NO: 31 mIL-12 (p40) signal peptide, mouse, amino acid sequence
MCPQKLTISWFAIVLLVSPLMA

SEQ ID NO: 32 mIL-12 (p40) signal peptide, mouse, nucleic acid sequence
CCATGTGTCCTCAGAAGCTAACCATCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCC ACTCATGGCCA

SEQ ID NO: 33 mIL-12 p35 signal peptide, mouse, amino acid sequence
MCQSRYLLFLATLALLNHLSLA

SEQ ID NO: 34 mIL-12 p35 signal peptide, mouse, nucleic acid sequence
atgtgtcaatcacgctacctcctcttttggccacccttgccctcctaaaccacctcagtttggcc

SEQ ID NO: 35 G_6S linker, amino acid sequence
GGGGGGS

SEQ ID NO: 36 $(G_3S)_2$ linker, amino acid sequence
GGGSGGGS

SEQ ID NO: 37 $(G_3S)_3$ linker, amino acid sequence
GGGSGGGSGGGS

SEQ ID NO: 38 $(G_3S)_4$ linker, amino acid sequence
GGGSGGGSGGGSGGGS

SEQ ID NO: 39 $(G_3S)_5$ linker , amino acid sequence
GGGSGGGSGGGSGGGSGGGS

SEQ ID NO: 40 $(G_4S)_2$ linker, amino acid sequence
GGGGSGGGGS

SEQ ID NO: 41 $(G_4S)_3GS$ linker, amino acid sequence
GGGGSGGGGSGGGGSGS

SEQ ID NO: 42 $(G_4S)_4$ linker, amino acid sequence
GGGGSGGGGSGGGGSGGGGS

SEQ ID NO: 43 $(G_4S)_5$ linker, amino acid sequence
GGGGSGGGGSGGGGSGGGGSGGGGS

SEQ ID NO: 44 $(G_4S)_6$ linker, amino acid sequence
GGGGSGGGGSGGGGSGGGGSGGGGSGGGGS

SEQ ID NO: 45 $(G_4S)_7$ linker, amino acid sequence
GGGGSGGGGSGGGGSGGGGSGGGGSGGGGSGGGGS

SEQ ID NO: 46 $(G_4S)_8$ linker, amino acid sequence
GGGGSGGGGSGGGGSGGGGSGGGGSGGGGSGGGGSGGGGS

SEQ ID NO: 47 $(GGGGS)_n$ linker, amino acid sequence
$(GGGGS)_n$, wherein n is an integer of 1-10

SEQ ID NO: 48 RnD linker (amino acid sequence), amino acid sequence
GSGSSRGGSGSGGSGGGGSK

SEQ ID NO: 49 VSV-M51R-mIL12p70 (amino acid sequence), mouse, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV
GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL

QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNS
PLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSD
NHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFL
DLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLD
ILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYD
LIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTV
DLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFN
DHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSI
IYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDD
DLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIK
KMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHE
FFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQRE
AKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGK
LGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVST
NALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYA
MLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAK
FRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDR
LRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEV
SSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKET
PCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRA
TRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGF
ASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIA
CKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAE
QSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVI
HRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRD
MGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGK
DKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPP
WGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGI
HYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDK
SRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVR
NYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCK
GLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIET
MLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQN
VGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKD
TRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWI
NRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 50 VSV-M51R-mIL12 encoding murine single chain IL-12, VSV-M51R-mIL12p70 (nucleic acid sequence), mouse, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC

ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA

ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC
TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA
GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG
ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG

TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT
GTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCT
GAGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCA
TGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACA
GCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGAT
GACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCAT
GCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGG
AAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTT
CTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAA
TGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTT
TTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCAT
CCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACT
CATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATT
AATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGG
CAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCT
TGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAAT
GGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGG
TGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCC
TTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTT
ATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCA
AGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACT
TCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG
CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT

AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA
TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG
GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT

GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 51 VSV-M51R-mIL12p70_2xALA (amino acid sequence), mouse, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKAALDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV
GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNS
PLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSD
NHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFL
DLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLD
ILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYD
LIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTV
DLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFN
DHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSI
IYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDD
DLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIK
KMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHE
FFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQRE
AKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGK

LGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVST
NALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYA
MLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAK
FRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDR
LRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEV
SSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKET
PCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRA
TRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGF
ASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIA
CKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAE
QSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVI
HRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRD
MGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGK
DKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPP
WGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGI
HYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDK
SRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVR
NYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCK
GLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIET
MLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQN
VGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKD
TRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWI
NRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 52 VSV-M51R-mIL12p70_2xALA (nucleic acid sequence), mouse, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT

TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT

CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGCGGCTCT
AGATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATC
TGCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCA
AAAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCT
CATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGT
TCCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTC
ACACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCAC
CTGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGC
AGAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCA
GACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAG
CTGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTT
GTTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACC
AGAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGG
AATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCA
TGTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGT
CTCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGA
CATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACA
TCGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCA
CTGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAAC
AAGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGG
TAGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAG
CACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCC
ATCGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCT
CCTGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCAC
GCCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCC

TGAGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACC
ATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAAC
AGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAG
ATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATC
ATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAG
GAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGT
TCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAA
ATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTT
TTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCA
TCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGAC
TCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACAT
TAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAG
GCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGC
TTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAA
TGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACG
GTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCC
CTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCT
TATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCA
AGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACT
TCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG
CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT
AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA
TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG
GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA

ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT
GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT

GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 53 VSV-M51R-mIL12p70_3xALa (amino acid sequence), mouse, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN

SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKAALDAGQYTCHKGGETLSHSHLLLHAKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV
GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNS
PLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSD
NHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFL
DLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLD
ILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYD
LIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTV
DLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFN
DHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSI
IYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDD
DLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIK
KMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHE
FFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQRE
AKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGK
LGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVST
NALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYA
MLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAK
FRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDR
LRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEV
SSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKET
PCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRA
TRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGF
ASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIA
CKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAE
QSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVI
HRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRD
MGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGK
DKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPP
WGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGI

HYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDK
SRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVR
NYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCK
GLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIET
MLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQN
VGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKD
TRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWI
NRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 54 VSV-M51R-mIL12p70_3xALa (nucleic acid sequence), mouse, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG

GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC

CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGCGGCTCT
AGATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATC
TGCTGCTCCACGCGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCA
AAAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCT
CATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGT
TCCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTC
ACACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCAC
CTGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGC
AGAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCA
GACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAG
CTGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTT
GTTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACC
AGAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGG
AATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCA
TGTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGT
CTCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGA
CATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACA
TCGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCA
CTGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAAC
AAGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGG
TAGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAG
CACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCC
ATCGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCT
CCTGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCAC
GCCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCC
TGAGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACC
ATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAAC
AGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAG
ATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATC
ATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAG
GAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGT
TCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAA
ATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTT
TTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCA
TCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGAC
TCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACAT
TAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAG
GCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGC
TTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAA
TGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACG

GTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCC
CTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCT
TATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCA
AGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACT
TCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG
CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT
AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA
TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG
GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA

AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT
GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC

AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 55 VSV-M51R-mIL12p70TM (amino acid sequence), mouse, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV

GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAGGGGSGGGGSGGGGSNTLVLFGAGFGAVITVVVIVVIIKCFCKH
RSCFRRRNEASRETNNSLTFGPEEALAEQTVFLMEVHDFETDEFNDFNEDDYATREFLN
PDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPI
PTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKK
ERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRV
PSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLL
NIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGA
KIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSY
AKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDK
WHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKAT
NWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFV
PMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVF
RVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLE
GLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQ
MVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTC
VTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSL
YEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHAR
SEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTI
RNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNS
FKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIG
TTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSES
TSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKR
TGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITT
TVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEI
KQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGF
LKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDE
LETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFS
ISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACK
FGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPT
GAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGA
SPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDME
VRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQT
EFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTL
TGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIR
VGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGG
YKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHL
KWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 56 VSV-M51R-mIL12p70TM (nucleic acid sequence), mouse, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG

ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT

CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC
TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA

GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG
ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG
TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT
GTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCT
GAGGGGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCAACACACTT
GTGCTCTTTGGGGCAGGATTCGGCGCAGTAATAACAGTCGTCGTCATCGTTGTCATC
ATCAAATGCTTCTGTAAGCACAGAAGCTGTTTCAGAAGAAGAAATGAGGCAAGCAG
AGAAACAAACAACAGCCTTACCTTCGGGCCTGAAGAAGCATTAGCTGAACAGACCG
TCTTCCTTTAGGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTT
GTGATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAA
AAACTAACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTC
AATGAAGATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTA
CTTGAATCATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAAT
TTAATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGG
GATGGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAG
ATGCATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGG
GTATAGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGG
AGACCTTCATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGA
TGGACTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACA
AGTTGACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGA
CTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGG
GTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTG
ATATTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGA
TGCAAACGGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGAC
ATCTTCTCCCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGA
AATTTTTCTTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATG
AAATTAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCAT
ATCAAGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCAT
GATCAGATAATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTC
AGACATTGGGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCC
CAAGTAACCATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGA
TTTAGCTCGGATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAAT
GGAGACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGG

CCCACAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATT
AAATGTTTTGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGT
CATTCAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCT
ATCCCTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAA
AGAATTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGG
TCTTAAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTC
TTGGAAATTGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGT
CCCTATGTTTAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGAT
GTTAGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAA
TCACATTGATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAG
TGTTCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATG
AATTTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTC
ACAACAACACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAG
GGTGGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATT
CAAAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAA
TCAAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTAC
AGGGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAA
TAGGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCA
GATTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAG
ACCAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCT
AATATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAAC
CCAATCAATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTG
ATGATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCG
GGCTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAG
GAGTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAAC
AGAAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAA
GGAGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACA
TAGACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCA
GCGAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCAT
CAGGAACCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGC
TCAGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAA
ATCAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCG
TACTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGT
GAGGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATC
ATGTAAAATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTG
GGGCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACA
ACATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTC
TGTGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGC
TTATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGA
AAGCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTT
TGTTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACA
GGCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCA
TAGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGC
ATTGACCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATT
TCGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAG
AGACGGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTT

GAGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATG
TATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATA
AAACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATC
CTATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATC
TACTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGT
CGAGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGT
AATACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAG
GTTTGATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAG
ATCAGGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCT
ATCCGACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAAT
GCCGTCTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCT
CAGATGTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCA
AATCCTATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGG
CAAATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAA
TTCTTCACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTC
GGGATTGCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATC
CAGAGGGACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGAT
GCTAGAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCC
AATTACCAACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCC
ATTACAGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTAC
TACGAGAAAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGG
TCAGTCATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGA
GATAAATCGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGT
GACCCAAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATT
GATTTAATTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAG
ACGAATGTTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTAC
AAGACTTATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGG
TCCCATGTTCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTC
TGAAGTATATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGA
TTGGTCTTCCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACA
GGAATTTGCCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTC
CCAATTCATTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTA
CCCACGGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTA
TTGACCATTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCA
GAGTAGGACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGG
ATCGCTATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTA
TATCAACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTT
TCAGTAAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAA
AGATACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGA
ATTGGTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCT
ATGTCGTACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAA
TGATTGAATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGA
AGAGTGACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTC
CAAACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTT
TTATCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGG
CTGGGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCG

ATCCGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAG
CAATAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTG
AAAGGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 57 VSV-M51R-mIL12p35TM (amino acid sequence), mouse, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCQSRYLLFLATLALLNHLSLARVIPVSGPARCLSQSRNLLKTTDDMVKT
ARELKLKHYSCTAEDIDHEDITRDQTSTLKTCLPLELHKNESCLATRETSSTTRGSCLPPQK
TSLMMTLCLGSIYEDLKMYQTEFQAINAALQNHNHQQIILDKGMLVAIDELMQSLNHN
GETLRQKPPVGEADPYRVKMKLCILLHAFSTRVVTINRVMGYLSSAGGGGSGGGGSGG
GGSNTLVLFGAGFGAVITVVVIVVIIKCFCKHRSCFRRRNEASRETNNSLTFGPEEALAEQ
TVFLMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIR
KFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSF
LHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNA
VSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLM
VKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICN
LKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSF
RHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNG
DLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMN
RSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKER
ELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQG
LKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNG

RPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKV
LAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDET
MQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAE
NPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGG
VSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLV
EDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINP
LFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKL
HLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSG
FNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISW
FVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALT
RLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIE
EITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCI
GFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLK
RPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYF
KYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELA
NLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTI
TTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCG
DGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETC
WEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDE
QGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEP
NPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVP
TGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGIS
FWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLA
PIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKED
RSILMLKSDLHEENSWRD

SEQ ID NO: 58 VSV-M51R-mIL12p35TM (nucleic acid sequence), mouse, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA

AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG

GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCAATCACGCTACCTCCT
CTTTTTGGCCACCCTTGCCCTCCTAAACCACCTCAGTTTGGCCAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCG
GGGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCAACACACTTGTG
CTCTTTGGGGCAGGATTCGGCGCAGTAATAACAGTCGTCGTCATCGTTGTCATCATC
AAATGCTTCTGTAAGCACAGAAGCTGTTTCAGAAGAAGAAATGAGGCAAGCAGAGA
AACAAACAACAGCCTTACCTTCGGGCCTGAAGAAGCATTAGCTGAACAGACCGTCT
TCCTTTAGGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTG
ATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAA
CTAACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAAT
GAAGATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTT
GAATCATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTA
ATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGAT
GGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATG
CATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTAT
AGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGAC
CTTCATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGA
CTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTT

GACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTT
CAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTC
CCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATA
TTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGC
AAACGGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCT
TCTCCCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATT
TTTCTTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAAT
TAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCA
AGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATC
AGATAATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGAC
ATTGGGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAG
TAACCATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAG
CTCGGATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAG
ACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCA
CAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAAT
GTTTTGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATT
CAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCC
CTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAA
TTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTT
AAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTG
GAAATTGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCC
TATGTTTAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTT
AGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCA
CATTGATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGT
TCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAAT
TTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACA
ACAACACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGT
GGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCA
AAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATC
AAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAG
GGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATA
GGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGA
TTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGAC
CAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAA
TATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCC
AATCAATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGAT
GATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGG
CTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGA
GTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAG
AAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGG
AGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATA
GACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGC
GAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCA
GGAACCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTC
AGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAAT
CAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTA

CTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGA
GGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCAT
GTAAAATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGG
GCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAAC
ATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTG
TGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTT
ATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAA
GCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTG
TTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAG
GCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCAT
AGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCA
TTGACCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTT
CGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGA
GACGGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTG
AGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGT
ATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAA
AACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCT
ATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTA
CTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCG
AGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAAT
ACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTT
TGATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATC
AGGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCC
GACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCC
GTCTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAG
ATGTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAAT
CCTATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAA
ATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCT
TCACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGA
TTGCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGA
GGGACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTA
GAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTA
CCAACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTAC
AGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGA
GAAAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTC
ATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAA
ATCGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCC
AAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTT
AATTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAA
TGTTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGAC
TTATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCAT
GTTCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGT
ATATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTC
TTCCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATT
TGCCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATT
CATTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCAC

GGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGAC
CATTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTA
GGACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGC
TATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCA
ACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGT
AAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGAT
ACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTG
GTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGT
CGTACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGAT
TGAATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGA
GTGACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAA
ACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTA
TCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTG
GGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATC
CGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAA
TAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAA
GGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 59 VSV-M51R-mIL12p70woSP (amino acid sequence), mouse, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMWELEKDVYVVEVDWTPDAPGETVNLTCDTPEEDDITWTSDQRHGVIGS
GKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKENGIWSTEILKNFKNKTFLKCEAP

NYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCGMASLSAEKVTLDQRDYEKYSVS
CQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIRDIIKPDPPKNLQMKPLKNSQVEV
SWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEGCNQKGAFLVEKTSTEVQCKGGN
VCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGVGRVIPVSGPARCLSQSRNLLKTT
DDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTCLPLELHKNESCLATRETSSTTRG
SCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAALQNHNHQQIILDKGMLVAIDELM
QSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFSTRVVTINRVMGYLSSAMEVHDF
ETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMW
DSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEIT
FDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLA
RTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQ
TVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARES
RPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDY
YTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFK
SHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVR
MNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFS
LMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIA
NHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHN
NTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVIC
TQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYG
KIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNY
FGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIR
AFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMG
MSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSG
TFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWT
CSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGI
HDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTI
LSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMR
DLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTP
PDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRK
STHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLI
YLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGK
YRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGW
EDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYP
KMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLR
ENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRT
WDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYI
CESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWK
NLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSS
DRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPL
YQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELV
RNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHE
ENSWRD

SEQ ID NO: 60 VSV-M51R-mIL12p70woSP (nucleic acid sequence), mouse, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT

CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGGGAGCTGGAGAAAGACG
TTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAGTGAACCTCA
CCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAGAGACATGGA
GTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTAGATGCTGGC
CAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCTGCTGCTCCA
CAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAAAAACAAGA
CTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTCATGGCTGG
TGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTTCCCCTGAC
TCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCACACTGGAC

CAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACCTGCCCAAC
TGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCAGAATAAAT
ATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAGACCCGCCC
AAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGCTGGGAGTA
CCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTGTTCGAATC
CAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCAGAAAGGTG
CGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGAATGTCTGC
GTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCATGTGTTCCC
TGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTCTCTGGACC
TGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGACATGGTGA
AGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACATCGATCAT
GAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCACTGGAACT
ACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACAAGAGGGA
GCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGTAGCATCT
ATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGCACTTCAG
AATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCATCGATGA
GCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCCTGTGGG
AGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACGCCTTCAG
CACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCTGAGCTAA
GCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATGCTCAA
AGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCA
TGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTATG
CCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATT
ACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTCA
ATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGA
TGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATGG
GAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATG
AAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGC
TGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAA
AATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTA
AATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTC
AGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCT
ACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGA
AACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCC
ATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAAT
ATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTG
ATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATC
AAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGAT
GAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGT
GAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCC
TTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAA
AGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCT
ATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCA
TGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGT
TCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACC
CGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTC

AGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGG
TGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAG
ATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGA
GAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGA
ATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGC
CTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCC
GGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGA
AAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGG
GCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAA
GTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGA
TCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGT
CTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAA
AATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCAC
ACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATC
AAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAG
TTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTAT
GGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTC
ACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTC
AGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCAT
GATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCT
GCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCT
ACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATG
TCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCAT
TCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCA
GTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGT
AGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAA
GACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGA
TTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTAT
GGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTT
GGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTC
CTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATC
CTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGAC
ATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTAT
TGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGA
CTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGA
CGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAA
AACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACT
GATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTC
TAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGAC
CAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATC
TCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGAT
GGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCA
AGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCAC
CAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGA
GATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAA
GACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTT

TAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGA
TGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGAC
AGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAG
GGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGT
CTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATT
GATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAG
ACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGT
GATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAG
GGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATA
GACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCAT
TTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGC
TAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATA
TTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAAT
AATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAAC
AATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAG
AATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCA
TTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAG
TTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATA
GCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCT
CTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTA
AATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGAC
TATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGAT
ATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTAT
GTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATAT
ATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTC
GACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGT
AAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAA
TCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAA
GAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCT
TTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCAT
GCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTT
ATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTC
CGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATA
AGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCA
GTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATAC
AAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGA
CTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGT
TCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAA
TCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATA
GACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAG
GAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAA
AAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTC
TTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAG
GGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAA
GCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACC

CCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATC
CGGATGCGGCCGC

SEQ ID NO: 61 hIL-12 p40 subunit mature form sequence, human, amino acid sequence
IWELKKDVYVVELDWYPDAPGEMVVLTCDTPEEDGITWTLDQSSEVLGSGKTLTIQVK
EFGDAGQYTCHKGGEVLSHSLLLLHKKEDGIWSTDILKDQKEPKNKTFLRCEAKNYSGR
FTCWWLTTISTDLTFSVKSSRGSSDPQGVTCGAATLSAERVRGDNKEYEYSVECQEDSA
CPAAEESLPIEVMVDAVHKLKYENYTSSFFIRDIIKPDPPKNLQLKPLKNSRQVEVSWEY
PDTWSTPHSYFSLTFCVQVQGKSKREKKDRVFTDKTSATVICRKNASISVRAQDRYYSS
SWSEWASVPCS

SEQ ID NO: 62 hIL-12 p40 subunit mature form sequence, human, nucleic acid sequence
atatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaatggtggtcctcacctgtgacacccct
gaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctgaccatccaagtcaaagagtttggag
atgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaaaaaggaagatggaatttggtccact
gatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattctggacgtttcacctgctggtggctg
acgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggtgacgtgcggagctgctacactctc
tgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagtgcctgcccagctgctgaggagagt
ctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttcttcatcagggacatcatcaaacctgac
ccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagtaccctgacacctggagtactccacatt
cctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagatagagtcttcacggacaagacctcagccac
ggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatcttggagcgaatgggcatctgtgccctgc
agt

SEQ ID NO: 63 hIL-12 p35 subunit mature form sequence, human, amino acid sequence
RNLPVATPDPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTST
VEACLPLELTKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTM
NAKLLMDPKRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHA
FRIRAVTIDRVMSYLNAS

SEQ ID NO: 64 hIL-12 p35 subunit mature form sequence, human, nucleic acid sequence
agaaacctccccgtggccactccagacccaggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctcc
agaaggccagacaaactctagaattttacccttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggag
gcctgtttaccattggaattaaccaagaatgagagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaa
agacctcttttatgatggccctgtgccttagtagtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctg
atggatcctaagaggcagatctttctagatcaaaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgc
cacaaaaatcctcccttgaagaaccggatttttataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattg
atagagtgatgagctatctgaatgcttcc

SEQ ID NO: 65 hIL-12 p40 signal peptide, human, amino acid sequence
MCHQQLVISWFSLVFLASPLVA

SEQ ID NO: 66 hIL-12 p40 signal peptide, human, nucleic acid sequence
atgtgtcaccagcagttggtcatctcttggttttccctggtttttctggcatctcccctcgtggcc

SEQ ID NO: 67 hIL-12 p35 signal peptide, human, amino acid sequence

MCPARSLLLVATLVLLDHLSLA

SEQ ID NO: 68 hIL-12 p35 signal peptide, human, nucleic acid sequence
atgtgtccagcgcgcagcctcctccttgtggctaccctggtcctcctggaccacctcagtttggcc

SEQ ID NO: 69 mIL-12 p40 subunit mature form sequence, mouse, amino acid sequence
MWELEKDVYVVEVDWTPDAPGETVNLTCDTPEEDDITWTSDQRHGVIGSGKTLTITVK
EFLDAGQYTCHKGGETLSHSHLLLHKKENGIWSTEILKNFKNKTFLKCEAPNYSGRFTCS
WLVQRNMDLKFNIKSSSSSPDSRAVTCGMASLSAEKVTLDQRDYEKYSVSCQEDVTCP
TAEETLPIELALEARQQNKYENYSTSFFIRDIIKPDPPKNLQMKPLKNSQVEVSWEYPDS
WSTPHSYFSLKFFVRIQRKKEKMKETEEGCNQKGAFLVEKTSTEVQCKGGNVCVQAQD
RYYNSSCSKWACVPCRVRS

SEQ ID NO: 70 mIL-12 p40 subunit mature form sequence, mouse, nucleic acid sequence
ATGTGGGAGCTGGAGAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGC
CCCTGGAGAAACAGTGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCT
GGACCTCAGACCAGAGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACT
GTCAAAGAGTTTCTAGATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCT
GAGCCACTCACATCTGCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAA
TTTTAAAAAATTTCAAAAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCG
GACGGTTCACGTGCTCATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATC
AAGAGCAGTAGCAGTTCCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTG
TCTGCAGAGAAGGTCACACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTG
CCAGGAGGATGTCACCTGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGT
TGGAAGCACGGCAGCAGAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGG
GACATCATCAAACCAGACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTC
ACAGGTGGAGGTCAGCTGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTT
CTCCCTCAAGTTCTTTGTTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAG
AGGAGGGGTGTAACCAGAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTC
CAATGCAAAGGCGGGAATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCA
TGCAGCAAGTGGGCATGTGTTCCCTGCAGAGTCCGATCG

SEQ ID NO: 71 mIL-12 p35 subunit mature form sequence, mouse, amino acid sequence
RVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTCL
PLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAALQ
NHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFSTR
VVTINRVMGYLSSA

SEQ ID NO: 72 mIL-12 p35 subunit mature form sequence, mouse, nucleic acid sequence
AGGGTCATACCGGTCTCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTG
AAGACCACAGATGACATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTG
CACTGCTGAAGACATCGATCATGAAGACATCACACGGGACCAAACCAGCACATTGA
AGACCTGTTTACCACTGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAG
ACTTCTTCCACAACAAGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATG
ACCCTGTGCCTTGGTAGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAG
GCCATCAACGCAGCACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGG

CATGCTGGTGGCCATCGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCT
GCGCCAGAAACCTCCTGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCT
GCATCCTGCTTCACGCCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCT
ATCTGAGCTCCGCCTGA

SEQ ID NO: 73 linker (rigid), H4-2, amino acid sequence
$A(EAAAK)_4ALEA(EAAAK)_4A$

SEQ ID NO: 74 linker (rigid), amino acid sequence
$A(EAAAK)_3A$

SEQ ID NO: 75 linker (flexible), amino acid sequence
$(Gly)_8$

SEQ ID NO: 76 linker (flexible), amino acid sequence
$(Gly)_6$

SEQ ID NO: 77 linker (rigid), amino acid sequence
$(EAAAK)_3$

SEQ ID NO: 78 linker (rigid), amino acid sequence
$(EAAAK)_n$, wherein n=1-4

SEQ ID NO: 79 linker (flexible), amino acid sequence
GGGGS

SEQ ID NO: 80 linker (rigid), amino acid sequence
PAPAP

SEQ ID NO: 81 linker (rigid), amino acid sequence
$A(EAAAK)_2A$

SEQ ID NO: 82 linker (rigid), amino acid sequence
$(AP)_n$, (10-34aa)

SEQ ID NO: 83 linker (cleavable), disulfide, amino acid sequence
S-S

SEQ ID NO: 84 linker (cleavable), amino acid sequence
VSQTSKLTRAETVFPDV

SEQ ID NO: 85 linker (cleavable), amino acid sequence
RVLAEA

SEQ ID NO: 86 linker (cleavable), amino acid sequence
EDVVCCSMSY

SEQ ID NO: 87 linker (cleavable), amino acid sequence
GGIEGRGS

SEQ ID NO: 88 linker (cleavable), amino acid sequence
TRHRQPRGWE

SEQ ID NO: 89 linker (cleavable), amino acid sequence
AGNRVRRSVG

SEQ ID NO: 90 linker (cleavable), amino acid sequence
RRRRRRRRR

SEQ ID NO: 91 linker, dipeptide, amino acid sequence
LE

SEQ ID NO: 92 vesicular stomatitis virus glycoprotein (G), amino acid sequence
MKCLLYLAFLFIGVNCKFTIVFPHNQKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQ
VKMPKSHKAIQADGWMCHASKWVTTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTK
QGTWLNPGFPPQSCGYATVTDAEAVIVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICP
TVHNSTTWHSDYKVKGLCDSNLISMDITFFSEDGELSSLGKEGTGFRSNYFAYETGGKA
CKMQYCKHWGVRLPSGVWFEMADKDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVE
RILDYSLCQETWSKIRAGLPISPVDLSYLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPI
LSRMVGMISGTTTERELWDDWAPYEDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLH
LSSKAQVFEHPHIQDAASQLPDDESLFFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLII
GLFLVLRVGIHLCIKLKHTKKRQIYTDIEMNRLGK

SEQ ID NO: 93 vesicular stomatitis virus glycoprotein (G), nucleic acid sequence
ATGAAGTGCCTTTTGTACTTAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCA
TAGTTTTTCCACACAACCAAAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATT
ATTGCCCGTCAAGCTCAGATTTAAATTGGCATAATGACTTAATAGGCACAGCCTTAC
AAGTCAAAATGCCCAAGAGTCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCAT
GCTTCCAAATGGGTCACTACTTGTGATTTCCGCTGGTATGGACCGAAGTATATAACA
CATTCCATCCGATCCTTCACTCCATCTGTAGAACAATGCAAGGAAAGCATTGAACAA
ACGAAACAAGGAACTTGGCTGAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCA
ACTGTGACGGATGCCGAAGCAGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTT
GATGAATACACAGGAGAATGGGTTGATTCACAGTTCATCAACGGAAAATGCAGCAA
TTACATATGCCCCACTGTCCATAACTCTACAACCTGGCATTCTGACTATAAGGTCAA
AGGGCTATGTGATTCTAACCTCATTTCCATGGACATCACCTTCTTCTCAGAGGACGG
AGAGCTATCATCCCTGGGAAAGGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTT
ATGAAACTGGAGGCAAGGCCTGCAAAATGCAATACTGCAAGCATTGGGGAGTCAGA
CTCCCATCAGGTGTCTGGTTCGAGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGA
TTCCCTGAATGCCCAGAAGGGTCAAGTATCTCTGCTCCATCTCAGACCTCAGTGGAT
GTAAGTCTAATTCAGGACGTTGAGAGGATCTTGGATTATTCCCTCTGCCAAGAAACC
TGGAGCAAAATCAGAGCGGGTCTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCT
CCTAAAAACCCAGGAACCGGTCCTGCTTTCACCATAATCAATGGTACCCTAAAATAC

TTTGAGACCAGATACATCAGAGTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTC
GGAATGATCAGTGGAACTACCACAGAAAGGGAACTGTGGGATGACTGGGCACCATA
TGAAGACGTGGAAATTGGACCCAATGGAGTTCTGAGGACCAGTTCAGGATATAAGT
TTCCTTTATACATGATTGGACATGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAA
GGCTCAGGTGTTCGAACATCCTCACATTCAAGACGCTGCTTCGCAACTTCCTGATGA
TGAGAGTTTATTTTTTGGTGATACTGGGCTATCCAAAAATCCAATCGAGCTTGTAGA
AGGTTGGTTCAGTAGTTGGAAAAGCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTA
ATCATTGGACTATTCTTGGTTCTCCGAGTTGGTATCCATCTTTGCATTAAATTAAAGC
ACACCAAGAAAAGACAGATTTATACAGACATAGAGATGAACCGACTTGGAAAGTAA

SEQ ID NO: 94 vesicular stomatitis virus large protein (L), amino acid sequence
MEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNS
LPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEV
DKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEV
ELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDV
IIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLM
KLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHW
GHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLL
PHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSE
VLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELK
LAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKS
YEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPD
LMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQ
GDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQS
ADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPI
NAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSG
MSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDP
TSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFP
RFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLR
RGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNY
VSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVE
PDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRL
MATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEIT
LDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGF
LYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRP
ANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKY
QCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLS
SLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIP
VYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGS
GGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEY
PSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGV
LIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPD
WSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGV
SHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWL
SLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGN

WIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSIL
MLKSDLHEENSWRD

SEQ ID NO: 95 vesicular stomatitis virus large protein (L), nucleic acid sequence

ATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTAT
GCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGAT
TACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTC
AATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAG
ATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATG
GGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACAT
GAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGG
CTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCA
AAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTT
AAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGT
CAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTC
CTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACC
GAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTAT
CCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAA
ATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACT
TGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAA
TCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTG
ATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGT
GTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCAT
CCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAG
AAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTT
CTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCT
CATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAA
GTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATA
CCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGG
TCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAG
GTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGA
GATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGG
AGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAG
AATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGG
CCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATC
CGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGA
AAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGG
GCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAA
GTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGA
TCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGT
CTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAA
AATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCAC
ACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATC
AAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAG
TTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTAT
GGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTC

ACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTC
AGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCAT
GATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCT
GCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCT
ACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATG
TCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCAT
TCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCA
GTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGT
AGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAA
GACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGA
TTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTAT
GGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTT
GGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTC
CTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATC
CTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGAC
ATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTAT
TGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGA
CTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGA
CGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAA
AACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACT
GATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTC
TAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGAC
CAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATC
TCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGAT
GGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCA
AGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCAC
CAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGA
GATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAA
GACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTT
TAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGA
TGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGAC
AGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAG
GGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGT
CTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATT
GATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAG
ACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGT
GATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAG
GGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATA
GACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCAT
TTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGC
TAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATA
TTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAAT
AATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAAC
AATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAG
AATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCA
TTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAG

TTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATA
GCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCT
CTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTA
AATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGAC
TATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGAT
ATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTAT
GTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATAT
ATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTC
GACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGT
AAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAA
TCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAA
GAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCT
TTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCAT
GCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTT
ATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTC
CGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATA
AGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCA
GTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATAC
AAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGA
CTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGT
TCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAA
TCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATA
GACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAG
GAAAACTCTTGGAGAGATTAA

SEQ ID NO: 96 hCD4, amino acid sequence
KKVVLGKKGDTVELTCTASQKKSIQFHWKNSNQIKILGNQGSFLTKGPSKLNDRADSRR
SLWDQGNFPLIIKNLKIEDSDTYICEVEDQKEEVQLLVFGLTANSDTHLLQGQSLTLTLES
PPGSSPSVQCRSPRGKNIQGGKTLSVSQLELQDSGTWTCTVLQNQKKVEFKIDIVVLAFQ
KASSIVYKKEGEQVEFSFPLAFTVEKLTGSGELWWQAERASSSKSWITFDLKNKEVSVK
WVTQDPKLQMGKKLPLHLTLPQALPQYAGSGNLTLALEAKTGKLHQEVNLVVMRATQ
LQKNLTCEVWGPTSPKLMLSLKLENKEAKVSKREKAVWVLNPEAGMWQCLLSDSGQV
LLESNIKVLPTWSTPVQP

SEQ ID NO: 97 hCD4, nucleic acid sequence
aagaaagtggtgctgggcaaaaaaggggatacagtggaactgacctgtacagcttcccagaagaagagcatacaattccactggaaaaac
tccaaccagataaagattctgggaaatcagggctccttcttaactaaaggtccatccaagctgaatgatcgcgctgactcaagaagaagcctt
tgggaccaaggaaacttcccccctgatcatcaagaatcttaagatagaagactcagatacttacatctgtgaagtggaggaccagaaggagg
aggtgcaattgctagtgttcggattgactgccaactctgacacccacctgcttcaggggcagagcctgaccctgaccttggagagccccct
ggtagtagcccctcagtgcaatgtaggagtccaaggggtaaaaacatacagggggggaagaccctctccgtgtctcagctggagctccag
gatagtggcacctggacatgcactgtcttgcagaaccagaagaaggtggagttcaaaatagacatcgtggtgcttgctttccagaaggcctc
cagcatagtctataagaaagaggggggaacaggtggagttctccttcccactcgcctttacagttgaaaagctgacgggcagtggcgagctg
tggtggcaggcggagagggcttcctcctccaagtcttggatcacctttgacctgaagaacaaggaagtgtctgtaaaatgggttacccagga
ccctaagctccagatgggcaagaagctcccgctccacctcaccctgccccaggccttgcctcagtatgctggctctggaaacctcaccctg
gcccttgaagcgaaaacaggaaagttgcatcaggaagtgaacctggtggtgatgagagccactcagctccagaaaaatttgacctgtgag
gtgtggggacccacctcccctaagctgatgctgagcttgaaactggagaacaaggaggcaaaggtctcgaagcgggagaaggcggtgt

gggtgctgaaccctgaggcggggatgtggcagtgtctgctgagtgactcgggacaggtcctgctggaatccaacatcaaggttctgccca
catggtccaccccggtgcagcca

SEQ ID NO: 98 hCD46, amino acid sequence
CEEPPTFEAMELIGKPKPYYEIGERVDYKCKKGYFYIPPLATHTICDRNHTWLPVSDDAC
YRETCPYIRDPLNGQAVPANGTYEFGYQMHFICNEGYYLIGEEILYCELKGSVAIWSGKP
PICEKVLCTPPPKIKNGKHTFSEVEVFEYLDAVTYSCDPAPGPDPFSLIGESTIYCGDNSV
WSRAAPECKVVKCRFPVVENGKQISGFGKKFYYKATVMFECDKGFYLDGSDTIVCDSN
STWDPPVPKCLKGPRPTYKPPVSNYPGYPKPEEGILDSLD

SEQ ID NO: 99 hCD46, nucleic acid sequence
tgtgaggagccaccaacatttgaagctatggagctcattggtaaaccaaaaccctactatgagattggtgaacgagtagattataagtgtaaa
aaaggatacttctatatacctcctcttgccacccatactatttgtgatcggaatcatacatggctacctgtctcagatgacgcctgttatagagaa
acatgtccatatatacgggatcctttaaatggccaagcagtccctgcaaatgggacttacgagtttggttatcagatgcactttatttgtaatgag
ggttattacttaattggtgaagaaattctatattgtgaacttaaaggatcagtagcaatttggagcggtaagcccccaatatgtgaaaaggttttg
tgtacaccacctccaaaaataaaaaatggaaaacacacctttagtgaagtagaagtatttgagtatcttgatgcagtaacttatagttgtgatcct
gcacctggaccagatccattttcacttattggagagagcacgatttattgtggtgacaattcagtgtggagtcgtgctgctccagagtgtaaagt
ggtcaaatgtcgatttccagtagtcgaaaatggaaaacagatatcaggatttggaaaaaaattttactacaaagcaacagttatgtttgaatgcg
ataagggtttttacctcgatggcagcgacacaattgtctgtgacagtaacagtacttgggatcccccagttccaaagtgtcttaaaggtcctag
gcctacttacaagcctccagtctcaaattatccaggatatcctaaacctgaggaaggaatacttgacagtttggat

SEQ ID NO: 100 CBD domain of VWF, amino acid sequence
CSGEGLQIPTLSPAPDCSQPLDVILLLDGSSSFPASYFDEMKSFAKAFISKANIGPRLTQVS
VLQYGSITTIDVPWNVVPEKAHLLSLVDVMQREGGPSQIGDALGFAVRYLTSEMHGAR
PGASKAVVILVTDVSVDSVDAAADAARSNRVTVFPIGIGDRYDAAQLRILAGPAGDSNV
VKLQRIEDLPTMVTLGNSFLHKLCSG

SEQ ID NO: 101 CBD domain of VWF, nucleic acid sequence
TGCTCCGGAGAGGGGCTGCAGATCCCCACCCTCTCCCCTGCACCTGACTGCAGCCAG
CCCCTGGACGTGATCCTTCTCCTGGATGGCTCCTCCAGTTTCCCAGCTTCTTATTTTG
ATGAAATGAAGAGTTTCGCCAAGGCTTTCATTTCAAAAGCCAATATAGGGCCTCGTC
TCACTCAGGTGTCAGTGCTGCAGTATGGAAGCATCACCACCATTGACGTGCCATGGA
ACGTGGTCCCGGAGAAAGCCCATTTGCTGAGCCTTGTGGACGTCATGCAGCGGGAG
GGAGGCCCCAGCCAAATCGGGGATGCCTTGGGCTTTGCTGTGCGATACTTGACTTCA
GAAATGCATGGTGCCAGGCCGGGAGCCTCAAAGGCGGTGGTCATCCTGGTCACGGA
CGTCTCTGTGGATTCAGTGGATGCAGCAGCTGATGCCGCCAGGTCCAACAGAGTGAC
AGTGTTCCCTATTGGAATTGGAGATCGCTACGATGCAGCCCAGCTACGGATCTTGGC
AGGCCCAGCAGGCGACTCCAACGTGGTGAAGCTCCAGCGAATCGAAGACCTCCCTA
CCATGGTCACCTTGGGCAATTCCTTCCTCCACAAACTGTGCTCTGGATAG

SEQ ID NO: 102 mIgG2a, amino acid sequence
EPRGPTIKPCPPCKCPAPNLLGGPSVFIFPPKIKDVLMISLSPIVTCVVVDVSEDDPDVQIS
WFVNNVEVHTAQTQTHREDYNSTLRVVSALPIQHQDWMSGKEFKCKVNNKDLPAPIER
TISKPKGSVRAPQVYVLPPPEEEMTKKQVTLTCMVTDFMPEDIYVEWTNNGKTELNYK
NTEPVLDSDGSYFMYSKLRVEKKNWVERNSYSCSVVHEGLHNHHTTKSFSRTPGK

SEQ ID NO: 103 mIgG2a, nucleic acid sequence
GAGCCCAGAGGGCCCACAATCAAGCCCTGTCCTCCATGCAAATGCCCAGCACCTAA
CCTCTTGGGTGGACCATCCGTCTTCATCTTCCCTCCAAAGATCAAGGATGTACTCATG
ATCTCCCTGAGCCCCATAGTCACATGTGTGGTGGTGGATGTGAGCGAGGATGACCCA
GATGTCCAGATCAGCTGGTTTGTGAACAACGTGGAAGTACACACAGCTCAGACACA
AACCCATAGAGAGGATTACAACAGTACTCTCCGGGTGGTCAGTGCCCTCCCCATCCA
GCACCAGGACTGGATGAGTGGCAAGGAGTTCAAATGCAAGGTCAACAACAAAGACC
TCCCAGCGCCCATCGAGAGAACCATCTCAAAACCCAAAGGGTCAGTAAGAGCTCCA
CAGGTATATGTCTTGCCTCCACCAGAAGAAGAGATGACTAAGAAACAGGTCACTCT
GACCTGCATGGTCACAGACTTCATGCCTGAAGACATTTACGTGGAGTGGACCAACA
ACGGGAAAACAGAGCTAAACTACAAGAACACTGAACCAGTCCTGGACTCTGATGGT
TCTTACTTCATGTACAGCAAGCTGAGAGTGGAAAAGAAGAACTGGGTGGAAAGAAA
TAGCTACTCCTGTTCAGTGGTCCACGAGGGTCTGCACAATCACCACACGACTAAGAG
CTTCTCCCGGACTCCGGGTAAA

SEQ ID NO: 104 hIgG1, amino acid sequence
ESKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKF
NWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPI
EKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNY
KTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK

SEQ ID NO: 105 hIgG1, nucleic acid sequence
gagtccaaatcttgtgacaaaactcacacatgcccaccgtgcccagcacctgaactcctgggggggaccgtcagtcttcctcttcccccaaa
acccaaggacaccctcatgatctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaa
ctggtacgtggacggcgtggaggtgcataatgccaagacaaagccacgggaggagcagtacaacagcacgtaccgtgtggtcagcgtc
ctcaccgtcctgcaccaggactggctgaatggcaaggagtacaagtgcaaggtctccaacaaagccctcccagcccccatcgagaaaac
catctccaaagccaaagggcagccccgagagccacaggtgtacaccctgcccccatcccgggatgagctgaccaagaaccaggtcagc
ctgacctgcctggtcaaaggcttctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccac
gcctcccgtgctggactccgacggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggggaacgtcttctca
tgctccgtgatgcatgaggctctgcacaaccactacacgcagaagagcctctccctgtctccgggtaaa

SEQ ID NO: 106 hIgG4, amino acid sequence
ESKYGPPCPSCPAPEFLGGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSQEDPEVQFNWY
VDGVEVHNAKTKPREEQFNSTYRVVSVLTVLHQDWLNGKEYKCKVSNKGLPSSIEKTIS
KAKGQPREPQVYTLPPSQEEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPP
VLDSDGSFFLYSRLTVDKSRWQEGNVFSCSVMHEALHNHYTQKSLSLSLGK

SEQ ID NO: 107 hIgG4, nucleic acid sequence
gagtccaaatatggtcccccatgcccatcatgcccagcacctgagttcctgggggggaccatcagtcttcctgttcccccaaaacccaagga
cactctcatgatctcccggacccctgaggtcacgtgcgtggtggtggacgtgagccaggaagaccccgaggtccagttcaactggtacgt
ggatggcgtggaggtgcataatgccaagacaaagccacgggaggagcagttcaacagcacgtaccgtgtggtcagcgtcctcaccgtcc
tgcaccaggactggctgaacggcaaggagtacaagtgcaaggtctccaacaaaggcctcccgtcctccatcgagaaaaccatctccaaag
ccaaagggcagccccgagagccacaggtgtacaccctgcccccatcccaggaggagatgaccaagaaccaggtcagcctgacctgcct
ggtcaaaggcttctaccccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtg
ctggactccgacggctccttcttcctctacagcaggctaaccgtggacaagagcaggtggcaggaggggaatgtcttctcatgctccgtgat
gcatgaggctctgcacaaccactacacacagaagagcctctccctgtctctgggtaaa

SEQ ID NO: 108 P2A, nucleic acid sequence
GGAAGCGGAGCTACTAACTTCAGCCTGCTGAAGCAGGCTGGAGACGTGGAGGAGAA
CCCTGGACCA

SEQ ID NO: 109 P2A, amino acid sequence
GSGATNFSLLKQAGDVEENPGP

SEQ ID NO: 110 VSV-M51R-mIL12p40-mIL12p35 sequence, mouse construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC

GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT

ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC
TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA
GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG
ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG
TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT
GTGTTCCCTGCAGAGTCCGATCGTGAGGCGCGCCTATGAAAAAAACTAACAGATAT
CATGTGTCAATCACGCTACCTCCTCTTTTTGGCCACCCTTGCCCTCCTAAACCACCTC
AGTTTGGCCAGGGTCATTCCAGTCTCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGA
AACCTGCTGAAGACCACAGATGACATGGTGAAGACGGCCAGAGAAAAACTGAAAC
ATTATTCCTGCACTGCTGAAGACATCGATCATGAAGACATCACACGGGACCAAACC
AGCACATTGAAGACCTGTTTACCACTGGAACTACACAAGAACGAGAGTTGCCTGGC
TACTAGAGAGACTTCTTCCACAACAAGAGGGAGCTGCCTGCCCCCACAGAAGACGT
CTTTGATGATGACCCTGTGCCTTGGTAGCATCTATGAGGACTTGAAGATGTACCAGA
CAGAGTTCCAGGCCATCAACGCAGCACTTCAGAATCACAACCATCAGCAGATCATT
CTAGACAAGGGCATGCTGGTGGCCATCGATGAGCTGATGCAGTCTCTGAATCATAAT
GGCGAGACTCTGCGCCAGAAACCTCCTGTGGGAGAAGCAGACCCTTACAGAGTGAA
AATGAAGCTCTGCATCCTGCTTCACGCCTTCAGCACCCGCGTCGTGACCATCAACAG
GGTGATGGGCTATCTGAGCTCCGCCTGAGCTAAGCAAATACAACAGATTCTTCATGT
TTGGACCAAATCAACTTGTGATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTT
TTTAATTTTTATGAAAAAAACTAACAGCAATCATGGAAGTCCACGATTTTGAGACCG
ACGAGTTCAATGATTTCAATGAAGATGACTATGCCACAAGAGAATTCCTGAATCCCG
ATGAGCGCATGACGTACTTGAATCATGCTGATTACAACCTGAATTCTCCTCTAATTA
GTGATGATATTGACAATTTAATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTG
GGATAGTAAGAACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCC
CATCCCAACATCTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCA
TGATGCCAGTCAAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAA
CATTTGACGTGGTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAATTGAATAC
ATCAAAAAGGAAAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAG
TTTTTGGACTTACACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGC
TCAACTTGGCGAGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAAC
ATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCT
TACTTCAAGAAACTTGATATTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGAT

GTGATTATAGGGAGGATGCAAACGGTGCTATCCATGGTATGTAGAATAGACAACCT
GTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATATCTACAGAATTGGAGATAAAAT
TGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGAACCGATATG
CAACTTGAAGCTGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCC
TCATTTTGAAAATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGG
TATAAGATTCCTCCATGATCAGATAATGAGTGTGAAAACAGTGGATCTCACACTGGT
GATTTATGGATCGTTCAGACATTGGGGTCATCCTTTTATAGATTATTACACTGGACTA
GAAAAATTACATTCCCAAGTAACCATGAAGAAAGATATTGATGTGTCATATGCAAA
AGCACTTGCAAGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCAATGATCATAA
AAAGTGGTTCGTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGT
TAAAGAAAATACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGC
ATGAACTTCCGCTGATTAAATGTTTTGAAATACCCGACTTACTAGACCCATCGATAA
TATACTCTGACAAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAA
TGAATCCGAACACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAA
AGGCTACCAATTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGAT
GATGATCTAATTATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAG
ATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAATACTTTGTAATTACCGAATATTTG
ATAAAGACTCATTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGACGATCTAACT
GCAGTCATTAAAAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAG
GCAATTTGCATAGCCAATCACATTGATTACGAAAAATGGAATAACCACCAAAGGAA
GTTATCAAACGGCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTA
ATCGAGAGAACTCATGAATTTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCA
GACTTGATGCGTGTTCACAACAACACACTGATCAATTCAACCTCCCAACGAGTTTGT
TGGCAAGGACAAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCT
CAATCTACTGGTTATTCAAAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTT
GGCACAAGGTGATAATCAAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAA
ACGTTGTAGAATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTA
TGACTGCAATCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAG
ACTATGCAATCTGCAGATTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTG
ATTAGAGGGTTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCA
AATACCCACTTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGC
TCATTTTGCTGAGAACCCAATCAATGCCATGATACAGTACAATTATTTTGGGACATT
TGCTAGACTCTTGTTGATGATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTT
CAAGATAAGATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTG
GACCCTTCCATTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCT
TCCCAGATCCCGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTC
GAAGTGAGCATCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAG
TTTCGAATAACTCACATAGACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCT
ATGGGAATGAGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGA
ATCAAGACAAACCATCAGGAACCAGGTGATTAAGGATGCAACCATATATTTGTATC
ATGAAGAGGATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGAT
TTTTAAGTGAATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTC
TATTTCAAAATTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAAT
TGGATGATTTGATTGTGAGGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTC
ATTTGAGAAGGGGATCATGTAAAATGTGGACATGTTCAGCTACTCATGCTGACACAT
TAAGATACAAATCCTGGGGCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAG

AAATGTTGGGTCCACAACATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCA
GGGTTCAATTATGTTTCTGTGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCAC
GGGGACCATTGCCTGCTTATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGC
AGCCTTGGGAAAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGA
GATGCTATCTCTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTA
ACATCCACTCTTTAACAGGCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGA
ACAGGGTCTGCCCTTCATAGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCA
TCTCAGAGCACTGCAGCATTGACCAGGTTGATGGCAACTACAGACACCATGAGGGA
TCTGGGAGATCAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATT
ACCACCACTGTTGCAAGAGACGGATGGATCACCAGTTGTACAGATCATTATCATATT
GCCTGTAAGTCCTGTTTGAGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGAC
TACACGCCCCCAGATGTATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTC
GTGGGGACAAGAGATAAAACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAG
CACCTGCAGAGCAATCCTATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACT
TGGCGTATAGAAAATCTACTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACA
AGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAG
CAAGTTGCTGCCAAGTAATACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCC
AACGCAGTGTACGGAGGTTTGATTTACTTGATTGATAAATTGAGTGTATCACCTCCA
TTCCTTTCTCTTACTAGATCAGGACCTATTAGAGACGAATTAGAAACGATTCCCCAC
AAGATCCCAACCTCCTATCCGACAAGCAACCGTGATATGGGGGTGATTGTCAGAAA
TTACTTCAAATACCAATGCCGTCTAATTGAAAAGGGAAAATACAGATCACATTATTC
ACAATTATGGTTATTCTCAGATGTCTTATCCATAGACTTCATTGGACCATTCTCTATT
TCCACCACCCTCTTGCAAATCCTATACAAGCCATTTTTATCTGGGAAAGATAAGAAT
GAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGA
AGACATACATGTGAAATTCTTCACCAAGGACATATTATTGTGTCCAGAGGAAATCAG
ACATGCTTGCAAGTTCGGGATTGCTAAGGATAATAATAAAGACATGAGCTATCCCCC
TTGGGGAAGGGAATCCAGAGGGACAATTACAACAATCCCTGTTTATTATACGACCA
CCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCG
GAATCAGGTTGGGCCAATTACCAACTGGCGCTCATTATAAAATTCGGAGTATATTAC
ATGGAATGGGAATCCATTACAGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGG
ATGACTGCTGCATTACTACGAGAAAATGTGCATAGCAGAGGAATATTCAATAGTCTG
TTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTA
GAAACTTTAGGAGGAGATAAATCGAGATGTGTAAATGGTGAAACATGTTGGGAATA
TCCATCTGACTTATGTGACCCAAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGG
CTTGGGGCTTCAAATTGATTTAATTGTAATGGATATGGAAGTTCGGGATTCTTCTACT
AGCCTGAAAATTGAGACGAATGTTAGAAATTATGTGCACCGGATTTTGGATGAGCA
AGGAGTTTTAATCTACAAGACTTATGGAACATATATTTGTGAGAGCGAAAAGAATG
CAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCGACTTAGTTCAAACAGAATTTA
GTAGTTCTCAAACGTCTGAAGTATATATGGTATGTAAAGGTTTGAAGAAATTAATCG
ATGAACCCAATCCCGATTGGTCTTCCATCAATGAATCCTGGAAAAACCTGTACGCAT
TCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAGAAGGTTAGTACATACTTTACCT
TGACAGGTATTCCCTCCCAATTCATTCCTGATCCTTTTGTAAACATTGAGACTATGCT
ACAAATATTCGGAGTACCCACGGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGA
TAGACCTGCAGATTTATTGACCATTAGCCTTTTTTATATGGCGATTATATCGTATTAT
AACATCAATCATATCAGAGTAGGACCGATACCTCCGAACCCCCCATCAGATGGAAT
TGCACAAAATGTGGGGATCGCTATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGA

GAAAGACATTCCACTATATCAACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGAT
TAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAG
GTGATGGGCTCCCAAAAGATACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACT
GGATCAGATCTCTGGAATTGGTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGA
TCTTGTTCAATCAGCTATGTCGTACAGTGGATAATCATTTGAAATGGTCAAATTTGC
GAAGAAACACAGGAATGATTGAATGGATCAATAGACGAATTTCAAAAGAAGACCG
GTCTATACTGATGTTGAAGAGTGACCTACACGAGGAAAACTCTTGGAGAGATTAAA
AAATCATGAGGAGACTCCAAACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCC
TCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGC
CTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGC
GAATGGGACGCGGCCGATCCGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGC
TGCTGCCACCGTTGAGCAATAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTT
GAGGGGTTTTTTGCTGAAAGGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 111 VSV-M51R-mIL12p40-mIL12p35 Sequence, mouse construct, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSMCQSRYLLF

LATLALLNHLSLARVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHE
DITRDQTSTLKTCLPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLK
MYQTEFQAINAALQNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYR
VKMKLCILLHAFSTRVVTINRVMGYLSSAMEVHDFETDEFNDFNEDDYATREFLNPDER
MTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQ
MHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERW
TDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLG
PTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYR
IGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDR
GIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKA
LASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHE
LPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNW
KEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMF
KGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVM
GQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLR
QKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVS
NNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTN
DQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEV
QDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEH
LKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQ
VIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKK
KYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTV
PHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSIL
QPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGS
ALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVA
RDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQI
YPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLK
GLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELE
TIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSIS
TTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKF
GIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPT
GAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGA
SPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDME
VRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQT
EFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTL
TGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIR
VGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGG
YKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHL
KWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 112 VSV-M51R-hIL12p70, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT

TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC

TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga

gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttcctaa
GCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATG
CTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGC
AATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGA
CTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGC
TGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAA
ATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCT
TGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATG
GATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTT
ACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCC
GCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCA
TTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAA
TCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCA
AAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTG
GGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATG
GACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGT
GCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCT
TCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTA
TGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAA
GAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTT
CTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG
CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT
AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA
TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG
GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC

AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT
GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA

GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 113 VSV-M51R-hIL12p70, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK

KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDI
DNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDAS
QGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKL
TLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDR
NFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMV
EPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLV
IYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKK
WFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSD
KSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIG
LKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLD
SSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKS
LIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRN
TAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLI
NDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTV
AHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYL
DPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRIT
HIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSF
LWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLT
HLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAP
CNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLR
DAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQS
TAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSC
LRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQ
VGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRS
LAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVI

VRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNE
LRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRE
SRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDF
LSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVN
GETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHR
ILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKL
IDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIF
GVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAIT
GISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISD
SLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRIS
KEDRSILMLKSDLHEENSWRD

SEQ ID NO: 114 VSV-M51R-hIL12p40-hIL12p35, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG

AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA

CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagttaaGGCGCGCCTATGAAAAAAACTAACAGATATCatgtgtcca
gcgcgcagcctcctccttgtggctaccctggtcctcctggaccacctcagtttggccagaaacctccccgtggccactccagacccaggaa
tgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccccttgca
cttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatgagagtt
gcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagtagtattt
atgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatcaaaaca
tgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttttataa
aactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttcctaaGCT
AAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATGCTC
AAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAAT
CATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTA
TGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGA
TTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTC
AATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAG
ATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATG
GGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACAT
GAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGG
CTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCA
AAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTT
AAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGT
CAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTC
CTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACC
GAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTAT
CCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAA
ATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACT
TGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAA
TCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTG
ATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGT
GTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCAT
CCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAG
AAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTT

CTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCT
CATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAA
GTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATA
CCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGG
TCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAG
GTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGA
GATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGG
AGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAG
AATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGG
CCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATC
CGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGA
AAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGG
GCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAA
GTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGA
TCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGT
CTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAA
AATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCAC
ACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATC
AAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAG
TTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTAT
GGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTC
ACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTC
AGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCAT
GATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCT
GCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCT
ACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATG
TCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCAT
TCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCA
GTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGT
AGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAA
GACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGA
TTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTAT
GGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTT
GGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTC
CTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATC
CTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGAC
ATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTAT
TGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGA
CTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGA
CGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAA
AACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACT
GATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTC
TAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGAC
CAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATC
TCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGAT
GGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCA

AGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCAC
CAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGA
GATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAA
GACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTT
TAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGA
TGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGAC
AGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAG
GGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGT
CTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATT
GATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAG
ACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGT
GATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAG
GGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATA
GACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCAT
TTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGC
TAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATA
TTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAAT
AATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAAC
AATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAG
AATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCA
TTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAG
TTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATA
GCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCT
CTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTA
AATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGAC
TATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGAT
ATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTAT
GTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATAT
ATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTC
GACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGT
AAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAA
TCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAA
GAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCT
TTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCAT
GCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTT
ATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTC
CGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATA
AGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCA
GTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATAC
AAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGA
CTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGT
TCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAA
TCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATA
GACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAG
GAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAA
AAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTC

TTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAG
GGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAA
GCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACC
CCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATC
CGGATGCGGCCGC

SEQ ID NO: 115 VSV-M51R-hIL12p40-hIL12p35, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSMCPARSLLLVATLVLLDH
LSLARNLPVATPDPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKD
KTSTVEACLPLELTKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVE
FKTMNAKLLMDPKRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLC
ILLHAFRIRAVTIDRVMSYLNASMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNH
ADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWM
GSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKIL
AYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEG
WAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIV
ERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLH

DQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLA
RIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCF
EIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEI
DEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTM
ADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLG
YPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSI
LNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIM
TAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCA
NIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGL
HSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSA
VFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATI
YLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHREL
DDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEML
GPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERES
KVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFST
SRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWIT
SCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGN
WKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGL
MRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIP
TSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQIL
YKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDN
NKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKI
RSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSA
LETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSST
SLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQT
SEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQF
IPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPN
PPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWS
TRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLR
RNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 116 VSV-M51R-L-hIL12p70, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA

TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC

TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATACAACAGATTCTT
CATGTTTGGACCAAATCAACTTGTGATACCATGCTCAAAGAGGCCTCAATTATATTT
GAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCATGGAAGTCCACGATTTTGA
GACCGACGAGTTCAATGATTTCAATGAAGATGACTATGCCACAAGAGAATTCCTGA
ATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATTACAACCTGAATTCTCCTC
TAATTAGTGATGATATTGACAATTTAATCAGGAAATTCAATTCTCTTCCAATTCCCTC
GATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAAG
CCAATCCCATCCCAACATCTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTCTG
ATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGCA
GAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAAT
TGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGTG
TCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGGT
GGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATG
GAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAG
GATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGAAACTTTCTGTTAATGG
TCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCCATGGTATGTAGAATA
GACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATATCTACAGAATTGGA
GATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGAA
CCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCCC
ACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAAT
TGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGTGAAAACAGTGGATCT
CACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCCTTTTATAGATTATTAC
ACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAAAGATATTGATGTGTC
ATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCAA

TGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTAA
AAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGAG
ATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACCCGACTTACTAGACC
CATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAAC
ATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATGT
TGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGGC
TTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGTT
GGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAATACTTTGTAATTACC
GAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGAC
GATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAAG
TCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGAAAAATGGAATAACCAC
CAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTTAT
CCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAAGTCTTATATACTACAAT
GGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGATCAATTCAACCTCCCA
ACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGGAT
GGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAAAATCAGAAACACTGCTG
TCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCACACAGTATAAAACGAAG
AAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAAT
GAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAAA
TGACGATGAGACTATGCAATCTGCAGATTACTTGAATTATGGAAAAATACCGATTTT
CCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTCA
CCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCTC
TCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCATGATACAGTACAATTATT
TTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCTGCTCTTCGTCAATCATT
GTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCAT
GTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTTG
ATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCAT
GTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCGA
GATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGTAGAAGATCCAACCTCTCT
GAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAAAT
GCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGATTAAGGATGCAACCATA
TATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTCTG
TTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACGGG
CTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGTATC
ATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATCCTCTTTGACACATTTAG
GGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGACATGTTCAGCTACTCATG
CTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTATTGGGACAACTGTACCCC
ATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGACTCCTTGTGCACCATGTA
ACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGACGGGATCCATGACGTCT
TTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAAAACATCTGAATCTACAT
CTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTACA
CGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGACT
ATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGACCAAAAGGCAGCATGG
GTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATCTCGGATGAGCCATGG
TGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGATGGCAACTACAGACAC
CATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTCTA

TGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCACCAGTTGTACAGATCA
TTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGAGATCACCCTGGACTC
AAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAAGACATGGAGGAATG
GGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTTTAGAAGGGAATTGG
AAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGATGTATAGGTTTTCTA
TATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGACAGTTCTCTATTTCCT
CTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACGGA
TTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGTCTGGCTCATTTGAA
GAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATTGATAAATTGAGTGT
ATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAGACGAATTAGAAAC
GATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGTGATATGGGGGTGAT
TGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAGGGAAAATACAGAT
CACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATAGACTTCATTGGACC
ATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCATTTTTATCTGGGAAA
GATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCTAAGATCAGGAGA
GGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATATTATTGTGTCCAGA
GGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAATAATAAAGACATGA
GCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAACAATCCCTGTTTATT
ATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGAATCCAAAATCCC
CTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCATTATAAAATTCGG
AGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAGTTGTGGAGACGGC
TCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATAGCAGAGGAATATT
CAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTCTCCTGAGCCCCC
CAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTAAATGGTGAAACAT
GTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGACTATTTCCTCCGAC
TCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGATATGGAAGTTCGGG
ATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTATGTGCACCGGATTT
TGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATATATTTGTGAGAGCG
AAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCGACTTAGTTCAAA
CAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGTAAAGGTTTGAAGA
AATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAATCCTGGAAAAACC
TGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAGAAGGTTAGTACA
TACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCTTTTGTAAACATTG
AGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCATGCGGCTGCCTTAA
AATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTTATATGGCGATTAT
ATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTCCGAACCCCCCATC
AGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATAAGCTTTTGGCTGAG
TTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCAGTTATCCAGCAATC
ATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACAAGCAGAAGTGGA
GTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGACTCCTTGGCCCCAA
TCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGTTCGTCTAAATCCAT
TCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAATCATTTGAAATGGT
CAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATAGACGAATTTCAAAA
GAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAGGAAAACTCTTGGAG
AGATTAAATCCTGCTAGGTATGAAAAAAACTAACAGATATCAGGCGCGCCTGCCAC
Catgtgtcaccagcagttggtcatctcttggttttccctggtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtc

gtagaattggattggtatccggatgcccctggagaaatggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttgga
ccagagcagtgaggtcttaggctctggcaaaaccctgaccatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaagga
ggcgaggttctaagccattcgctcctgctgcttcacaaaaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaa
aataagacctttctaagatgcgaggccaagaattattctggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgt
caaaagcagcagaggctcttctgacccccaaggggtgacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaag
gagtatgagtactcagtggagtgccaggaggacagtgcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttc
acaagctcaagtatgaaaactacaccagcagcttcttcatcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccatta
aagaattctcggcaggtggaggtcagctgggagtaccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtc
cagggcaagagcaagagagaaaagaaagatagagtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattag
cgtgcgggcccaggaccgctactatagctcatcttggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtg
ggcagaaacctccccgtggccactccagacccaggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatg
ctccagaaggccagacaaactctagaattttaccttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtg
gaggcctgtttaccattggaattaaccaagaatgagagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctcca
gaaagacctcttttatgatggccctgtgccttagtagtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagctt
ctgatggatcctaagaggcagatctttctagatcaaaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactg
tgccacaaaaatcctcccttgaagaaccggatttttataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgacta
ttgatagagtgatgagctatctgaatgcttcctaaAAAATCATGAGGAGACTCCAAACTTTAAGTATGAAA
AAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCT
TCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAGG
GGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAAG
CCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACCC
CTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATCC
GGATGCGGCCGC

SEQ ID NO: 117 VSV-M51R-L-hIL12p70, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS

YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDI
DNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDAS
QGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKL
TLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDR
NFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMV
EPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLV
IYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKK
WFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSD
KSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIG
LKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLD
SSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKS
LIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRN
TAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLI
NDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTV
AHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYL
DPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRIT
HIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSF
LWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLT
HLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAP
CNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLR
DAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQS
TAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSC
LRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQ
VGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRS
LAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVI
VRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNE
LRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRE
SRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDF
LSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVN
GETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHR
ILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKL
IDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIF
GVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAIT
GISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISD
SLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRIS
KEDRSILMLKSDLHEENSWRDMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDW
YPDAPGEMVVLTCDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGE
VLSHSLLLLHKKEDGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFS
VKSSRGSSDPQGVTCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDA
VHKLKYENYTSSFFIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFC
VQVQGKSKREKKDRVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGV
GVPGVGRNLPVATPDPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDIT
KDKTSTVEACLPLELTKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQ

VEFKTMNAKLLMDPKRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIK
LCILLHAFRIRAVTIDRVMSYLNAS

SEQ ID NO: 118 VSV-M51R-hIL12p70.P2A.L, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT

CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc

tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG
AAGCGGAGCTACTAACTTCAGCCTGCTGAAGCAGGCTGGAGACGTGGAGGAGAACC
CTGGACCAATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAG
ATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATC
ATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAG
GAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGT
TCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAA
ATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTT
TTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCA
TCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGAC
TCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACAT
TAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAG
GCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGC
TTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAA
TGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACG
GTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCC
CTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCT
TATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCA
AGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACT
TCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG
CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT
AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA

TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG
GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT
GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG

ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 119 VSV-M51R-hIL12p70.P2A.L, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI

TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGSGATNFSLLKQAGDVEENPGPMEVHDFETDEFNDFNEDDYATREFLNP
DERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIP
TSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKE
RWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVP
SLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLL
NIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGA
KIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSY
AKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDK
WHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKAT
NWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFV
PMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVF
RVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLE
GLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQ
MVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTC
VTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSL
YEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHAR
SEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTI

RNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNS
FKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIG
TTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSES
TSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKR
TGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITT
TVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEI
KQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGF
LKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDE
LETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFS
ISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACK
FGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPT
GAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGA
SPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDME
VRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQT
EFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTL
TGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIR
VGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGG
YKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHL
KWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 120 VSV-M51R-hIL12p70TM, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT

AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG

AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG
AGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCctgctcccatcctgggccatta
ccttaatctcagtaaatggaatttttgtgatatgctgcctgacctactgctttgccccaagatgcagagagagaaggaggaatgagagattgag
aagggaaagtgtacgccctgtataaGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATC
AACTTGTGATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATG
AAAAAAACTAACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATG
ATTTCAATGAAGATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATG
ACGTACTTGAATCATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTG
ACAATTTAATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGA
ACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACAT
CTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTC
AAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTG
GTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGA
AAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTA
CACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCG
AGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGAT
TAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAA

ACTTGATATTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGG
GAGGATGCAAACGGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGC
AAGACATCTTCTCCCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGC
AGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGC
TGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAA
ATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCC
TCCATGATCAGATAATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGAT
CGTTCAGACATTGGGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTAC
ATTCCCAAGTAACCATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCA
AGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTC
GTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAAT
ACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCG
CTGATTAAATGTTTTGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGAC
AAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAA
CACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAA
TTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAAT
TATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCT
AATGTCTTGGAAATTGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCA
TTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAA
AAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCAT
AGCCAATCACATTGATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACG
GCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAA
CTCATGAATTTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGC
GTGTTCACAACAACACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGAC
AAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTG
GTTATTCAAAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGG
TGATAATCAAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAG
AATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAA
TCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAA
TCTGCAGATTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGG
TTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCAC
TTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCT
GAGAACCCAATCAATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTC
TTGTTGATGATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAG
ATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCA
TTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCC
CGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCA
TCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAA
CTCACATAGACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATG
AGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACA
AACCATCAGGAACCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGG
ATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGA
ATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAA
TTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTT
GATTGTGAGGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAG
GGGATCATGTAAAATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAA

ATCCTGGGGCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGG
TCCACAACATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTA
TGTTTCTGTGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATT
GCCTGCTTATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGA
AAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCT
CTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTC
TTTAACAGGCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTG
CCCTTCATAGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCA
CTGCAGCATTGACCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGAT
CAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTG
TTGCAAGAGACGGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGT
CCTGTTTGAGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCC
CAGATGTATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAA
GAGATAAAACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGA
GCAATCCTATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAG
AAAATCTACTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATT
AGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTG
CCAAGTAATACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGT
ACGGAGGTTTGATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCT
TACTAGATCAGGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAA
CCTCCTATCCGACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAAT
ACCAATGCCGTCTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGT
TATTCTCAGATGTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCT
CTTGCAAATCCTATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGA
GCTGGCAAATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGT
GAAATTCTTCACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAA
GTTCGGGATTGCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGG
AATCCAGAGGGACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAA
AGATGCTAGAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGG
GCCAATTACCAACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAA
TCCATTACAGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCAT
TACTACGAGAAAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAG
GGTCAGTCATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAG
GAGATAAATCGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTAT
GTGACCCAAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAA
TTGATTTAATTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTG
AGACGAATGTTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCT
ACAAGACTTATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTT
GGTCCCATGTTCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACG
TCTGAAGTATATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCC
GATTGGTCTTCCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAA
CAGGAATTTGCCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCC
TCCCAATTCATTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAG
TACCCACGGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATT
TATTGACCATTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATAT
CAGAGTAGGACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGG

GGATCGCTATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCAC
TATATCAACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTG
TTTCAGTAAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCA
AAAGATACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTG
GAATTGGTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAG
CTATGTCGTACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGG
AATGATTGAATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTT
GAAGAGTGACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGAC
TCCAAACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATT
TTTTATCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCC
GGCTGGGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGC
CGATCCGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTG
AGCAATAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGC
TGAAAGGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 121 VSV-M51R-hIL12p70TM, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP

DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGGGGSGGGGSGGGGSLLPSWAITLISVNGIFVICCLTYCFAPRCRERRRNE
RLRRESVRPVMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDD
IDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDAS
QGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKL
TLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDR
NFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMV
EPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLV
IYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKK
WFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSD
KSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIG
LKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLD
SSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKS
LIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRN
TAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLI
NDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTV
AHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYL
DPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRIT
HIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSF
LWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLT
HLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAP
CNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLR
DAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQS
TAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSC
LRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQ
VGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRS
LAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVI
VRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNE
LRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRE
SRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDF
LSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVN
GETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHR
ILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKL
IDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIF
GVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAIT
GISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISD
SLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRIS
KEDRSILMLKSDLHEENSWRD

SEQ ID NO: 122 VSV-M51R-hIL12p70_hCD4, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG

GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG

GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc

ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG
AGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCaagaaagtggtgctgggcaa
aaaaggggatacagtggaactgacctgtacagcttcccagaagaagagcatacaattccactggaaaaactccaaccagataaagattctg
ggaaatcagggctccttcttaactaaaggtccatccaagctgaatgatcgcgctgactcaagaagaagcctttgggaccaaggaaacttccc
cctgatcatcaagaatcttaagatagaagactcagatacttacatctgtgaagtggaggaccagaaggaggaggtgcaattgctagtgttcg
gattgactgccaactctgacacccacctgcttcaggggcagagcctgaccctgaccttggagagccccccctggtagtagcccctcagtgca
atgtaggagtccaaggggtaaaaacatacaggggggggaagaccctctccgtgtctcagctggagctccaggatagtggcacctggacatg
cactgtcttgcagaaccagaagaaggtggagttcaaaatagacatcgtggtgcttgctttccagaaggcctccagcatagtctataagaaag
agggggaacaggtggagttctccttcccactcgcctttacagttgaaaagctgacgggcagtggcgagctgtggtggcaggcggagagg
gcttcctcctccaagtcttggatcacctttgacctgaagaacaaggaagtgtctgtaaaatgggttacccaggaccctaagctccagatgggc
aagaagctcccgctccacctcaccctgccccaggccttgcctcagtatgctggctctggaaacctcaccctggcccttgaagcgaaaacag
gaaagttgcatcaggaagtgaacctggtggtgatgagagccactcagctccagaaaaatttgacctgtgaggtgtggggacccacctcccc
taagctgatgctgagcttgaaactggagaacaaggaggcaaaggtctcgaagcgggagaaggcggtgtgggtgctgaaccctgaggcg
gggatgtggcagtgtctgctgagtgactcgggacaggtcctgctggaatccaacatcaaggttctgcccacatggtccaccccggtgcagc
caatggccctgattgtgctgggggcgtcgccggcctcctgcttttcattgggctaggcatcttcttctgtgtcaggtgccggcaccgaaggc
gccaagcagagcggatgtctcagatcaagagactcctcagtgagaagaagacctgccagtgccctcaccggtttcagaagacatgtagcc
ccatttgaGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATA
CCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTA
ACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAA
GATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAAT
CATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCA
GGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAG
TTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATA
AATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTT
TTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTC
ATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGA
CTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACA
TTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAA
GGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAG
CTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTA
ATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAAC
GGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTC
CCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTC
TTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGC
AAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGAC
TTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGAT
AATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTG
GGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAAC
CATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCG
GATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTT
GCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGC
TGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTT

TGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAAT
GAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAG
TAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTC
TTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAG
GAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAAT
TGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTT
TAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATT
CCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTG
ATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGA
GTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTG
AGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAAC
ACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACT
GGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAG
AGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTT
ATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGC
TCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC

CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT
GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT

AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 123 VSV-M51R-hIL12p70_hCD4, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGGGGSGGGGSGGGGSKKVVLGKKGDTVELTCTASQKKSIQFHWKNSNQ
IKILGNQGSFLTKGPSKLNDRADSRRSLWDQGNFPLIIKNLKIEDSDTYICEVEDQKEEVQ
LLVFGLTANSDTHLLQGQSLTLTLESPPGSSPSVQCRSPRGKNIQGGKTLSVSQLELQDS
GTWTCTVLQNQKKVEFKIDIVVLAFQKASSIVYKKEGEQVEFSFPLAFTVEKLTGSGEL
WWQAERASSSKSWITFDLKNKEVSVKWVTQDPKLQMGKKLPLHLTLPQALPQYAGSG
NLTLALEAKTGKLHQEVNLVVMRATQLQKNLTCEVWGPTSPKLMLSLKLENKEAKVS
KREKAVWVLNPEAGMWQCLLSDSGQVLLESNIKVLPTWSTPVQPMALIVLGGVAGLLL
FIGLGIFFCVRCRHRRRQAERMSQIKRLLSEKKTCQCPHRFQKTCSPIMEVHDFETDEFN
DFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNW

DGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVE
TFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKG
KVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSM
VCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVP
QFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGL
EKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVK
ENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPN
TPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMS
WKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHID
YEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLI
NSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQY
KTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPI
FRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGT
FARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFP
DPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSP
ANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFL
GVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCS
ATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHD
VFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILS
NIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDL
GDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPD
VSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKST
HAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYL
IDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYR
SHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWED
IHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKM
LEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLREN
VHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWD
YFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICE
SEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNL
YAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDR
PADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQ
QCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRN
QVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEEN
SWRD

SEQ ID NO: 124 VSV-M51R-hIL12p70_hCD46, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA

TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG

AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG

AGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCtgtgaggagccaccaacattt
gaagctatggagctcattggtaaaccaaaaccctactatgagattggtgaacgagtagattataagtgtaaaaaaggatacttctatatacctc
ctcttgccacccatactatttgtgatcggaatcatacatggctacctgtctcagatgacgcctgttatagagaaacatgtccatatatacgggatc
ctttaaatggccaagcagtccctgcaaatgggacttacgagtttggttatcagatgcactttatttgtaatgagggttattacttaattggtgaaga
aattctatattgtgaacttaaaggatcagtagcaatttggagcggtaagcccccaatatgtgaaaaggttttgtgtacaccacctccaaaaataa
aaaatggaaaacacacctttagtgaagtagaagtatttgagtatcttgatgcagtaacttatagttgtgatcctgcacctggaccagatccatttt
cacttattggagagagcacgatttattgtggtgacaattcagtgtggagtcgtgctgctccagagtgtaaagtggtcaaatgtcgatttccagta
gtcgaaaatggaaaacagatatcaggatttggaaaaaaattttactacaaagcaacagttatgtttgaatgcgataaggtttttacctcgatgg
cagcgacacaattgtctgtgacagtaacagtacttgggatcccccagttccaaagtgtcttaaaggtcctaggcctacttacaagcctccagtc
tcaaattatccaggatatcctaaacctgaggaaggaatacttgacagtttggatgtttgggtcattgctgtgattgttattgccatagttgttggag
ttgcagtaatttgtgttgtcccgtacagatatcttcaaaggaggaagaagaaaggcacatacctaactgatgagacccacagagaagtaaaat
ttacttctctctgaGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTG
ATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAA
CTAACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAAT
GAAGATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTT
GAATCATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTA
ATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGAT
GGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATG
CATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTAT
AGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGAC
CTTCATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGA
CTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTT
GACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTT
CAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTC
CCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATA
TTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGC
AAACGGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCT
TCTCCCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATT
TTTCTTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAAT
TAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCA
AGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATC
AGATAATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGAC
ATTGGGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAG
TAACCATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAG
CTCGGATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAG
ACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCA
CAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAAT
GTTTTGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATT
CAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCC
CTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAA
TTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTT
AAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTG
GAAATTGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCC
TATGTTTAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTT
AGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCA
CATTGATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGT

TCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAAT
TTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACA
ACAACACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGT
GGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCA
AAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATC
AAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAG
GGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATA
GGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGA
TTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGAC
CAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAA
TATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCC
AATCAATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGAT
GATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGG
CTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGA
GTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAG
AAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGG
AGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATA
GACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGC
GAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCA
GGAACCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTC
AGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAAT
CAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTA
CTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGA
GGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCAT
GTAAAATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGG
GCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAAC
ATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTG
TGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTT
ATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAA
GCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTG
TTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAG
GCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCAT
AGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCA
TTGACCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTT
CGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGA
GACGGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTG
AGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGT
ATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAA
AACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCT
ATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTA
CTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCG
AGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAAT
ACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTT
TGATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATC
AGGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCC
GACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCC

GTCTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAG
ATGTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAAT
CCTATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAA
ATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCT
TCACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGA
TTGCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGA
GGGACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTA
GAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTA
CCAACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTAC
AGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGA
GAAAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTC
ATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAA
ATCGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCC
AAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTT
AATTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAA
TGTTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGAC
TTATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCAT
GTTCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGT
ATATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTC
TTCCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATT
TGCCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATT
CATTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCAC
GGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGAC
CATTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTA
GGACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGC
TATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCA
ACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGT
AAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGAT
ACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTG
GTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGT
CGTACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGAT
TGAATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGA
GTGACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAA
ACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTA
TCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTG
GGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATC
CGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAA
TAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAA
GGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 125 VSV-M51R-hIL12p70_hCD46, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP

AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGGGGSGGGGSGGGGSCEEPPTFEAMELIGKPKPYYEIGERVDYKCKKGY
FYIPPLATHTICDRNHTWLPVSDDACYRETCPYIRDPLNGQAVPANGTYEFGYQMHFIC
NEGYYLIGEEILYCELKGSVAIWSGKPPICEKVLCTPPPKIKNGKHTFSEVEVFEYLDAVT
YSCDPAPGPDPFSLIGESTIYCGDNSVWSRAAPECKVVKCRFPVVENGKQISGFGKKFYY
KATVMFECDKGFYLDGSDTIVCDSNSTWDPPVPKCLKGPRPTYKPPVSNYPGYPKPEEG
ILDSLDVWVIAVIVIAIVVGVAVICVVPYRYLQRRKKKGTYLTDETHREVKFTSLMEVH
DFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSM
WDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAE
ITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNL
ARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRM
QTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARE
SRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFID
YYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPF
KSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHV
RMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRF
FSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICI
ANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVH
NNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVI

CTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNY
GKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYN
YFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLI
RAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMG
MSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSG
TFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWT
CSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGI
HDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTI
LSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMR
DLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTP
PDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRK
STHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLI
YLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGK
YRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGW
EDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYP
KMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLR
ENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRT
WDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYI
CESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWK
NLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSS
DRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPL
YQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELV
RNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHE
ENSWRD

SEQ ID NO: 126 VSV-M51R-hIL12p70_CBD1, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT

TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT

CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG
AGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCTGCTCCGGAGAGG
GGCTGCAGATCCCCACCCTCTCCCCTGCACCTGACTGCAGCCAGCCCCTGGACGTGA
TCCTTCTCCTGGATGGCTCCTCCAGTTTCCCAGCTTCTTATTTTGATGAAATGAAGAG
TTTCGCCAAGGCTTTCATTTCAAAAGCCAATATAGGGCCTCGTCTCACTCAGGTGTC
AGTGCTGCAGTATGGAAGCATCACCACCATTGACGTGCCATGGAACGTGGTCCCGG
AGAAAGCCCATTTGCTGAGCCTTGTGGACGTCATGCAGCGGGAGGGAGGCCCCAGC
CAAATCGGGGATGCCTTGGGCTTTGCTGTGCGATACTTGACTTCAGAAATGCATGGT
GCCAGGCCGGGAGCCTCAAAGGCGGTGGTCATCCTGGTCACGGACGTCTCTGTGGA
TTCAGTGGATGCAGCAGCTGATGCCGCCAGGTCCAACAGAGTGACAGTGTTCCCTAT
TGGAATTGGAGATCGCTACGATGCAGCCCAGCTACGGATCTTGGCAGGCCCAGCAG
GCGACTCCAACGTGGTGAAGCTCCAGCGAATCGAAGACCTCCCTACCATGGTCACCT

TGGGCAATTCCTTCCTCCACAAACTGTGCTCTGGATAGGCTAAGCAAATACAACAGA
TTCTTCATGTTTGGACCAAATCAACTTGTGATACCATGCTCAAAGAGGCCTCAATTA
TATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCATGGAAGTCCACGAT
TTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTATGCCACAAGAGAATTC
CTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATTACAACCTGAATTCT
CCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTCAATTCTCTTCCAATTC
CCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTC
AAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATGGGAAGTTGGTTAATGT
CTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGG
CAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCA
ATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAAAATTCTCGCTTATTTG
TGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTAAATGCTGTCTCTGAG
GTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCA
TGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGA
AGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGAAACTTTCTGTTAAT
GGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCCATGGTATGTAGAA
TAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATATCTACAGAATTG
GAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGATTAAAATGGTGG
AACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTC
CCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGATGAAGGGGCAAAA
ATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGTGAAAACAGTGGA
TCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCCTTTTATAGATTAT
TACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAAAGATATTGATGT
GTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCTATTTCAACAGTT
CAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCATGATCATCCCTT
TAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGG
AGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACCCGACTTACTAGA
CCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAA
ACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTAT
GTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGG
GCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAG
TTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAATACTTTGTAATTA
CCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGG
ACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCCGGCCAAGGATTGA
AGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGAAAAATGGAATAAC
CACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGT
TATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAAGTCTTATATACTAC
AATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGATCAATTCAACCTCC
CAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGG
ATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAAAATCAGAAACACTGC
TGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCACACAGTATAAAACGAA
GAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAA
TGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAA
ATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTATGGAAAAATACCGATTT
TCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTC
ACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCT

CTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCATGATACAGTACAATTAT
TTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCTGCTCTTCGTCAATCAT
TGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCA
TGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTT
GATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCA
TGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCG
AGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGTAGAAGATCCAACCTCT
CTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAA
ATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGATTAAGGATGCAACCA
TATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTC
TGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACG
GGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGT
ATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATCCTCTTTGACACATT
TAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGACATGTTCAGCTACTC
ATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTATTGGGACAACTGTAC
CCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGACTCCTTGTGCACCAT
GTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGACGGGATCCATGACG
TCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAAAACATCTGAATCTAC
ATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTA
CACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGA
CTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGACCAAAAGGCAGCATG
GGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATCTCGGATGAGCCATG
GTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGATGGCAACTACAGAC
ACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTC
TATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCACCAGTTGTACAGAT
CATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGAGATCACCCTGGAC
TCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAAGACATGGAGGAA
TGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTTTAGAAGGGAATT
GGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGATGTATAGGTTTTC
TATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGACAGTTCTCTATTTC
CTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACG
GATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGTCTGGCTCATTTG
AAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATTGATAAATTGAGT
GTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAGACGAATTAGAA
ACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGTGATATGGGGGT
GATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAGGGAAAATACA
GATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATAGACTTCATTGG
ACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCATTTTTATCTGGG
AAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCTAAGATCAGG
AGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATATTATTGTGTCC
AGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAATAATAAAGACA
TGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAACAATCCCTGTTT
ATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGAATCCAAAATC
CCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCATTATAAAATTC
GGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAGTTGTGGAGACG
GCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATAGCAGAGGAATA

TTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTCTCCTGAGCCC
CCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTAAATGGTGAAAC
ATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGACTATTTCCTCCG
ACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGATATGGAAGTTCG
GGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTATGTGCACCGGAT
TTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATATATTTGTGAGAG
CGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCGACTTAGTTCA
AACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGTAAAGGTTTGAA
GAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAATCCTGGAAAAA
CCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAGAAGGTTAGTA
CATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCTTTTGTAAACAT
TGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCATGCGGCTGCCTT
AAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTTATATGGCGATT
ATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTCCGAACCCCCCA
TCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATAAGCTTTTGGCTG
AGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCAGTTATCCAGCAA
TCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACAAGCAGAAGTG
GAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGACTCCTTGGCCCC
AATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGTTCGTCTAAATCC
ATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAATCATTTGAAATG
GTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATAGACGAATTTCAA
AAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAGGAAAACTCTTGG
AGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAAAAAAACTTTGAT
CCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCTTCGTGGCCGGC
ATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAGGGGACCGTCCCC
TCGGTAATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAAGCCCGAAAGGAA
GCTGAGTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACCCCTTGGGGCCTCT
AAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATCCGGATGCGGCCG
C

SEQ ID NO: 127 VSV-M51R-hIL12p70_CBD1, human construct, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN

QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGGGGSGGGGSGGGGSCSGEGLQIPTLSPAPDCSQPLDVILLLDGSSSFPAS
YFDEMKSFAKAFISKANIGPRLTQVSVLQYGSITTIDVPWNVVPEKAHLLSLVDVMQRE
GGPSQIGDALGFAVRYLTSEMHGARPGASKAVVILVTDVSVDSVDAAADAARSNRVTV
FPIGIGDRYDAAQLRILAGPAGDSNVVKLQRIEDLPTMVTLGNSFLHKLCSGMEVHDFET
DEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDS
KNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFD
VVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLART
FKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTV
LSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRP
LVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYY
TGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKS
HVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRM
NPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSL
MSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIAN
HIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNN
TLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICT
QYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGK
IPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYF
GTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIR
AFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMG
MSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSG
TFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWT
CSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGI
HDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTI
LSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMR
DLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTP
PDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRK
STHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLI
YLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGK

YRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGW
EDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYP
KMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLR
ENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRT
WDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYI
CESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWK
NLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSS
DRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPL
YQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELV
RNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHE
ENSWRD

SEQ ID NO: 128 VSV-M51R-hIL12p70_CBD2, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG

AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA

CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG
AGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCTGCTCCGGAGAGG
GGCTGCAGATCCCCACCCTCTCCCCTGCACCTGACTGCAGCCAGCCCCTGGACGTGA
TCCTTCTCCTGGATGGCTCCTCCAGTTTCCCAGCTTCTTATTTTGATGAAATGAAGAG
TTTCGCCAAGGCTTTCATTTCAAAAGCCAATATAGGGCCTCGTCTCACTCAGGTGTC
AGTGCTGCAGTATGGAAGCATCACCACCATTGACGTGCCATGGAACGTGGTCCCGG
AGAAAGCCCATTTGCTGAGCCTTGTGGACGTCATGCAGCGGGAGGGAGGCCCCAGC
CAAATCGGGGATGCCTTGGGCTTTGCTGTGCGATACTTGACTTCAGAAATGCATGGT
GCCAGGCCGGGAGCCTCAAAGGCGGTGGTCATCCTGGTCACGGACGTCTCTGTGGA
TTCAGTGGATGCAGCAGCTGATGCCGCCAGGTCCAACAGAGTGACAGTGTTCCCTAT
TGGAATTGGAGATCGCTACGATGCAGCCCAGCTACGGATCTTGGCAGGCCCAGCAG
GCGACTCCAACGTGGTGAAGCTCCAGCGAATCGAAGACCTCCCTACCATGGTCACCT
TGGGCAATTCCTTCCTCCACAAACTGTGCTCTGGAGGAGGGGGAGGCAGTGGAGGC
GGTGGTTCAGGTGGTGGTGGGTCCTGCTCCGGAGAGGGGCTGCAGATCCCCACCCTC
TCCCCTGCACCTGACTGCAGCCAGCCCCTGGACGTGATCCTTCTCCTGGATGGCTCC
TCCAGTTTCCCAGCTTCTTATTTTGATGAAATGAAGAGTTTCGCCAAGGCTTTCATTT
CAAAAGCCAATATAGGGCCTCGTCTCACTCAGGTGTCAGTGCTGCAGTATGGAAGC
ATCACCACCATTGACGTGCCATGGAACGTGGTCCCGGAGAAAGCCCATTTGCTGAG
CCTTGTGGACGTCATGCAGCGGGAGGGAGGCCCCAGCCAAATCGGGGATGCCTTGG
GCTTTGCTGTGCGATACTTGACTTCAGAAATGCATGGTGCCAGGCCGGGAGCCTCAA
AGGCGGTGGTCATCCTGGTCACGGACGTCTCTGTGGATTCAGTGGATGCAGCAGCTG
ATGCCGCCAGGTCCAACAGAGTGACAGTGTTCCCTATTGGAATTGGAGATCGCTACG
ATGCAGCCCAGCTACGGATCTTGGCAGGCCCAGCAGGCGACTCCAACGTGGTGAAG
CTCCAGCGAATCGAAGACCTCCCTACCATGGTCACCTTGGGCAATTCCTTCCTCCAC
AAACTGTGCTCTGGATAGGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAA

TCAACTTGTGATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTA
TGAAAAAAACTAACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAA
TGATTTCAATGAAGATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCAT
GACGTACTTGAATCATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATT
GACAATTTAATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAG
AACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACA
TCTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGT
CAAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGT
GGTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGG
AAAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTT
ACACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGC
GAGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGA
TTAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGA
AACTTGATATTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAG
GGAGGATGCAAACGGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAG
CAAGACATCTTCTCCCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGG
CAGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAG
CTGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAA
AATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATT
CCTCCATGATCAGATAATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGG
ATCGTTCAGACATTGGGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATT
ACATTCCCAAGTAACCATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGC
AAGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTT
CGTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAA
TACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCC
GCTGATTAAATGTTTTGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGA
CAAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGA
ACACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCA
ATTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTA
ATTATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCC
CTAATGTCTTGGAAATTGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACT
CATTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATT
AAAAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGC
ATAGCCAATCACATTGATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAA
CGGCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAG
AACTCATGAATTTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGAT
GCGTGTTCACAACAACACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGG
ACAAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTAC
TGGTTATTCAAAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAA
GGTGATAATCAAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGT
AGAATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGC
AATCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGC
AATCTGCAGATTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAG
GGTTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCC
ACTTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTG
CTGAGAACCCAATCAATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGAC

TCTTGTTGATGATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAA
GATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCC
ATTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGAT
CCCGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAG
CATCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAAT
AACTCACATAGACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAA
TGAGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGA
CAAACCATCAGGAACCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGA
GGATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGT
GAATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAA
AATTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGAT
TTGATTGTGAGGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGA
AGGGGATCATGTAAAATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATAC
AAATCCTGGGGCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTG
GGTCCACAACATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAAT
TATGTTTCTGTGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCA
TTGCCTGCTTATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGG
AAAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATC
TCTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACT
CTTTAACAGGCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCT
GCCCTTCATAGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGC
ACTGCAGCATTGACCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGA
TCAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACT
GTTGCAAGAGACGGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAG
TCCTGTTTGAGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCC
CCAGATGTATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACA
AGAGATAAAACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAG
AGCAATCCTATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATA
GAAAATCTACTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTAT
TAGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCT
GCCAAGTAATACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTG
TACGGAGGTTTGATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTC
TTACTAGATCAGGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCA
ACCTCCTATCCGACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAA
TACCAATGCCGTCTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGG
TTATTCTCAGATGTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCC
TCTTGCAAATCCTATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAG
AGCTGGCAAATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACAT
GTGAAATTCTTCACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGC
AAGTTCGGGATTGCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAG
GGAATCCAGAGGGACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCC
AAAGATGCTAGAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTT
GGGCCAATTACCAACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGG
AATCCATTACAGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGC
ATTACTACGAGAAAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATC
AGGGTCAGTCATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGG

AGGAGATAAATCGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACT
TATGTGACCCAAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTC
AAATTGATTTAATTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAA
TTGAGACGAATGTTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAA
TCTACAAGACTTATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATC
CTTGGTCCCATGTTCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAA
ACGTCTGAAGTATATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAAT
CCCGATTGGTCTTCCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCA
GAACAGGAATTTGCCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATT
CCCTCCCAATTCATTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCG
GAGTACCCACGGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAG
ATTTATTGACCATTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCA
TATCAGAGTAGGACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATG
TGGGGATCGCTATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTC
CACTATATCAACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGG
CTGTTTCAGTAAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTC
CCAAAAGATACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCT
CTGGAATTGGTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAAT
CAGCTATGTCGTACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACA
GGAATGATTGAATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGAT
GTTGAAGAGTGACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGA
GACTCCAAACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTT
ATTTTTTATCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGC
GCCGGCTGGGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGC
GGCCGATCCGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCG
TTGAGCAATAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTT
TGCTGAAAGGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 129 VSV-M51R-hIL12p70_CBD2, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV

TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGGGGSGGGGSGGGGSCSGEGLQIPTLSPAPDCSQPLDVILLLDGSSSFPAS
YFDEMKSFAKAFISKANIGPRLTQVSVLQYGSITTIDVPWNVVPEKAHLLSLVDVMQRE
GGPSQIGDALGFAVRYLTSEMHGARPGASKAVVILVTDVSVDSVDAAADAARSNRVTV
FPIGIGDRYDAAQLRILAGPAGDSNVVKLQRIEDLPTMVTLGNSFLHKLCSGGGGGSGG
GGSGGGGSCSGEGLQIPTLSPAPDCSQPLDVILLLDGSSSFPASYFDEMKSFAKAFISKANI
GPRLTQVSVLQYGSITTIDVPWNVVPEKAHLLSLVDVMQREGGPSQIGDALGFAVRYLT
SEMHGARPGASKAVVILVTDVSVDSVDAAADAARSNRVTVFPIGIGDRYDAAQLRILAG
PAGDSNVVKLQRIEDLPTMVTLGNSFLHKLCSGMEVHDFETDEFNDFNEDDYATREFLN
PDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPI
PTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKK
ERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNICRIRV
PSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLL
NIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGA
KIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSY
AKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDK
WHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKAT
NWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLIKTHFV
PMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVF
RVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLE
GLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQGALNQ
MVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTC
VTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLMMHDPALRQSL
YEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHAR
SEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTI
RNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNS
FKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSWGRTVIG
TTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSES
TSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKR
TGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITT
TVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEI

KQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGF
LKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDE
LETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFS
ISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACK
FGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPT
GAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGA
SPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDME
VRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQT
EFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTL
TGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIR
VGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGG
YKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHL
KWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 130 VSV-M51R-hIL12p70_hIgG4, human construct, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC

TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA

TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt
gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG
AGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCgagtccaaatatggtccccca
tgcccatcatgcccagcacctgagttcctgggggggaccatcagtcttcctgttcccccaaaacccaaggacactctcatgatctcccggac
ccctgaggtcacgtgcgtggtggtggacgtgagccaggaagaccccgaggtccagttcaactggtacgtggatggcgtggaggtgcata
atgccaagacaaagccacgggaggagcagttcaacagcacgtaccgtgtggtcagcgtcctcaccgtcctgcaccaggactggctgaac
ggcaaggagtacaagtgcaaggtctccaacaaaggcctcccgtcctccatcgagaaaaccatctccaaagccaaagggcagccccgag
agccacaggtgtacaccctgcccccatcccaggaggagatgaccaagaaccaggtcagcctgacctgcctggtcaaaggcttctacccca
gcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtgctggactccgacggctcctt
cttcctctacagcaggctaaccgtggacaagagcaggtggcaggaggggaatgtcttctcatgctccgtgatgcatgaggctctgcacaac
cactacacacagaagagcctctccctgtctctgggtaaactgctcccatcctgggccattaccttaatctcagtaaatggaatttttgtgatatgc
tgcctgacctactgctttgccccaagatgcagagagagaaggaggaatgagagattgagaagggaaagtgtacgccctgtatgaGCTA
AGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATGCTCA
AAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATC
ATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTAT
GCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGAT
TACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTC
AATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAG
ATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATG
GGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACAT
GAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGG
CTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCA
AAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTT
AAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGT

CAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTC
CTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACC
GAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTAT
CCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAA
ATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACT
TGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAA
TCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTG
ATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGT
GTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCAT
CCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAG
AAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTT
CTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCT
CATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAA
GTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATA
CCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGG
TCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAG
GTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGA
GATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGG
AGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAG
AATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGG
CCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATC
CGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGA
AAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGG
GCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAA
GTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGA
TCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGT
CTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAA
AATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCAC
ACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATC
AAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAG
TTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTAT
GGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTC
ACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTC
AGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCAT
GATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCT
GCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCT
ACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATG
TCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCAT
TCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCA
GTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGT
AGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAA
GACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGA
TTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTAT
GGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTT
GGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTC
CTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATC

CTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGAC
ATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTAT
TGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGA
CTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGA
CGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAA
AACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACT
GATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTC
TAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGAC
CAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATC
TCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGAT
GGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCA
AGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCAC
CAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGA
GATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAA
GACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTT
TAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGA
TGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGAC
AGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAG
GGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGT
CTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATT
GATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAG
ACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGT
GATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAG
GGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATA
GACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCAT
TTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGC
TAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATA
TTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAAT
AATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAAC
AATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAG
AATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCA
TTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAG
TTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATA
GCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCT
CTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTA
AATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGAC
TATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGAT
ATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTAT
GTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATAT
ATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTC
GACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGT
AAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAA
TCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAA
GAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCT
TTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCAT
GCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTT

ATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTC
CGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATA
AGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCA
GTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATAC
AAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGA
CTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGT
TCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAA
TCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATA
GACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAG
GAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAA
AAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTC
TTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAG
GGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAA
GCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACC
CCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATC
CGGATGCGGCCGC

SEQ ID NO: 131 VSV-M51R-hIL12p70_hIgG4, human construct, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF

FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGGGGSGGGGSGGGGSESKYGPPCPSCPAPEFLGGPSVFLFPPKPKDTLMIS
RTPEVTCVVVDVSQEDPEVQFNWYVDGVEVHNAKTKPREEQFNSTYRVVSVLTVLHQ
DWLNGKEYKCKVSNKGLPSSIEKTISKAKGQPREPQVYTLPPSQEEMTKNQVSLTCLVK
GFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSRLTVDKSRWQEGNVFSCSVMH
EALHNHYTQKSLSLSLGKLLPSWAITLISVNGIFVICCLTYCFAPRCRERRRNERLRRESV
RPVMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRK
FNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFL
HEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNA
VSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLM
VKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICN
LKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSF
RHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNG
DLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMN
RSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKER
ELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQG
LKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNG
RPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKV
LAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDET
MQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAE
NPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGG
VSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLV
EDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINP
LFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKL
HLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSG
FNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISW
FVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALT
RLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIE
EITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCI
GFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLK
RPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYF
KYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELA
NLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTI
TTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCG
DGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETC
WEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDE
QGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEP
NPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVP
TGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGIS
FWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLA
PIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKED
RSILMLKSDLHEENSWRD

SEQ ID NO: 132 VSV-M51R-hIL12p70_hIgG1 sequence, human construct, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT

GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctg
gtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaat
ggtggtcctcacctgtgacaccctgaagaagatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctg
accatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaa
aaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattc
tggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggt

gacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagt
gcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttctt
catcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagta
ccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagataga
gtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatctt
ggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagaccca
ggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttaccc
ttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatga
gagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagta
gtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatca
aaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttt
tataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttccGG
AGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCgagtccaaatcttgtgacaaa
actcacacatgcccaccgtgcccagcacctgaactcctgggggggaccgtcagtcttcctcttcccccaaaacccaaggacaccctcatga
tctcccggacccctgaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactggtacgtggacggcgtgg
aggtgcataatgccaagacaaagccacgggaggagcagtacaacagcacgtaccgtgtggtcagcgtcctcaccgtcctgcaccaggac
tggctgaatggcaaggagtacaagtgcaaggtctccaacaaagccctcccagcccccatcgagaaaaccatctccaaagccaaagggca
gccccgagagccacaggtgtacaccctgcccccatcccgggatgagctgaccaagaaccaggtcagcctgacctgcctggtcaaaggct
tctatcccagcgacatcgccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtgctggactccgac
ggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggggaacgtcttctcatgctccgtgatgcatgaggctct
gcacaaccactacacgcagaagagcctctccctgtctccgggtaaactgctcccatcctgggccattaccttaatctcagtaaatggaatttt
gtgatatgctgcctgacctactgctttgccccaagatgcagagagagaaggaggaatgagagattgagaagggaaagtgtacgccctgtat
gaGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCAT
GCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAG
CAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATG
ACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATG
CTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGA
AATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTC
TTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAAT
GGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTT
TACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATC
CGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTC
ATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTA
ATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGC
AAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTT
GGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAAT
GGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGG
TGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCC
TTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTT
ATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCA
AGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACT
TCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG

CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT
AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA
TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG
GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC

GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT
GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG

GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 133 VSV-M51R-hIL12p70_hIgG1 Sequence, human construct, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLT
CDTPEEDGITWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKE
DGIWSTDILKDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGV
TCGAATLSAERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSF
FIRDIIKPDPPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKD
RVFTDKTSATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATP
DPGMFPCLHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLEL
TKNESCLNSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDP
KRQIFLDQNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTID
RVMSYLNASGGGGSGGGGSGGGGSESKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDT
LMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTV
LHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTLPPSRDELTKNQVSLTC
LVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCS
VMHEALHNHYTQKSLSLSPGKLLPSWAITLISVNGIFVICCLTYCFAPRCRERRRNERLR
RESVRPVMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDN

LIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQG
YSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLI
LNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNF
LLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEP
ICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIY
GSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWF
VNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSH
SMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKG
KERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSS
GQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIY
YNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTA
VKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLIND
DETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAH
FAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPS
IGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDK
LVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSI
NPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLG
KLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNT
SGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAI
SWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTA
ALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLR
PIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVG
RCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLA
HLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVR
NYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRE
LANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRG
TITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSC
GDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGET
CWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILD
EQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDE
PNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGV
PTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGI
SFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSL
APIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKE
DRSILMLKSDLHEENSWRD

SEQ ID NO: 134 VSV-M51R-mIL12p70-mCD4-d1-4TM, mouse, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA

TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG

AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC
TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA
GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG
ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG
TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT

GTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCG
GAGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCAAGACGCTGGTG
CTGGGGAAGGAAGGGGAATCAGCAGAACTGCCCTGCGAGAGTTCCCAGAAGAAGA
TCACAGTCTTCACCTGGAAGTTCTCTGACCAGAGGAAGATTCTGGGGCAGCATGGCA
AAGGTGTATTAATTAGAGGAGGTTCGCCTTCGCAGTTTGATCGTTTTGATTCCAAAA
AAGGGGCATGGGAGAAAGGATCGTTTCCTCTCATCATCAATAAACTTAAGATGGAA
GACTCTCAGACTTATATCTGTGAGCTGGAGAACAGGAAAGAGGAGGTGGAGTTGTG
GGTGTTCAAAGTGACCTTCAGTCCGGGTACCAGCCTGTTGCAAGGGCAGAGCCTGAC
CCTGACCTTGGATAGCAACTCTAAGGTCTCTAACCCCTTGACAGAGTGCAAACACAA
AAAGGGTAAAGTTGTCAGTGGTTCCAAAGTTCTCTCCATGTCCAACCTAAGGGTTCA
GGACAGCGACTTCTGGAACTGCACCGTGACCCTGGACCAGAAAAAGAACTGGTTCG
GCATGACACTCTCAGTGCTGGGTTTTCAGAGCACAGCTATCACGGCCTATAAGAGTG
AGGGAGAGTCAGCGGAGTTCTCCTTCCCACTCAACTTTGCAGAGGAAAACGGGTGG
GGAGAGCTGATGTGGAAGGCAGAGAAGGATTCTTTCTTCCAGCCCTGGATCTCCTTC
TCCATAAAGAACAAAGAGGTGTCCGTACAAAAGTCCACCAAAGACCTCAAGCTCCA
GCTGAAGGAAACGCTCCCACTCACCCTCAAGATACCCCAGGTCTCGCTTCAGTTTGC
TGGTTCTGGCAACCTGACTCTGACTCTGGACAAAGGGACACTGCATCAGGAAGTGA
ACCTGGTGGTGATGAAAGTGGCTCAGCTCAACAATACTTTGACCTGTGAGGTGATGG
GACCTACCTCTCCCAAGATGAGACTGACCCTGAAGCAGGAGAACCAGGAGGCCAGG
GTCTCTGAGGAGCAGAAAGTAGTTCAAGTGGTGGCCCCTGAGACAGGGCTGTGGCA
GTGTCTACTGAGTGAAGGTGATAAGGTCAAGATGGACTCCAGGATCCAGGTTTTATC
CAGAGGGGTGAACCAGACAGTGGGAGGGGGAGGCAGTGGAGGCGGTGGTTCAGGT
GGTGGTGGGTCCAACACACTTGTGCTCTTTGGGGCAGGATTCGGCGCAGTAATAACA
GTCGTCGTCATCGTTGTCATCATCAAATGCTTCTGTAAGCACAGAAGCTGTTTCAGA
AGAAGAAATGAGGCAAGCAGAGAAACAAACAACAGCCTTACCTTCGGGCCTGAAG
AAGCATTAGCTGAACAGACCGTCTTCCTTTAGGCTAAGCAAATACAACAGATTCTTC
ATGTTTGGACCAAATCAACTTGTGATACCATGCTCAAAGAGGCCTCAATTATATTTG
AGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCATGGAAGTCCACGATTTTGAG
ACCGACGAGTTCAATGATTTCAATGAAGATGACTATGCCACAAGAGAATTCCTGAAT
CCCGATGAGCGCATGACGTACTTGAATCATGCTGATTACAACCTGAATTCTCCTCTA
ATTAGTGATGATATTGACAATTTAATCAGGAAATTCAATTCTCTTCCAATTCCCTCGA
TGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAAGCCA
ATCCCATCCCAACATCTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTCTGATA
ATCATGATGCCAGTCAAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGCAGAA
ATAACATTTGACGTGGTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAATTGA
ATACATCAAAAAGGAAAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGTGTCA

AAAGTTTTTGGACTTACACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGGTGGA
ATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATGGAA
CGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAGGAT
GGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGAAACTTTCTGTTAATGGTCA
AAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCCATGGTATGTAGAATAGAC
AACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATATCTACAGAATTGGAGAT
AAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGAACCG
ATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCCCACA
ATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAATTGA
CCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGTGAAAACAGTGGATCTCAC
ACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCCTTTTATAGATTATTACACT
GGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAAAGATATTGATGTGTCATA
TGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCAATGA
TCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTAAAAG
TCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGAGATAA
ATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACCCGACTTACTAGACCCATC
GATAATATACTCTGACAAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAACATGT
CCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATGTTGGA
CACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGGCTTAG
ATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGTTGGCA
GGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAATACTTTGTAATTACCGAAT
ATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGACGATC
TAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAAGTCAT
ATGAGGCAATTTGCATAGCCAATCACATTGATTACGAAAAATGGAATAACCACCAA
AGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTTATCCA
TCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAAGTCTTATATACTACAATGGA
AGACCAGACTTGATGCGTGTTCACAACAACACACTGATCAATTCAACCTCCCAACGA
GTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGGATGGAG
TATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAAAATCAGAAACACTGCTGTCAA
AGTCTTGGCACAAGGTGATAATCAAGTTATTTGCACACAGTATAAAACGAAGAAAT
CGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAATGAGA
AAATTATGACTGCAATCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAAATGAC
GATGAGACTATGCAATCTGCAGATTACTTGAATTATGGAAAAATACCGATTTTCCGT
GGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTCACCAA
TGACCAAATACCCACTTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCTCTCAC
CGTAGCTCATTTTGCTGAGAACCCAATCAATGCCATGATACAGTACAATTATTTTGG
GACATTTGCTAGACTCTTGTTGATGATGCATGATCCTGCTCTTCGTCAATCATTGTAT
GAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCATGTTG
TATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTA
GAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCATGTAC
ATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCGAGATA
GCCAAGTTTCGAATAACTCACATAGACAAGCTAGTAGAAGATCCAACCTCTCTGAAC
ATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAAATGCTT
AATCGAATCAAGACAAACCATCAGGAACCAGGTGATTAAGGATGCAACCATATATT
TGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTCTGTTCC
CTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACGGGCTCA

TCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGTATCATA
GGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATCCTCTTTGACACATTTAGGGA
AACTTCATTTGAGAAGGGGATCATGTAAAATGTGGACATGTTCAGCTACTCATGCTG
ACACATTAAGATACAAATCCTGGGGCCGTACAGTTATTGGGACAACTGTACCCCATC
CATTAGAAATGTTGGGTCCACAACATCGAAAAGAGACTCCTTGTGCACCATGTAACA
CATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGACGGGATCCATGACGTCTTTAG
TTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAAAACATCTGAATCTACATCTATT
TTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTACACGTCT
TAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGACTATACTT
TCTAACATCCACTCTTTAACAGGCGAAGAATGGACCAAAAGGCAGCATGGGTTCAA
AAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATCTCGGATGAGCCATGGTGGGTT
CGCATCTCAGAGCACTGCAGCATTGACCAGGTTGATGGCAACTACAGACACCATGA
GGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTCTATGCTC
AAATTACCACCACTGTTGCAAGAGACGGATGGATCACCAGTTGTACAGATCATTATC
ATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGAGATCACCCTGGACTCAAGTA
TGGACTACACGCCCCCAGATGTATCCCATGTGCTGAAGACATGGAGGAATGGGGAA
GGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTTTAGAAGGGAATTGGAAGAA
TTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGATGTATAGGTTTTCTATATGG
AGACTTGGCGTATAGAAAATCTACTCATGCCGAGGACAGTTCTCTATTTCCTCTATCT
ATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACGGATTAATG
AGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGTCTGGCTCATTTGAAGAGGCC
GGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATTGATAAATTGAGTGTATCACC
TCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAGACGAATTAGAAACGATTCC
CCACAAGATCCCAACCTCCTATCCGACAAGCAACCGTGATATGGGGGTGATTGTCA
GAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAGGGAAAATACAGATCACAT
TATTCACAATTATGGTTATTCTCAGATGTCTTATCCATAGACTTCATTGGACCATTCT
CTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCATTTTTATCTGGGAAAGATAA
GAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCTAAGATCAGGAGAGGGGT
GGGAAGACATACATGTGAAATTCTTCACCAAGGACATATTATTGTGTCCAGAGGAA
ATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAATAATAAAGACATGAGCTA
TCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAACAATCCCTGTTTATTATAC
GACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGAATCCAAAATCCCCTGCT
GTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCATTATAAAATTCGGAGTAT
ATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAGTTGTGGAGACGGCTCCGG
AGGGATGACTGCTGCATTACTACGAGAAAATGTGCATAGCAGAGGAATATTCAATA
GTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTCTCCTGAGCCCCCCAGTG
CCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTAAATGGTGAAACATGTTGG
GAATATCCATCTGACTTATGTGACCCAAGGACTTGGGACTATTTCCTCCGACTCAAA
GCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGATATGGAAGTTCGGGATTCT
TCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTATGTGCACCGGATTTTGGAT
GAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATATATTTGTGAGAGCGAAAA
GAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCGACTTAGTTCAAACAGA
ATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGTAAAGGTTTGAAGAAATT
AATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAATCCTGGAAAAACCTGTA
CGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAGAAGGTTAGTACATACT
TTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCTTTTGTAAACATTGAGAC

TATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCATGCGGCTGCCTTAAAATC
ATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTTATATGGCGATTATATCG
TATTATAACATCAATCATATCAGAGTAGGACCGATACCTCCGAACCCCCCATCAGAT
GGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATAAGCTTTTGGCTGAGTTTG
ATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCAGTTATCCAGCAATCATTC
CCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACAAGCAGAAGTGGAGTAC
TAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGACTCCTTGGCCCCAATCGG
GAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGTTCGTCTAAATCCATTCAA
TGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAATCATTTGAAATGGTCAAA
TTTGCGAAGAAACACAGGAATGATTGAATGGATCAATAGACGAATTTCAAAAGAAG
ACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAGGAAAACTCTTGGAGAGAT
TAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAAAAAAACTTTGATCCTTAA
GACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTC
CCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAGGGGACCGTCCCCTCGGTA
ATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAAGCCCGAAAGGAAGCTGA
GTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACCCCTTGGGGCCTCTAAACG
GGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 135 VSV-M51R-mIL12p70-mCD4-d1-4TM, mouse, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG

MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV
GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAGGGGSGGGGSGGGGSKTLVLGKEGESAELPCESSQKKITVFTW
KFSDQRKILGQHGKGVLIRGGSPSQFDRFDSKKGAWEKGSFPLIINKLKMEDSQTYICEL
ENRKEEVELWVFKVTFSPGTSLLQGQSLTLTLDSNSKVSNPLTECKHKKGKVVSGSKVL
SMSNLRVQDSDFWNCTVTLDQKKNWFGMTLSVLGFQSTAITAYKSEGESAEFSFPLNFA
EENGWGELMWKAEKDSFFQPWISFSIKNKEVSVQKSTKDLKLQLKETLPLTLKIPQVSL
QFAGSGNLTLTLDKGTLHQEVNLVVMKVAQLNNTLTCEVMGPTSPKMRLTLKQENQE
ARVSEEQKVVQVVAPETGLWQCLLSEGDKVKMDSRIQVLSRGVNQTVGGGGSGGGGS
GGGGSNTLVLFGAGFGAVITVVVIVVIIKCFCKHRSCFRRRNEASRETNNSLTFGPEEAL
AEQTVFLMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDN
LIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQG
YSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLI
LNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNF
LLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEP
ICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIY
GSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWF
VNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSH
SMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKG
KERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSS
GQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIY
YNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTA
VKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLIND
DETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAH
FAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPS
IGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDK
LVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSI
NPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLG
KLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNT
SGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAI
SWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTA
ALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLR
PIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVG
RCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLA
HLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVR
NYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRE
LANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRG
TITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSC
GDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGET
CWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILD
EQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDE
PNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGV

PTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGI
SFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSL
APIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKE
DRSILMLKSDLHEENSWRD

SEQ ID NO: 136 VSV-M51R-mIL12p70-H4-2TM, mouse, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT

CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG

TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC
TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA
GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG
ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG
TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT
GTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCG
CTGAGGCCGCAGCCAAGGAGGCTGCTGCCAAGGAGGCCGCAGCAAAGGAAGCTGC
TGCCAAGGCCCTGGAGGCAGAAGCCGCTGCAAAAGAAGCAGCCGCCAAAGAGGCG
GCGGCCAAAGAAGCGGCAGCTAAGGCTAACACACTTGTGCTCTTTGGGGCAGGATT
CGGCGCAGTAATAACAGTCGTCGTCATCGTTGTCATCATCAAATGCTTCTGTAAGCA
CAGAAGCTGTTTCAGAAGAAGAAATGAGGCAAGCAGAGAAACAAACAACAGCCTT
ACCTTCGGGCCTGAAGAAGCATTAGCTGAACAGACCGTCTTCCTTTAGGCTAAGCAA
ATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATGCTCAAAGAG
GCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCATGGA
AGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTATGCCAC
AAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATTACAA
CCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTCAATTCT
CTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGATGTTA
ACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATGGGAAGT
TGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATGAAGTG
GACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGCTGGGG
CAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAAAATTC
TCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTAAATGC
TGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTCAGAA
GAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTACTT
TTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGAAACT

TTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCCATGG
TATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATATCT
ACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGATTA
AAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATCAAGG
CCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGATGAAG
GGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGTGAAA
ACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCCTTTT
ATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAAAGA
TATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCTATTT
CAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCATGAT
CATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGTTCAA
GATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACCCGAC
TTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTCAGAG
GTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGGTGTTG
CAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAGATTGA
TGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGAGAGGG
AACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAATACT
TTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGCCTGAC
AATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCCGGCCA
AGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGAAAAAT
GGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGGGCCAG
TTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAAGTCTTA
TATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGATCAATT
CAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGTCTACGG
CAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAAAATCAG
AAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCACACAGTA
TAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATCAAATGG
TTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAGTTAGGA
CTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTATGGAAAA
ATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTCACGAGT
GACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTCAGTTTC
CACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCATGATACA
GTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCTGCTCTT
CGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCTACTTTC
AAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATGTCTTTG
TCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCATTCTGG
AGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCAGTATTT
GGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGTAGAAGA
TCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAAGACTGA
GGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGATTAAGG
ATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTATGGTCAA
TAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTTGGGAGT
CGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTCCTTTAA
GAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATCCTCTTT
GACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGACATGTTC
AGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTATTGGGAC

AACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGACTCCTTG
TGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGACGGGAT
CCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAAAACATC
TGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACTGATTAA
AAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTCTAAACT
AGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGACCAAAAG
GCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATCTCGGAT
GAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGATGGCAA
CTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCAAGCAA
CGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCACCAGTT
GTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGAGATCA
CCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAAGACAT
GGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTTTAGAA
GGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGATGTAT
AGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGACAGTTC
TCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGGGTTG
CTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGTCTGGC
TCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATTGATAA
ATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAGACGAA
TTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGTGATATG
GGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAGGGAAA
ATACAGATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATAGACTTC
ATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCATTTTTAT
CTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCTAAGAT
CAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATATTATTG
TGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAATAATAA
AGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAACAATCC
CTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGAATCC
AAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCATTATA
AAATTCGGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAGTTGTG
GAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATAGCAGA
GGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTCTCCT
GAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTAAATGG
TGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGACTATTT
CCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGATATGGA
AGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTATGTGCA
CCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATATATTTG
TGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCGACT
TAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGTAAAG
GTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAATCCT
GGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAGAAG
GTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCTTTTG
TAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCATGCGG
CTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTTATAT
GGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTCCGAA
CCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATAAGCTT

TTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCAGTTAT
CCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACAAGC
AGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGACTCC
TTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGTTCGT
CTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAATCAT
TTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATAGACG
AATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAGGAAA
ACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAAAAAA
ACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCTTCG
TGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAGGGG
ACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAAGCC
CGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACCCCTT
GGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATCCGGA
TGCGGCCGC

SEQ ID NO: 137 VSV-M51R-mIL12p70-H4-2TM, mouse, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV

GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAAEAAAKEAAAKEAAAKEAAAKALEAEAAAKEAAAKEAAAKEAAAKE
AAAKANTLVLFGAGFGAVITVVVIVVIIKCFCKHRSCFRRRNEASRETNNSLTFGPEEAL
AEQTVFLMEVHDFETDEFNDFNEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDN
LIRKFNSLPIPSMWDSKNWDGVLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQG
YSFLHEVDKEAEITFDVVETFIRGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLI
LNAVSEVELLNLARTFKGKVRRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNF
LLMVKDVIIGRMQTVLSMVCRIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEP
ICNLKLMKLARESRPLVPQFPHFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIY
GSFRHWGHPFIDYYTGLEKLHSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWF
VNGDLLPHDHPFKSHVKENTWPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSH
SMNRSEVLKHVRMNPNTPIPSKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKG
KERELKLAGRFFSLMSWKLREYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSS
GQGLKSYEAICIANHIDYEKWNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIY
YNGRPDLMRVHNNTLINSTSQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTA
VKVLAQGDNQVICTQYKTKKSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLIND
DETMQSADYLNYGKIPIFRGVIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAH
FAENPINAMIQYNYFGTFARLLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPS
IGGVSGMSLSRFLIRAFPDPVTESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDK
LVEDPTSLNIAMGMSPANLLKTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSI
NPLFPRFLSEFKSGTFLGVADGLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLG
KLHLRRGSCKMWTCSATHADTLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNT
SGFNYVSVHCPDGIHDVFSSRGPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAI
SWFVEPDSKLAMTILSNIHSLTGEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTA
ALTRLMATTDTMRDLGDQNFDFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLR
PIEEITLDSSMDYTPPDVSHVLKTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVG
RCIGFLYGDLAYRKSTHAEDSSLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLA
HLKRPANAVYGGLIYLIDKLSVSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVR
NYFKYQCRLIEKGKYRSHYSQLWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRE
LANLSSLLRSGEGWEDIHVKFFTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRG
TITTIPVYYTTTPYPKMLEMPPRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSC
GDGSGGMTAALLRENVHSRGIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGET
CWEYPSDLCDPRTWDYFLRLKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILD
EQGVLIYKTYGTYICESEKNAVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDE
PNPDWSSINESWKNLYAFQSSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGV
PTGVSHAAALKSSDRPADLLTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGI
SFWLSLMEKDIPLYQQCLAVIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSL
APIGNWIRSLELVRNQVRLNPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKE
DRSILMLKSDLHEENSWRD

SEQ ID NO: 138 VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM, mouse, nucleic acid sequence

TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG

GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG

TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC

TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA
GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG
ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG
TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT
GTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCG
CAGAGGCTGCAGCCAAAGAAGCTGCTGCCAAGGAGGCCGCCGCCAAGGCCAACAC
ACTTGTGCTCTTTGGGGCAGGATTCGGCGCAGTAATAACAGTCGTCGTCATCGTTGT
CATCATCAAATGCTTCTGTAAGCACAGAAGCTGTTTCAGAAGAAGAAATGAGGCAA
GCAGAGAAACAAACAACAGCCTTACCTTCGGGCCTGAAGAAGCATTAGCTGAACAG
ACCGTCTTCCTTTAGGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCA
ACTTGTGATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGA
AAAAAACTAACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGA
TTTCAATGAAGATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGAC
GTACTTGAATCATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGAC
AATTTAATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAAC
TGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCT
CAGATGCATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAA
GGGTATAGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGT
GGAGACCTTCATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAA
GATGGACTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACA
CAAGTTGACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAG
GACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTA
GGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAAC
TTGATATTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGA
GGATGCAAACGGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAA
GACATCTTCTCCCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAG
GGAAATTTTTCTTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTG
ATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAAT
CATATCAAGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTC
CATGATCAGATAATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCG
TTCAGACATTGGGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACAT
TCCCAAGTAACCATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAG
TGATTTAGCTCGGATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTG

AATGGAGACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACA
TGGCCCACAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTG
ATTAAATGTTTTGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAA
AGTCATTCAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACAC
TCCTATCCCTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTG
GAAAGAATTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTAT
TGGTCTTAAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAAT
GTCTTGGAAATTGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTT
CGTCCCTATGTTTAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAA
GATGTTAGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGC
CAATCACATTGATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCC
CAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTC
ATGAATTTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTG
TTCACAACAACACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAG
AGGGTGGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTT
ATTCAAAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGA
TAATCAAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAAT
TACAGGGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCA
AAATAGGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCT
GCAGATTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTA
GAGACCAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTG
TGCTAATATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAG
AACCCAATCAATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTG
TTGATGATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATA
CCGGGCTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTG
GAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCG
TAACAGAAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATC
TGAAGGAGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACT
CACATAGACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAG
TCCAGCGAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAA
CCATCAGGAACCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGAT
CGGCTCAGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAAT
TCAAATCAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATT
CTCGTACTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGA
TTGTGAGGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGG
GATCATGTAAAATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAAT
CCTGGGGCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTC
CACAACATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATG
TTTCTGTGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGC
CTGCTTATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAA
GGGAAAGCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTT
GGTTTGTTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTT
AACAGGCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCC
CTTCATAGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACT
GCAGCATTGACCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCA
GAATTTCGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTT

GCAAGAGACGGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCC
TGTTTGAGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCC
AGATGTATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAG
AGATAAAACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAG
CAATCCTATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGA
AAATCTACTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTA
GAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGC
CAAGTAATACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTA
CGGAGGTTTGATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTT
ACTAGATCAGGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAAC
CTCCTATCCGACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATA
CCAATGCCGTCTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTT
ATTCTCAGATGTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTC
TTGCAAATCCTATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAG
CTGGCAAATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTG
AAATTCTTCACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAG
TTCGGGATTGCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGA
ATCCAGAGGGACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAA
GATGCTAGAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGG
CCAATTACCAACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAAT
CCATTACAGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATT
ACTACGAGAAAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAG
GGTCAGTCATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAG
GAGATAAATCGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTAT
GTGACCCAAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAA
TTGATTTAATTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTG
AGACGAATGTTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCT
ACAAGACTTATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTT
GGTCCCATGTTCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACG
TCTGAAGTATATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCC
GATTGGTCTTCCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAA
CAGGAATTTGCCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCC
TCCCAATTCATTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAG
TACCCACGGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATT
TATTGACCATTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATAT
CAGAGTAGGACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGG
GGATCGCTATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCAC
TATATCAACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTG
TTTCAGTAAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCA
AAAGATACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTG
GAATTGGTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAG
CTATGTCGTACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGG
AATGATTGAATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTT
GAAGAGTGACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGAC
TCCAAACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATT
TTTTATCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCC

GGCTGGGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGC
CGATCCGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTG
AGCAATAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGC
TGAAAGGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 139 VSV-M51R-mIL12p70-AEAAKEAAAKEAAAKATM, mouse, amino acid sequence

MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV
GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAAEAAAKEAAAKEAAAKANTLVLFGAGFGAVITVVVIVVIIKCFC
KHRSCFRRRNEASRETNNSLTFGPEEALAEQTVFLMCPQKLTISWFAIVLLVSPLMAMW
ELEKDVYVVEVDWTPDAPGETVNLTCDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFL
DAGQYTCHKGGETLSHSHLLLHKKENGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWL
VQRNMDLKFNIKSSSSSPDSRAVTCGMASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAE
ETLPIELALEARQQNKYENYSTSFFIRDIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTP

HSYFSLKFFVRIQRKKEKMKETEEGCNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYN
SSCSKWACVPCRVRSVPGVGVPGVGRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKL
KHYSCTAEDIDHEDITRDQTSTLKTCLPLELHKNESCLATRETSSTTRGSCLPPQKTSLM
MTLCLGSIYEDLKMYQTEFQAINAALQNHNHQQIILDKGMLVAIDELMQSLNHNGETLR
QKPPVGEADPYRVKMKLCILLHAFSTRVVTINRVMGYLSSAMEVHDFETDEFNDFNED
DYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLE
MLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGW
GNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSS
HGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDN
LFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFEN
HIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQV
TMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPT
AAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKK
VLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYF
VITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNN
HQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRV
CWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRN
VVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGL
ETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLM
MHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESL
SFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTE
VKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLI
SLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTL
RYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGP
LPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGE
EWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFL
FQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKT
WRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSL
FPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVS
PPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQL
WLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFF
TKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPP
RIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRG
IFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRL
KAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNA
VTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSS
EQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTI
SLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQ
QSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPF
NEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 140 VSV-M51R-mIL12p70-D265A_mIgG1TM, mouse, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG

GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC
GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG

GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT
ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC
TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA
GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG

ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG
TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT
GTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCG
GGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCGTGCCCAGGGATTGT
GGTTGTAAGCCTTGCATATGTACAGTCCCAGAAGTATCATCTGTCTTCATCTTCCCCC
CAAAGCCCAAGGATGTGCTCACCATTACTCTGACTCCTAAGGTCACGTGTGTTGTGG
TAGCCATCAGCAAGGATGATCCCGAGGTCCAGTTCAGCTGGTTTGTAGATGATGTGG
AGGTGCACACAGCTCAGACGCAACCCCGGGAGGAGCAGTTCAACAGCACTTTCCGC
TCAGTCAGTGAACTTCCCATCATGCACCAGGACTGGCTCAATGGCAAGGAGTTCAAA
TGCAGGGTCAACAGTGCAGCTTTCCCTGCCCCCATCGAGAAAACCATCTCCAAAACC
AAAGGCAGACCGAAGGCTCCACAGGTGTACACCATTCCACCTCCCAAGGAGCAGAT
GGCCAAGGATAAAGTCAGTCTGACCTGCATGATAACAGACTTCTTCCCTGAAGACAT
TACTGTGGAGTGGCAGTGGAATGGGCAGCCAGCGGAGAACTACAAGAACACTCAGC
CCATCATGGACACAGATGGCTCTTACTTCGTCTACAGCAAGCTCAATGTGCAGAAGA
GCAACTGGGAGGCAGGAAATACTTTCACCTGCTCTGTGTTACATGAGGGCCTGCACA
ACCACCATACTGAGAAGAGCCTCTCCCACTCTCCTGGTAAAGGAGGGGGAGGCAGT
GGAGGCGGTGGTTCAGGTGGTGGTGGGTCCAACACACTTGTGCTCTTTGGGGCAGG
ATTCGGCGCAGTAATAACAGTCGTCGTCATCGTTGTCATCATCAAATGCTTCTGTAA
GCACAGAAGCTGTTTCAGAAGAAGAAATGAGGCAAGCAGAGAAACAAACAACAGC
CTTACCTTCGGGCCTGAAGAAGCATTAGCTGAACAGACCGTCTTCCTTTAGGCTAAG
CAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATGCTCAAA
GAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCAT
GGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTATGC
CACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATTA
CAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTCAA
TTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGAT
GTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATGGG
AAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATGA
AGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGCT
GGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAAA
ATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTAA
ATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTCA
GAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTA

CTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGAA
ACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCCA
TGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATA
TCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGA
TTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATCA
AGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGATG
AAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGTG
AAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCCT
TTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAAA
GATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCTA
TTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCAT
GATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGTT
CAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACCC
GACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTCA
GAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGGT
GTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAGA
TTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGAG
AGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAA
TACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGCC
TGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCCG
GCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGAA
AAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGGG
CCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAAG
TCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGAT
CAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGTC
TACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAAA
ATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCACA
CAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATCA
AATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAGT
TAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTATG
GAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTCA
CGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTCA
GTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCATG
ATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCTG
CTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCTA
CTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATGT
CTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCATT
CTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCAG
TATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGTA
GAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAAG
ACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGAT
TAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTATG
GTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTTG
GGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTCC
TTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATCC
TCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGACA

TGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTATT
GGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGAC
TCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGAC
GGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAAA
ACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACTG
ATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTCT
AAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGACC
AAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATCT
CGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGATG
GCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCAA
GCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCACC
AGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGAG
ATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAAG
ACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTTT
AGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGAT
GTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGACA
GTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGG
GTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGTC
TGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATTG
ATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAGA
CGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGTG
ATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAGG
GAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATAG
ACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCATT
TTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCT
AAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATAT
TATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAATA
ATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAACA
ATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGA
ATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCAT
TATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAGT
TGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATAG
CAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTC
TCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTAA
ATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGACT
ATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGATA
TGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTATG
TGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATATA
TTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCG
ACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGTA
AAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAAT
CCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAG
AAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCTT
TTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCATG
CGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTTA
TATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTCC

GAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATAA
GCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCAG
TTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACA
AGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGAC
TCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGTT
CGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAAT
CATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATAG
ACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAGG
AAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAAA
AAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCT
TCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGGGCAACATTCCGAGG
GGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCCGGCTGCTAACAAAG
CCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAATAACTAGCATAACCC
CTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAGGAGGAACTATATCC
GGATGCGGCCGC

SEQ ID NO: 141 VSV-M51R-mIL12p70-D265A_mIgG1TM, mouse, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN
SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG

CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV
GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAGGGSGGGGSGGGGSVPRDCGCKPCICTVPEVSSVFIFPPKPKDVL
TITLTPKVTCVVVAISKDDPEVQFSWFVDDVEVHTAQTQPREEQFNSTFRSVSELPIMHQ
DWLNGKEFKCRVNSAAFPAPIEKTISKTKGRPKAPQVYTIPPPKEQMAKDKVSLTCMIT
DFFPEDITVEWQWNGQPAENYKNTQPIMDTDGSYFVYSKLNVQKSNWEAGNTFTCSVL
HEGLHNHHTEKSLSHSPGKGGGGSGGGGSGGGGSNTLVLFGAGFGAVITVVVIVVIIKC
FCKHRSCFRRRNEASRETNNSLTFGPEEALAEQTVFLMCPQKLTISWFAIVLLVSPLMAM
WELEKDVYVVEVDWTPDAPGETVNLTCDTPEEDDITWTSDQRHGVIGSGKTLTITVKEF
LDAGQYTCHKGGETLSHSHLLLHKKENGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSW
LVQRNMDLKFNIKSSSSSPDSRAVTCGMASLSAEKVTLDQRDYEKYSVSCQEDVTCPTA
EETLPIELALEARQQNKYENYSTSFFIRDIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWS
TPHSYFSLKFFVRIQRKKEKMKETEEGCNQKGAFLVEKTSTEVQCKGGNVCVQAQDRY
YNSSCSKWACVPCRVRSVPGVGVPGVGRVIPVSGPARCLSQSRNLLKTTDDMVKTARE
KLKHYSCTAEDIDHEDITRDQTSTLKTCLPLELHKNESCLATRETSSTTRGSCLPPQKTSL
MMTLCLGSIYEDLKMYQTEFQAINAALQNHNHQQIILDKGMLVAIDELMQSLNHNGET
LRQKPPVGEADPYRVKMKLCILLHAFSTRVVTINRVMGYLSSAMEVHDFETDEFNDFNE
DDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVL
EMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRG
WGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRS
SHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRID
NLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFE
NHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQ
VTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWP
TAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSK
KVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLRE
YFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWN
NHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQR
VCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSR
NVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRG
LETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLL
MMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTES
LSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKT
EVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGL
ISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTL
RYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGP
LPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGE
EWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFL
FQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKT
WRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSL
FPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVS
PPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQL
WLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFF
TKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPP

RIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRG
IFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRL
KAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNA
VTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSS
EQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTI
SLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQ
QSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPF
NEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 142 VSV-M51R-mIL12p70-mIgG2aTM, mouse, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC
TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGGATAATCTCACAAAAGTTCGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAG
GCGGTAGGAGAGATAGATGAGATCGAAGCACAACGAGCTGAAAAGTCCAATTATGA
GTTGTTCCAAGAGGATGGAGTGGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGC
AGATGATTCTGACACAGAATCTGAACCAGAAATTGAAGACAATCAAGGCTTGTATG
CACCAGATCCAGAAGCAGAGCAAGTTGAAGGCTTTATACAGGGGCCTTTAGATGAC
TATGCAGATGAGGAAGTGGATGTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTT
GAATCTGACGAGCATGGAAAGACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGG
AGAGCAGAAATCCCAGTGGCTTTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAAT
ACTGGAATCTGGCAGAGTGCACATTTGAAGCATCGGGAGAAGGGGTCATTATGAAG
GAGCGCCAGATAACTCCGGATGTATATAAGGTCACTCCAGTGATGAACACACATCC

GTCCCAATCAGAAGCAGTATCAGATGTTTGGTCTCTCTCAAAGACATCCATGACTTT
CCAACCCAAGAAAGCAAGTCTTCAGCCTCTCACCATATCCTTGGATGAATTGTTCTC
ATCTAGAGGAGAGTTCATCTCTGTCGGAGGTGACGGACGAATGTCTCATAAAGAGG
CCATCCTGCTCGGCCTGAGATACAAAAAGTTGTACAATCAGGCGAGAGTCAAATATT
CTCTGTAGACTATGAAAAAAAGTAACAGATATCACGATCTAAGTGTTACCCGGGTCC
ATTCATCATGAGTTCCTTAAAGAAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAAT
CTAAGAAATTAGGGATCGCACCACCCCCTTATGAAGAGGACACTAGCATGGAGTAT
GCTCCGAGCGCTCCAATTGACAAATCCTATTTTGGAGTTGACGAGCGAGACACCTAT
GATCCGAATCAATTAAGATATGAGAAATTCTTCTTTACAGTGAAAATGACGGTTAGA
TCTAATCGTCCGTTCAGAACATACTCAGATGTGGCAGCCGCTGTATCCCATTGGGAT
CACATGTACATCGGAATGGCAGGGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTG
GGTTCTTCTAATCTAAAGGCCACTCCAGCGGTATTGGCAGATCAAGGTCAACCAGAG
TATCACGCTCACTGCGAAGGCAGGGCTTATTTGCCACATAGGATGGGGAAGACCCCT
CCCATGCTCAATGTACCAGAGCACTTCAGAAGACCATTCAATATAGGTCTTTACAAG
GGAACGATTGAGCTCACAATGACCATCTACGATGATGAGTCACTGGAAGCAGCTCC
TATGATCTGGGATCATTTCAATTCTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTA
ATGTTTGGCCTGATTGTCGAGAAAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATC
GGCCACTTCAAATGAGCTAGTCTAACTGCATGCTTCTGAACAATCCCCGGTTTACTC
AGTCTCCCCTAATTCCAGCCTCTCGAACAACTAATATCCTGTCTTTTCTATCCCTATG
AAAAAAACTAACAGAGATCGATCTGTTTACGCGTCACTATGAAGTGCCTTTTGTACT
TAGCCTTTTTATTCATTGGGGTGAATTGCAAGTTCACCATAGTTTTTCCACACAACCA
AAAAGGAAACTGGAAAAATGTTCCTTCTAATTACCATTATTGCCCGTCAAGCTCAGA
TTTAAATTGGCATAATGACTTAATAGGCACAGCCTTACAAGTCAAAATGCCCAAGAG
TCACAAGGCTATTCAAGCAGACGGTTGGATGTGTCATGCTTCCAAATGGGTCACTAC
TTGTGATTTCCGCTGGTATGGACCGAAGTATATAACACATTCCATCCGATCCTTCACT
CCATCTGTAGAACAATGCAAGGAAAGCATTGAACAAACGAAACAAGGAACTTGGCT
GAATCCAGGCTTCCCTCCTCAAAGTTGTGGATATGCAACTGTGACGGATGCCGAAGC
AGTGATTGTCCAGGTGACTCCTCACCATGTGCTGGTTGATGAATACACAGGAGAATG
GGTTGATTCACAGTTCATCAACGGAAAATGCAGCAATTACATATGCCCCACTGTCCA
TAACTCTACAACCTGGCATTCTGACTATAAGGTCAAAGGGCTATGTGATTCTAACCT
CATTTCCATGGACATCACCTTCTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAA
GGAGGGCACAGGGTTCAGAAGTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCT
GCAAAATGCAATACTGCAAGCATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCG
AGATGGCTGATAAGGATCTCTTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGT
CAAGTATCTCTGCTCCATCTCAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTG
AGAGGATCTTGGATTATTCCCTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGT
CTTCCAATCTCTCCAGTGGATCTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGT
CCTGCTTTCACCATAATCAATGGTACCCTAAAATACTTTGAGACCAGATACATCAGA
GTCGATATTGCTGCTCCAATCCTCTCAAGAATGGTCGGAATGATCAGTGGAACTACC
ACAGAAAGGGAACTGTGGGATGACTGGGCACCATATGAAGACGTGGAAATTGGACC
CAATGGAGTTCTGAGGACCAGTTCAGGATATAAGTTTCCTTTATACATGATTGGACA
TGGTATGTTGGACTCCGATCTTCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCT
CACATTCAAGACGCTGCTTCGCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATA
CTGGGCTATCCAAAAATCCAATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAA
GCTCTATTGCCTCTTTTTTCTTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTC
CGAGTTGGTATCCATCTTTGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTAT

ACAGACATAGAGATGAACCGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATG
AAAAAAACTAACAGATATCAGCTCAGCTGCCACCATGTGTCCTCAGAAGCTAACCA
TCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGA
GAAAGACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAG
TGAACCTCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAG
AGACATGGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTA
GATGCTGGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCT
GCTGCTCCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAA
AAACAAGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTC
ATGGCTGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTT
CCCCTGACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCA
CACTGGACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACC
TGCCCAACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCA
GAATAAATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAG
ACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGC
TGGGAGTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTG
TTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCA
GAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGA
ATGTCTGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCAT
GTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTC
TCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGAC
ATGGTGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACAT
CGATCATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCAC
TGGAACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACA
AGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGT
AGCATCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGC
ACTTCAGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCAT
CGATGAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCC
TGTGGGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACG
CCTTCAGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCG
GGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCGAGCCCAGAGGGCCC
ACAATCAAGCCCTGTCCTCCATGCAAATGCCCAGCACCTAACCTCTTGGGTGGACCA
TCCGTCTTCATCTTCCCTCCAAAGATCAAGGATGTACTCATGATCTCCCTGAGCCCCA
TAGTCACATGTGTGGTGGTGGATGTGAGCGAGGATGACCCAGATGTCCAGATCAGC
TGGTTTGTGAACAACGTGGAAGTACACACAGCTCAGACACAAACCCATAGAGAGGA
TTACAACAGTACTCTCCGGGTGGTCAGTGCCCTCCCCATCCAGCACCAGGACTGGAT
GAGTGGCAAGGAGTTCAAATGCAAGGTCAACAACAAAGACCTCCCAGCGCCCATCG
AGAGAACCATCTCAAAACCCAAAGGGTCAGTAAGAGCTCCACAGGTATATGTCTTG
CCTCCACCAGAAGAAGAGATGACTAAGAAACAGGTCACTCTGACCTGCATGGTCAC
AGACTTCATGCCTGAAGACATTTACGTGGAGTGGACCAACAACGGGAAAACAGAGC
TAAACTACAAGAACACTGAACCAGTCCTGGACTCTGATGGTTCTTACTTCATGTACA
GCAAGCTGAGAGTGGAAAAGAAGAACTGGGTGGAAAGAAATAGCTACTCCTGTTCA
GTGGTCCACGAGGGTCTGCACAATCACCACACGACTAAGAGCTTCTCCCGGACTCCG
GGTAAAGGAGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCAACA
CACTTGTGCTCTTTGGGGCAGGATTCGGCGCAGTAATAACAGTCGTCGTCATCGTTG
TCATCATCAAATGCTTCTGTAAGCACAGAAGCTGTTTCAGAAGAAGAAATGAGGCA

AGCAGAGAAACAAACAACAGCCTTACCTTCGGGCCTGAAGAAGCATTAGCTGAACA
GACCGTCTTCCTTTAGGCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATC
AACTTGTGATACCATGCTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATG
AAAAAAACTAACAGCAATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATG
ATTTCAATGAAGATGACTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATG
ACGTACTTGAATCATGCTGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTG
ACAATTTAATCAGGAAATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGA
ACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACAT
CTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTC
AAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTG
GTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGA
AAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTA
CACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCG
AGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGAT
TAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAA
ACTTGATATTCTAATGGACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGG
GAGGATGCAAACGGTGCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGC
AAGACATCTTCTCCCTTCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGC
AGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGC
TGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAA
ATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCC
TCCATGATCAGATAATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGAT
CGTTCAGACATTGGGGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTAC
ATTCCCAAGTAACCATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCA
AGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTC
GTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAAT
ACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCG
CTGATTAAATGTTTTGAAATACCCGACTTACTAGACCCATCGATAATATACTCTGAC
AAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAA
CACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAA
TTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAAT
TATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCT
AATGTCTTGGAAATTGCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCA
TTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAA
AAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCAT
AGCCAATCACATTGATTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACG
GCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAA
CTCATGAATTTTTTGAGAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGC
GTGTTCACAACAACACACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGAC
AAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTG
GTTATTCAAAGAGAGGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGG
TGATAATCAAGTTATTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAG
AATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAA
TCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAA
TCTGCAGATTACTTGAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGG
TTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCAC

TTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCT
GAGAACCCAATCAATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTC
TTGTTGATGATGCATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAG
ATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCA
TTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCC
CGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCA
TCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAA
CTCACATAGACAAGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATG
AGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACA
AACCATCAGGAACCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGG
ATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGA
ATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAA
TTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTT
GATTGTGAGGAGTGAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAG
GGGATCATGTAAAATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAA
ATCCTGGGGCCGTACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGG
TCCACAACATCGAAAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTA
TGTTTCTGTGCATTGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATT
GCCTGCTTATCTAGGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGA
AAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCT
CTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTC
TTTAACAGGCGAAGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTG
CCCTTCATAGGTTTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCA
CTGCAGCATTGACCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGAT
CAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTG
TTGCAAGAGACGGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGT
CCTGTTTGAGACCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCC
CAGATGTATCCCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAA
GAGATAAAACAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGA
GCAATCCTATCAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAG
AAAATCTACTCATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATT
AGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTG
CCAAGTAATACACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGT
ACGGAGGTTTGATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCT
TACTAGATCAGGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAA
CCTCCTATCCGACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAAT
ACCAATGCCGTCTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGT
TATTCTCAGATGTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCT
CTTGCAAATCCTATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGA
GCTGGCAAATCTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGT
GAAATTCTTCACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAA
GTTCGGGATTGCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGG
AATCCAGAGGGACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAA
AGATGCTAGAGATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGG
GCCAATTACCAACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAA
TCCATTACAGGGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCAT

TACTACGAGAAAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAG
GGTCAGTCATGCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAG
GAGATAAATCGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTAT
GTGACCCAAGGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAA
TTGATTTAATTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTG
AGACGAATGTTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCT
ACAAGACTTATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTT
GGTCCCATGTTCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACG
TCTGAAGTATATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCC
GATTGGTCTTCCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAA
CAGGAATTTGCCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCC
TCCCAATTCATTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAG
TACCCACGGGTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATT
TATTGACCATTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATAT
CAGAGTAGGACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGG
GGATCGCTATAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCAC
TATATCAACAGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTG
TTTCAGTAAAAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCA
AAAGATACCCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTG
GAATTGGTCCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAG
CTATGTCGTACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGG
AATGATTGAATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTT
GAAGAGTGACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGAC
TCCAAACTTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATT
TTTTATCTGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCC
GGCTGGGCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGC
CGATCCGGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTG
AGCAATAACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGC
TGAAAGGAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 143 VSV-M51R-mIL12p70-mIgG2aTM, mouse, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG
VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGEIDEIEAQRAEKSNYELFQEDGVE
EHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQVEGFIQGPLDDYADEEVDVVFTS
DWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTIKAVVQSAKYWNLAECTFEASGE
GVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSLSKTSMTFQPKKASLQPLTISLDEL
FSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQARVKYSLMSSLKKILGLKGKGKKSK
KLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTYDPNQLRYEKFFFTVKMTVRSNRPF
RTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLGSSNLKATPAVLADQGQPEYHAHC
EGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTIELTMTIYDDESLEAAPMIWDHFN

SSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKMKCLLYLAFLFIGVNCKFTIVFPHN
QKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGWMCHASKWV
TTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGYATVTDAEAV
IVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVKGLCDSNLISM
DITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPSGVWFEMAD
KDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRAGLPISPVDLS
YLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERELWDDWAPY
EDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDAASQLPDDESL
FFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKLKHTKKRQIYT
DIEMNRLGKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLT
CDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKE
NGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCG
MASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIR
DIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEG
CNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGV
GRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTC
LPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAAL
QNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFST
RVVTINRVMGYLSSAGGGSGGGGSGGGGSEPRGPTIKPCPPCKCPAPNLLGGPSVFIFPP
KIKDVLMISLSPIVTCVVVDVSEDDPDVQISWFVNNVEVHTAQTQTHREDYNSTLRVVS
ALPIQHQDWMSGKEFKCKVNNKDLPAPIERTISKPKGSVRAPQVYVLPPPEEEMTKKQV
TLTCMVTDFMPEDIYVEWTNNGKTELNYKNTEPVLDSDGSYFMYSKLRVEKKNWVER
NSYSCSVVHEGLHNHHTTKSFSRTPGKGGGGSGGGGSGGGGSNTLVLFGAGFGAVITV
VVIVVIIKCFCKHRSCFRRRNEASRETNNSLTFGPEEALAEQTVFLMEVHDFETDEFNDF
NEDDYATREFLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDG
VLEMLTSCQANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFI
RGWGNKPIEYIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKV
RRSSHGTNICRIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVC
RIDNLFSEQDIFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFP
HFENHIKTSVDEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKL
HSQVTMKKDIDVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENT
WPTAAQVQDFGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIP
SKKVLQTMLDTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKL
REYFVITEYLIKTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEK
WNNHQRKLSNGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINST
SQRVCWQGQEGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTK
KSRNVVELQGALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRG
VIRGLETKRWSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFAR
LLLMMHDPALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPV
TESLSFWRFIHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLL
KTEVKKCLIESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVAD
GLISLFQNSRTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHAD
TLRYKSWGRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSR
GPLPAYLGSKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLT
GEEWTKRQHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNF
DFLFQATLLYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVL

KTWRNGEGSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDS
SLFPLSIQGRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLS
VSPPFLSLTRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQ
LWLFSDVLSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKF
FTKDILLCPEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMP
PRIQNPLLSGIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSR
GIFNSLLELSGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLR
LKAGLGLQIDLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKN
AVTILGPMFKTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQ
SSEQEFARAKKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADL
LTISLFYMAIISYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLA
VIQQSFPIRWEAVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRL
NPFNEILFNQLCRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWR
D

SEQ ID NO: 144 VSV-mIL12p70TM-N-M51R-GFP, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTGTCCTCAGAAGCTAACCATCTCCT
GGTTTGCCATCGTTTTGCTGGTGTCTCCACTCATGGCCATGTGGGAGCTGGAGAAAG
ACGTTTATGTTGTAGAGGTGGACTGGACTCCCGATGCCCCTGGAGAAACAGTGAACC
TCACCTGTGACACGCCTGAAGAAGATGACATCACCTGGACCTCAGACCAGAGACAT
GGAGTCATAGGCTCTGGAAAGACCCTGACCATCACTGTCAAAGAGTTTCTAGATGCT
GGCCAGTACACCTGCCACAAAGGAGGCGAGACTCTGAGCCACTCACATCTGCTGCT
CCACAAGAAGGAAAATGGAATTTGGTCCACTGAAATTTTAAAAAATTTCAAAAACA
AGACTTTCCTGAAGTGTGAAGCACCAAATTACTCCGGACGGTTCACGTGCTCATGGC
TGGTGCAAAGAAACATGGACTTGAAGTTCAACATCAAGAGCAGTAGCAGTTCCCCT
GACTCTCGGGCAGTGACATGTGGAATGGCGTCTCTGTCTGCAGAGAAGGTCACACTG
GACCAAAGGGACTATGAGAAGTATTCAGTGTCCTGCCAGGAGGATGTCACCTGCCC
AACTGCCGAGGAGACCCTGCCCATTGAACTGGCGTTGGAAGCACGGCAGCAGAATA
AATATGAGAACTACAGCACCAGCTTCTTCATCAGGGACATCATCAAACCAGACCCG
CCCAAGAACTTGCAGATGAAGCCTTTGAAGAACTCACAGGTGGAGGTCAGCTGGGA
GTACCCTGACTCCTGGAGCACTCCCCATTCCTACTTCTCCCTCAAGTTCTTTGTTCGA
ATCCAGCGCAAGAAAGAAAAGATGAAGGAGACAGAGGAGGGGTGTAACCAGAAAG
GTGCGTTCCTCGTAGAGAAGACATCTACCGAAGTCCAATGCAAAGGCGGGAATGTC
TGCGTGCAAGCTCAGGATCGCTATTACAATTCCTCATGCAGCAAGTGGGCATGTGTT
CCCTGCAGAGTCCGATCGgttcctggagtaggggtacctggagtgggcAGGGTCATACCGGTCTCTGG
ACCTGCCAGGTGTCTTAGCCAGTCCCGAAACCTGCTGAAGACCACAGATGACATGG
TGAAGACGGCCAGAGAAAAGCTGAAACATTATTCCTGCACTGCTGAAGACATCGAT
CATGAAGACATCACACGGGACCAAACCAGCACATTGAAGACCTGTTTACCACTGGA
ACTACACAAGAACGAGAGTTGCCTGGCTACTAGAGAGACTTCTTCCACAACAAGAG
GGAGCTGCCTGCCCCCACAGAAGACGTCTTTGATGATGACCCTGTGCCTTGGTAGCA
TCTATGAGGACTTGAAGATGTACCAGACAGAGTTCCAGGCCATCAACGCAGCACTTC
AGAATCACAACCATCAGCAGATCATTCTAGACAAGGGCATGCTGGTGGCCATCGAT
GAGCTGATGCAGTCTCTGAATCATAATGGCGAGACTCTGCGCCAGAAACCTCCTGTG
GGAGAAGCAGACCCTTACAGAGTGAAAATGAAGCTCTGCATCCTGCTTCACGCCTTC

AGCACCCGCGTCGTGACCATCAACAGGGTGATGGGCTATCTGAGCTCCGCCTGAGG
GGGGGGAGGCAGTGGAGGCGGTGGTTCAGGTGGTGGTGGGTCCAACACACTTGTGC
TCTTTGGGGCAGGATTCGGCGCAGTAATAACAGTCGTCGTCATCGTTGTCATCATCA
AATGCTTCTGTAAGCACAGAAGCTGTTTCAGAAGAAGAAATGAGGCAAGCAGAGAA
ACAAACAACAGCCTTACCTTCGGGCCTGAAGAAGCATTAGCTGAACAGACCGTCTT
CCTTTAGATCCTGCTAGGTATGAAAAAAACTAACAGATATCAGGCGCGCCTGCCACC
ATGTCTGTTACAGTCAAGAGAATCATTGACAACACAGTCGTAGTTCCAAAACTTCCT
GCAAATGAGGATCCAGTGGAATACCCGGCAGATTACTTCAGAAAATCAAAGGAGAT
TCCTCTTTACATCAATACTACAAAAAGTTTGTCAGATCTAAGAGGATATGTCTACCA
AGGCCTCAAATCCGGAAATGTATCAATCATACATGTCAACAGCTACTTGTATGGAGC
ATTAAAGGACATCCGGGGTAAGTTGGATAAAGATTGGTCAAGTTTCGGAATAAACA
TCGGGAAAGCAGGGGATACAATCGGAATATTTGACCTTGTATCCTTGAAAGCCCTGG
ACGGCGTACTTCCAGATGGAGTATCGGATGCTTCCAGAACCAGCGCAGATGACAAA
TGGTTGCCTTTGTATCTACTTGGCTTATACAGAGTGGGCAGAACACAAATGCCTGAA
TACAGAAAAAAGCTCATGGATGGGCTGACAAATCAATGCAAAATGATCAATGAACA
GTTTGAACCTCTTGTGCCAGAAGGTCGTGACATTTTTGATGTGTGGGGAAATGACAG
TAATTACACAAAAATTGTCGCTGCAGTGGACATGTTCTTCCACATGTTCAAAAAACA
TGAATGTGCCTCGTTCAGATACGGAACTATTGTTTCCAGATTCAAAGATTGTGCTGC
ATTGGCAACATTTGGACACCTCTGCAAAATAACCGGAATGTCTACAGAAGATGTAA
CGACCTGGATCTTGAACCGAGAAGTTGCAGATGAAATGGTCCAAATGATGCTTCCA
GGCCAAGAAATTGACAAGGCCGATTCATACATGCCTTATTTGATCGACTTTGGATTG
TCTTCTAAGTCTCCATATTCTTCCGTCAAAAACCCTGCCTTCCACTTCTGGGGGCAAT
TGACAGCTCTTCTGCTCAGATCCACCAGAGCAAGGAATGCCCGACAGCCTGATGAC
ATTGAGTATACATCTCTTACTACAGCAGGTTTGTTGTACGCTTATGCAGTAGGATCCT
CTGCCGACTTGGCACAACAGTTTTGTGTTGGAGATAACAAATACACTCCAGATGATA
GTACCGGAGGATTGACGACTAATGCACCGCCACAAGGCAGAGATGTGGTCGAATGG
CTCGGATGGTTTGAAGATCAAAACAGAAAACCGACTCCTGATATGATGCAGTATGC
GAAAAGAGCAGTCATGTCACTGCAAGGCCTAAGAGAGAAGACAATTGGCAAGTATG
CTAAGTCAGAATTTGACAAATGACCCTATAATTCTCGAGTCACCTATTATATATTAT
GCTACATATGAAAAAAACTAACAGATATCATGGATAATCTCACAAAAGTTCGTGAG
TATCTCAAGTCCTATTCTCGTCTGGATCAGGCGGTAGGAGAGATAGATGAGATCGAA
GCACAACGAGCTGAAAAGTCCAATTATGAGTTGTTCCAAGAGGATGGAGTGGAAGA
GCATACTAAGCCCTCTTATTTTCAGGCAGCAGATGATTCTGACACAGAATCTGAACC
AGAAATTGAAGACAATCAAGGCTTGTATGCACCAGATCCAGAAGCAGAGCAAGTTG
AAGGCTTTATACAGGGGCCTTTAGATGACTATGCAGATGAGGAAGTGGATGTTGTAT
TTACTTCGGACTGGAAACAGCCTGAGCTTGAATCTGACGAGCATGGAAAGACCTTAC
GGTTGACATCGCCAGAGGGTTTAAGTGGAGAGCAGAAATCCCAGTGGCTTTCGACG
ATTAAAGCAGTCGTGCAAAGTGCCAAATACTGGAATCTGGCAGAGTGCACATTTGA
AGCATCGGGAGAAGGGGTCATTATGAAGGAGCGCCAGATAACTCCGGATGTATATA
AGGTCACTCCAGTGATGAACACACATCCGTCCCAATCAGAAGCAGTATCAGATGTTT
GGTCTCTCTCAAAGACATCCATGACTTTCCAACCCAAGAAAGCAAGTCTTCAGCCTC
TCACCATATCCTTGGATGAATTGTTCTCATCTAGAGGAGAGTTCATCTCTGTCGGAG
GTGACGGACGAATGTCTCATAAAGAGGCCATCCTGCTCGGCCTGAGATACAAAAAG
TTGTACAATCAGGCGAGAGTCAAATATTCTCTGTAGACTATGAAAAAAAGTAACAG
ATATCACGATCTAAGTGTTACCCGGGTCCATTCATCATGAGTTCCTTAAAGAAGATT
CTCGGTCTGAAGGGGAAAGGTAAGAAATCTAAGAAATTAGGGATCGCACCACCCCC

TTATGAAGAGGACACTAGCATGGAGTATGCTCCGAGCGCTCCAATTGACAAATCCTA
TTTTGGAGTTGACGAGCGAGACACCTATGATCCGAATCAATTAAGATATGAGAAATT
CTTCTTTACAGTGAAAATGACGGTTAGATCTAATCGTCCGTTCAGAACATACTCAGA
TGTGGCAGCCGCTGTATCCCATTGGGATCACATGTACATCGGAATGGCAGGGAAAC
GTCCCTTCTACAAAATCTTGGCTTTTTTGGGTTCTTCTAATCTAAAGGCCACTCCAGC
GGTATTGGCAGATCAAGGTCAACCAGAGTATCACGCTCACTGCGAAGGCAGGGCTT
ATTTGCCACATAGGATGGGGAAGACCCCTCCCATGCTCAATGTACCAGAGCACTTCA
GAAGACCATTCAATATAGGTCTTTACAAGGGAACGATTGAGCTCACAATGACCATCT
ACGATGATGAGTCACTGGAAGCAGCTCCTATGATCTGGGATCATTTCAATTCTTCCA
AATTTTCTGATTTCAGAGAGAAGGCCTTAATGTTTGGCCTGATTGTCGAGAAAAAGG
CATCTGGAGCGTGGGTCCTGGACTCTATCGGCCACTTCAAATGAGCTAGTCTAACTG
CATGCTTCTGAACAATCCCCGGTTTACTCAGTCTCCCCTAATTCCAGCCTCTCGAACA
ACTAATATCCTGTCTTTTCTATCCCTATGAAAAAAACTAACAGAGATCGATCTGTTTA
CGCGTCACTATGAAGTGCCTTTTGTACTTAGCCTTTTTATTCATTGGGGTGAATTGCA
AGTTCACCATAGTTTTTCCACACAACCAAAAAGGAAACTGGAAAAATGTTCCTTCTA
ATTACCATTATTGCCCGTCAAGCTCAGATTTAAATTGGCATAATGACTTAATAGGCA
CAGCCTTACAAGTCAAAATGCCCAAGAGTCACAAGGCTATTCAAGCAGACGGTTGG
ATGTGTCATGCTTCCAAATGGGTCACTACTTGTGATTTCCGCTGGTATGGACCGAAG
TATATAACACATTCCATCCGATCCTTCACTCCATCTGTAGAACAATGCAAGGAAAGC
ATTGAACAAACGAAACAAGGAACTTGGCTGAATCCAGGCTTCCCTCCTCAAAGTTGT
GGATATGCAACTGTGACGGATGCCGAAGCAGTGATTGTCCAGGTGACTCCTCACCAT
GTGCTGGTTGATGAATACACAGGAGAATGGGTTGATTCACAGTTCATCAACGGAAA
ATGCAGCAATTACATATGCCCCACTGTCCATAACTCTACAACCTGGCATTCTGACTA
TAAGGTCAAAGGGCTATGTGATTCTAACCTCATTTCCATGGACATCACCTTCTTCTCA
GAGGACGGAGAGCTATCATCCCTGGGAAAGGAGGGCACAGGGTTCAGAAGTAACTA
CTTTGCTTATGAAACTGGAGGCAAGGCCTGCAAAATGCAATACTGCAAGCATTGGG
GAGTCAGACTCCCATCAGGTGTCTGGTTCGAGATGGCTGATAAGGATCTCTTTGCTG
CAGCCAGATTCCCTGAATGCCCAGAAGGGTCAAGTATCTCTGCTCCATCTCAGACCT
CAGTGGATGTAAGTCTAATTCAGGACGTTGAGAGGATCTTGGATTATTCCCTCTGCC
AAGAAACCTGGAGCAAAATCAGAGCGGGTCTTCCAATCTCTCCAGTGGATCTCAGCT
ATCTTGCTCCTAAAAACCCAGGAACCGGTCCTGCTTTCACCATAATCAATGGTACCC
TAAAATACTTTGAGACCAGATACATCAGAGTCGATATTGCTGCTCCAATCCTCTCAA
GAATGGTCGGAATGATCAGTGGAACTACCACAGAAAGGGAACTGTGGGATGACTGG
GCACCATATGAAGACGTGGAAATTGGACCCAATGGAGTTCTGAGGACCAGTTCAGG
ATATAAGTTTCCTTTATACATGATTGGACATGGTATGTTGGACTCCGATCTTCATCTT
AGCTCAAAGGCTCAGGTGTTCGAACATCCTCACATTCAAGACGCTGCTTCGCAACTT
CCTGATGATGAGAGTTTATTTTTTGGTGATACTGGGCTATCCAAAAATCCAATCGAG
CTTGTAGAAGGTTGGTTCAGTAGTTGGAAAAGCTCTATTGCCTCTTTTTTCTTTATCA
TAGGGTTAATCATTGGACTATTCTTGGTTCTCCGAGTTGGTATCCATCTTTGCATTAA
ATTAAAGCACACCAAGAAAAGACAGATTTATACAGACATAGAGATGAACCGACTTG
GAAAGTAAGCTAGCAAATCCTGCTAGGTATGAAAAAAACTAACAGATATCAGCTCA
GCTGCCACCATGGTGAGCAAGGGCGAGGAGCTGTTCACCGGGGTGGTGCCCATCCT
GGTCGAGCTGGACGGCGACGTAAACGGCCACAAGTTCAGCGTGTCCGGCGAGGGCG
AGGGCGATGCCACCTACGGCAAGCTGACCCTGAAGTTCATCTGCACCACCGGCAAG
CTGCCCGTGCCCTGGCCCACCCTCGTGACCACCCTGACCTACGGCGTGCAGTGCTTC
AGCCGCTACCCCGACCACATGAAGCAGCACGACTTCTTCAAGTCCGCCATGCCCGA

AGGCTACGTCCAGGAGCGCACCATCTTCTTCAAGGACGACGGCAACTACAAGACCC
GCGCCGAGGTGAAGTTCGAGGGCGACACCCTGGTGAACCGCATCGAGCTGAAGGGC
ATCGACTTCAAGGAGGACGGCAACATCCTGGGGCACAAGCTGGAGTACAACTACAA
CAGCCACAACGTCTATATCATGGCCGACAAGCAGAAGAACGGCATCAAGGTGAACT
TCAAGATCCGCCACAACATCGAGGACGGCAGCGTGCAGCTCGCCGACCACTACCAG
CAGAACACCCCCATCGGCGACGGCCCCGTGCTGCTGCCCGACAACCACTACCTGAG
CACCCAGTCCGCCCTGAGCAAAGACCCCAACGAGAAGCGCGATCACATGGTCCTGC
TGGAGTTCGTGACCGCCGCCGGGATCACTCTCGGCATGGACGAGCTGTACAAGTAA
GCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATG
CTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGC
AATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGA
CTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGC
TGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAA
ATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCT
TGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATG
GATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTT
ACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCC
GCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCA
TTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAA
TCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCA
AAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTG
GGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATG
GACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGT
GCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCT
TCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTA
TGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAA
GAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTT
CTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG
CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT
AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA
TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG

GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT
GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT

CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 145 VSV-mIL12p70TM-N-M51R-GFP, amino acid sequence
MCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLTCDTPEEDDI
TWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKENGIWSTEILK
NFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCGMASLSAEKV
TLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIRDIIKPDPPKN
LQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEGCNQKGAFLV
EKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGVGRVIPVSGPA
RCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTCLPLELHKNES
CLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAALQNHNHQQIIL

DKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFSTRVVTINRVM
GYLSSAGGGGSGGGGSGGGGSNTLVLFGAGFGAVITVVVIVVIIKCFCKHRSCFRRRNE
ASRETNNSLTFGPEEALAEQTVFLMSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSK
EIPLYINTTKSLSDLRGYVYQGLKSGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGK
AGDTIGIFDLVSLKALDGVLPDGVSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKK
LMDGLTNQCKMINEQFEPLVPEGRDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASF
RYGTIVSRFKDCAALATFGHLCKITGMSTEDVTTWILNREVADEMVQMMLPGQEIDKA
DSYMPYLIDFGLSSKSPYSSVKNPAFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAG
LLYAYAVGSSADLAQQFCVGDNKYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRK
PTPDMMQYAKRAVMSLQGLREKTIGKYAKSEFDKMDNLTKVREYLKSYSRLDQAVGE
IDEIEAQRAEKSNYELFQEDGVEEHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQ
VEGFIQGPLDDYADEEVDVVFTSDWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTI
KAVVQSAKYWNLAECTFEASGEGVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSL
SKTSMTFQPKKASLQPLTISLDELFSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQAR
VKYSLMSSLKKILGLKGKGKKSKKLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTY
DPNQLRYEKFFFTVKMTVRSNRPFRTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLG
SSNLKATPAVLADQGQPEYHAHCEGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTI
ELTMTIYDDESLEAAPMIWDHFNSSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKM
KCLLYLAFLFIGVNCKFTIVFPHNQKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVK
MPKSHKAIQADGWMCHASKWVTTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGT
WLNPGFPPQSCGYATVTDAEAVIVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVH
NSTTWHSDYKVKGLCDSNLISMDITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKM
QYCKHWGVRLPSGVWFEMADKDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILD
YSLCQETWSKIRAGLPISPVDLSYLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSR
MVGMISGTTTERELWDDWAPYEDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSS
KAQVFEHPHIQDAASQLPDDESLFFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLF
LVLRVGIHLCIKLKHTKKRQIYTDIEMNRLGKMVSKGEELFTGVVPILVELDGDVNGHK
FSVSGEGEGDATYGKLTLKFICTTGKLPVPWPTLVTTLTYGVQCFSRYPDHMKQHDFFK
SAMPEGYVQERTIFFKDDGNYKTRAEVKFEGDTLVNRIELKGIDFKEDGNILGHKLEYN
YNSHNVYIMADKQKNGIKVNFKIRHNIEDGSVQLADHYQQNTPIGDGPVLLPDNHYLST
QSALSKDPNEKRDHMVLLEFVTAAGITLGMDELYKMEVHDFETDEFNDFNEDDYATRE
FLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQ
ANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIE
YIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNIC
RIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQD
IFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSV
DEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDI
DVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQD
FGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTML
DTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLI
KTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLS
NGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQ
EGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQ
GALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKR
WSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLMMHDP
ALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRF

IHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLI
ESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNS
RTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSW
GRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLG
SKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKR
QHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFLFQATL
LYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGE
GSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQ
GRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSL
TRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDV
LSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLC
PEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLS
GIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLEL
SGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQI
DLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMF
KTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARA
KKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAII
SYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWE
AVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQL
CRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 146 VSV-N-mIL12p70TM-P-M51R-GFP, nucleic acid sequence
TACGTATTGTAATACGACTCACTATAGGGAGACTTCGTCTGATGAGTCCGTGAGGAC
GAAACGGAGTCTAGACTCCGTCACGAAGACAAACAAACCATTATTATCATTAAAAG
GCTCAGGAGAAACTTTAACAGTAATCAAAATGTCTGTTACAGTCAAGAGAATCATTG
ACAACACAGTCGTAGTTCCAAAACTTCCTGCAAATGAGGATCCAGTGGAATACCCG
GCAGATTACTTCAGAAAATCAAAGGAGATTCCTCTTTACATCAATACTACAAAAAGT
TTGTCAGATCTAAGAGGATATGTCTACCAAGGCCTCAAATCCGGAAATGTATCAATC
ATACATGTCAACAGCTACTTGTATGGAGCATTAAAGGACATCCGGGGTAAGTTGGAT
AAAGATTGGTCAAGTTTCGGAATAAACATCGGGAAAGCAGGGGATACAATCGGAAT
ATTTGACCTTGTATCCTTGAAAGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGA
TGCTTCCAGAACCAGCGCAGATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATA
CAGAGTGGGCAGAACACAAATGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGA
CAAATCAATGCAAAATGATCAATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTG
ACATTTTTGATGTGTGGGGAAATGACAGTAATTACACAAAAATTGTCGCTGCAGTGG
ACATGTTCTTCCACATGTTCAAAAAACATGAATGTGCCTCGTTCAGATACGGAACTA
TTGTTTCCAGATTCAAAGATTGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAA
TAACCGGAATGTCTACAGAAGATGTAACGACCTGGATCTTGAACCGAGAAGTTGCA
GATGAAATGGTCCAAATGATGCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATA
CATGCCTTATTTGATCGACTTTGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAA
AACCCTGCCTTCCACTTCTGGGGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGA
GCAAGGAATGCCCGACAGCCTGATGACATTGAGTATACATCTCTTACTACAGCAGGT
TTGTTGTACGCTTATGCAGTAGGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTG
GAGATAACAAATACACTCCAGATGATAGTACCGGAGGATTGACGACTAATGCACCG
CCACAAGGCAGAGATGTGGTCGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAA
ACCGACTCCTGATATGATGCAGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCC

TAAGAGAGAAGACAATTGGCAAGTATGCTAAGTCAGAATTTGACAAATGACCCTAT
AATTCTCGAGTCACCTATTATATATTATGCTACATATGAAAAAAACTAACAGATATC
ATGTGTCCTCAGAAGCTAACCATCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCAC
TCATGGCCATGTGGGAGCTGGAGAAAGACGTTTATGTTGTAGAGGTGGACTGGACT
CCCGATGCCCCTGGAGAAACAGTGAACCTCACCTGTGACACGCCTGAAGAAGATGA
CATCACCTGGACCTCAGACCAGAGACATGGAGTCATAGGCTCTGGAAAGACCCTGA
CCATCACTGTCAAAGAGTTTCTAGATGCTGGCCAGTACACCTGCCACAAAGGAGGC
GAGACTCTGAGCCACTCACATCTGCTGCTCCACAAGAAGGAAAATGGAATTTGGTCC
ACTGAAATTTTAAAAAATTTCAAAAACAAGACTTTCCTGAAGTGTGAAGCACCAAAT
TACTCCGGACGGTTCACGTGCTCATGGCTGGTGCAAAGAAACATGGACTTGAAGTTC
AACATCAAGAGCAGTAGCAGTTCCCCTGACTCTCGGGCAGTGACATGTGGAATGGC
GTCTCTGTCTGCAGAGAAGGTCACACTGGACCAAAGGGACTATGAGAAGTATTCAG
TGTCCTGCCAGGAGGATGTCACCTGCCCAACTGCCGAGGAGACCCTGCCCATTGAAC
TGGCGTTGGAAGCACGGCAGCAGAATAAATATGAGAACTACAGCACCAGCTTCTTC
ATCAGGGACATCATCAAACCAGACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAA
GAACTCACAGGTGGAGGTCAGCTGGGAGTACCCTGACTCCTGGAGCACTCCCCATTC
CTACTTCTCCCTCAAGTTCTTTGTTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGA
GACAGAGGAGGGGTGTAACCAGAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCG
AAGTCCAATGCAAAGGCGGGAATGTCTGCGTGCAAGCTCAGGATCGCTATTACAAT
TCCTCATGCAGCAAGTGGGCATGTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtac
ctggagtgggcAGGGTCATACCGGTCTCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAA
CCTGCTGAAGACCACAGATGACATGGTGAAGACGGCCAGAGAAAAGCTGAAACATT
ATTCCTGCACTGCTGAAGACATCGATCATGAAGACATCACACGGGACCAAACCAGC
ACATTGAAGACCTGTTTACCACTGGAACTACACAAGAACGAGAGTTGCCTGGCTACT
AGAGAGACTTCTTCCACAACAAGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTT
GATGATGACCCTGTGCCTTGGTAGCATCTATGAGGACTTGAAGATGTACCAGACAGA
GTTCCAGGCCATCAACGCAGCACTTCAGAATCACAACCATCAGCAGATCATTCTAGA
CAAGGGCATGCTGGTGGCCATCGATGAGCTGATGCAGTCTCTGAATCATAATGGCG
AGACTCTGCGCCAGAAACCTCCTGTGGGAGAAGCAGACCCTTACAGAGTGAAAATG
AAGCTCTGCATCCTGCTTCACGCCTTCAGCACCCGCGTCGTGACCATCAACAGGGTG
ATGGGCTATCTGAGCTCCGCCTGAGGGGGGGGAGGCAGTGGAGGCGGTGGTTCAGG
TGGTGGTGGGTCCAACACACTTGTGCTCTTTGGGGCAGGATTCGGCGCAGTAATAAC
AGTCGTCGTCATCGTTGTCATCATCAAATGCTTCTGTAAGCACAGAAGCTGTTTCAG
AAGAAGAAATGAGGCAAGCAGAGAAACAAACAACAGCCTTACCTTCGGGCCTGAA
GAAGCATTAGCTGAACAGACCGTCTTCCTTTAGATCCTGCTAGGTATGAAAAAAACT
AACAGATATCAGGCGCGCCTGCCACCATGGATAATCTCACAAAAGTTCGTGAGTATC
TCAAGTCCTATTCTCGTCTGGATCAGGCGGTAGGAGAGATAGATGAGATCGAAGCA
CAACGAGCTGAAAAGTCCAATTATGAGTTGTTCCAAGAGGATGGAGTGGAAGAGCA
TACTAAGCCCTCTTATTTTCAGGCAGCAGATGATTCTGACACAGAATCTGAACCAGA
AATTGAAGACAATCAAGGCTTGTATGCACCAGATCCAGAAGCAGAGCAAGTTGAAG
GCTTTATACAGGGGCCTTTAGATGACTATGCAGATGAGGAAGTGGATGTTGTATTTA
CTTCGGACTGGAAACAGCCTGAGCTTGAATCTGACGAGCATGGAAAGACCTTACGG
TTGACATCGCCAGAGGGTTTAAGTGGAGAGCAGAAATCCCAGTGGCTTTCGACGATT
AAAGCAGTCGTGCAAAGTGCCAAATACTGGAATCTGGCAGAGTGCACATTTGAAGC
ATCGGGAGAAGGGGTCATTATGAAGGAGCGCCAGATAACTCCGGATGTATATAAGG
TCACTCCAGTGATGAACACACATCCGTCCCAATCAGAAGCAGTATCAGATGTTTGGT

CTCTCTCAAAGACATCCATGACTTTCCAACCCAAGAAAGCAAGTCTTCAGCCTCTCA
CCATATCCTTGGATGAATTGTTCTCATCTAGAGGAGAGTTCATCTCTGTCGGAGGTG
ACGGACGAATGTCTCATAAAGAGGCCATCCTGCTCGGCCTGAGATACAAAAAGTTG
TACAATCAGGCGAGAGTCAAATATTCTCTGTAGACTATGAAAAAAAGTAACAGATA
TCACGATCTAAGTGTTACCCGGGTCCATTCATCATGAGTTCCTTAAAGAAGATTCTC
GGTCTGAAGGGGAAAGGTAAGAAATCTAAGAAATTAGGGATCGCACCACCCCCTTA
TGAAGAGGACACTAGCATGGAGTATGCTCCGAGCGCTCCAATTGACAAATCCTATTT
TGGAGTTGACGAGCGAGACACCTATGATCCGAATCAATTAAGATATGAGAAATTCTT
CTTTACAGTGAAAATGACGGTTAGATCTAATCGTCCGTTCAGAACATACTCAGATGT
GGCAGCCGCTGTATCCCATTGGGATCACATGTACATCGGAATGGCAGGGAAACGTC
CCTTCTACAAAATCTTGGCTTTTTTGGGTTCTTCTAATCTAAAGGCCACTCCAGCGGT
ATTGGCAGATCAAGGTCAACCAGAGTATCACGCTCACTGCGAAGGCAGGGCTTATTT
GCCACATAGGATGGGGAAGACCCCTCCCATGCTCAATGTACCAGAGCACTTCAGAA
GACCATTCAATATAGGTCTTTACAAGGGAACGATTGAGCTCACAATGACCATCTACG
ATGATGAGTCACTGGAAGCAGCTCCTATGATCTGGGATCATTTCAATTCTTCCAAAT
TTTCTGATTTCAGAGAGAAGGCCTTAATGTTTGGCCTGATTGTCGAGAAAAAGGCAT
CTGGAGCGTGGGTCCTGGACTCTATCGGCCACTTCAAATGAGCTAGTCTAACTGCAT
GCTTCTGAACAATCCCCGGTTTACTCAGTCTCCCCTAATTCCAGCCTCTCGAACAACT
AATATCCTGTCTTTTCTATCCCTATGAAAAAAACTAACAGAGATCGATCTGTTTACG
CGTCACTATGAAGTGCCTTTTGTACTTAGCCTTTTTATTCATTGGGGTGAATTGCAAG
TTCACCATAGTTTTTCCACACAACCAAAAAGGAAACTGGAAAAATGTTCCTTCTAAT
TACCATTATTGCCCGTCAAGCTCAGATTTAAATTGGCATAATGACTTAATAGGCACA
GCCTTACAAGTCAAAATGCCCAAGAGTCACAAGGCTATTCAAGCAGACGGTTGGAT
GTGTCATGCTTCCAAATGGGTCACTACTTGTGATTTCCGCTGGTATGGACCGAAGTA
TATAACACATTCCATCCGATCCTTCACTCCATCTGTAGAACAATGCAAGGAAAGCAT
TGAACAAACGAAACAAGGAACTTGGCTGAATCCAGGCTTCCCTCCTCAAAGTTGTG
GATATGCAACTGTGACGGATGCCGAAGCAGTGATTGTCCAGGTGACTCCTCACCATG
TGCTGGTTGATGAATACACAGGAGAATGGGTTGATTCACAGTTCATCAACGGAAAA
TGCAGCAATTACATATGCCCCACTGTCCATAACTCTACAACCTGGCATTCTGACTAT
AAGGTCAAAGGGCTATGTGATTCTAACCTCATTTCCATGGACATCACCTTCTTCTCA
GAGGACGGAGAGCTATCATCCCTGGGAAAGGAGGGCACAGGGTTCAGAAGTAACTA
CTTTGCTTATGAAACTGGAGGCAAGGCCTGCAAAATGCAATACTGCAAGCATTGGG
GAGTCAGACTCCCATCAGGTGTCTGGTTCGAGATGGCTGATAAGGATCTCTTTGCTG
CAGCCAGATTCCCTGAATGCCCAGAAGGGTCAAGTATCTCTGCTCCATCTCAGACCT
CAGTGGATGTAAGTCTAATTCAGGACGTTGAGAGGATCTTGGATTATTCCCTCTGCC
AAGAAACCTGGAGCAAAATCAGAGCGGGTCTTCCAATCTCTCCAGTGGATCTCAGCT
ATCTTGCTCCTAAAAACCCAGGAACCGGTCCTGCTTTCACCATAATCAATGGTACCC
TAAAATACTTTGAGACCAGATACATCAGAGTCGATATTGCTGCTCCAATCCTCTCAA
GAATGGTCGGAATGATCAGTGGAACTACCACAGAAAGGGAACTGTGGGATGACTGG
GCACCATATGAAGACGTGGAAATTGGACCCAATGGAGTTCTGAGGACCAGTTCAGG
ATATAAGTTTCCTTTATACATGATTGGACATGGTATGTTGGACTCCGATCTTCATCTT
AGCTCAAAGGCTCAGGTGTTCGAACATCCTCACATTCAAGACGCTGCTTCGCAACTT
CCTGATGATGAGAGTTTATTTTTTGGTGATACTGGGCTATCCAAAAATCCAATCGAG
CTTGTAGAAGGTTGGTTCAGTAGTTGGAAAAGCTCTATTGCCTCTTTTTTCTTTATCA
TAGGGTTAATCATTGGACTATTCTTGGTTCTCCGAGTTGGTATCCATCTTTGCATTAA
ATTAAAGCACACCAAGAAAAGACAGATTTATACAGACATAGAGATGAACCGACTTG

GAAAGTAAGCTAGCAAATCCTGCTAGGTATGAAAAAAACTAACAGATATCAGCTCA
GCTGCCACCATGGTGAGCAAGGGCGAGGAGCTGTTCACCGGGGTGGTGCCCATCCT
GGTCGAGCTGGACGGCGACGTAAACGGCCACAAGTTCAGCGTGTCCGGCGAGGGCG
AGGGCGATGCCACCTACGGCAAGCTGACCCTGAAGTTCATCTGCACCACCGGCAAG
CTGCCCGTGCCCTGGCCCACCCTCGTGACCACCCTGACCTACGGCGTGCAGTGCTTC
AGCCGCTACCCCGACCACATGAAGCAGCACGACTTCTTCAAGTCCGCCATGCCCGA
AGGCTACGTCCAGGAGCGCACCATCTTCTTCAAGGACGACGGCAACTACAAGACCC
GCGCCGAGGTGAAGTTCGAGGGCGACACCCTGGTGAACCGCATCGAGCTGAAGGGC
ATCGACTTCAAGGAGGACGGCAACATCCTGGGGCACAAGCTGGAGTACAACTACAA
CAGCCACAACGTCTATATCATGGCCGACAAGCAGAAGAACGGCATCAAGGTGAACT
TCAAGATCCGCCACAACATCGAGGACGGCAGCGTGCAGCTCGCCGACCACTACCAG
CAGAACACCCCCATCGGCGACGGCCCCGTGCTGCTGCCCGACAACCACTACCTGAG
CACCCAGTCCGCCCTGAGCAAAGACCCCAACGAGAAGCGCGATCACATGGTCCTGC
TGGAGTTCGTGACCGCCGCCGGGATCACTCTCGGCATGGACGAGCTGTACAAGTAA
GCTAAGCAAATACAACAGATTCTTCATGTTTGGACCAAATCAACTTGTGATACCATG
CTCAAAGAGGCCTCAATTATATTTGAGTTTTTAATTTTTATGAAAAAAACTAACAGC
AATCATGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGA
CTATGCCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGC
TGATTACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAA
ATTCAATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCT
TGAGATGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATG
GATGGGAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTT
ACATGAAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCC
GCGGCTGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCA
TTCAAAATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAA
TCTTAAATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCA
AAGTCAGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTG
GGTCCTACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATG
GACCGAAACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGT
GCTATCCATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCT
TCTAAATATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTA
TGACTTGATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAA
GAGAATCAAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTT
CTGTTGATGAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATA
ATGAGTGTGAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGG
GGTCATCCTTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACC
ATGAAGAAAGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGG
ATTGTTCTATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTG
CTCCCTCATGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCT
GCTCAAGTTCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTT
GAAATACCCGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATG
AATAGGTCAGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGT
AAAAAGGTGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCT
TAAAGAGATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGG
AAAGGAGAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATT
GCGAGAATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTT

AAAGGCCTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTC
CTCATCCGGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGA
TTACGAAAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAG
TTATGGGCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGA
GAAAAGTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACA
CACTGATCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTG
GAAGGTCTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGA
GGCTAAAATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTA
TTTGCACACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCT
CTCAATCAAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGAC
AGGGAAGTTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTT
GAATTATGGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGA
GATGGTCACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAA
TGAGCTCAGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCA
ATGCCATGATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGC
ATGATCCTGCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGC
ACAGTTCTACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTC
GGGCATGTCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAG
TCTCTCATTCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGAT
GAGTGCAGTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACA
AGCTAGTAGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAAC
TTGTTAAAGACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAA
CCAGGTGATTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAA
GTTTCTTATGGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGG
CACTTTTTTGGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATT
CGGAACTCCTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGT
GAGGTATCCTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAA
ATGTGGACATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGT
ACAGTTATTGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGA
AAAGAGACTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCAT
TGTCCAGACGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTA
GGGTCTAAAACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAA
AGTCCCACTGATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGA
ACCCGACTCTAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGA
AGAATGGACCAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGT
TTTCGACATCTCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGA
CCAGGTTGATGGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGAC
TTTTTATTCCAAGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGAC
GGATGGATCACCAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGA
CCCATAGAAGAGATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATC
CCATGTGCTGAAGACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAA
CAGATCTATCCTTTAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTAT
CAAGTCGGCAGATGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACT
CATGCCGAGGACAGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGA
GGTTTCTTAAAAGGGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATA
CACCGGAGAAGTCTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTT

GATTTACTTGATTGATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCA
GGACCTATTAGAGACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCG
ACAAGCAACCGTGATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGT
CTAATTGAAAAGGGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGAT
GTCTTATCCATAGACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCC
TATACAAGCCATTTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAAT
CTTTCTTCATTGCTAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTC
ACCAAGGACATATTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATT
GCTAAGGATAATAATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGG
GACAATTACAACAATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGA
GATGCCTCCAAGAATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACC
AACTGGCGCTCATTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAG
GGACTTCTTGAGTTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGA
AAATGTGCATAGCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCAT
GCGAGGCGCCTCTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAAT
CGAGATGTGTAAATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAA
GGACTTGGGACTATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAA
TTGTAATGGATATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATG
TTAGAAATTATGTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTT
ATGGAACATATATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGT
TCAAGACGGTCGACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTAT
ATATGGTATGTAAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTT
CCATCAATGAATCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTG
CCAGAGCAAAGAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCA
TTCCTGATCCTTTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGG
GTGTGTCTCATGCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCA
TTAGCCTTTTTTATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGG
ACCGATACCTCCGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTA
TAACTGGTATAAGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAAC
AGTGTTTAGCAGTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAA
AAGGAGGATACAAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATAC
CCGAATTTCAGACTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGT
CCGAAACCAAGTTCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCG
TACAGTGGATAATCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTG
AATGGATCAATAGACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGT
GACCTACACGAGGAAAACTCTTGGAGAGATTAAAAAATCATGAGGAGACTCCAAAC
TTTAAGTATGAAAAAAACTTTGATCCTTAAGACCCTCTTGTGGTTTTTATTTTTTATC
TGGTTTTGTGGTCTTCGTGGCCGGCATGGTCCCAGCCTCCTCGCTGGCGCCGGCTGG
GCAACATTCCGAGGGGACCGTCCCCTCGGTAATGGCGAATGGGACGCGGCCGATCC
GGCTGCTAACAAAGCCCGAAAGGAAGCTGAGTTGGCTGCTGCCACCGTTGAGCAAT
AACTAGCATAACCCCTTGGGGCCTCTAAACGGGTCTTGAGGGGTTTTTTGCTGAAAG
GAGGAACTATATCCGGATGCGGCCGC

SEQ ID NO: 147 VSV-N-mIL12p70TM-P-M51R-GFP, amino acid sequence
MSVTVKRIIDNTVVVPKLPANEDPVEYPADYFRKSKEIPLYINTTKSLSDLRGYVYQGLK
SGNVSIIHVNSYLYGALKDIRGKLDKDWSSFGINIGKAGDTIGIFDLVSLKALDGVLPDG

VSDASRTSADDKWLPLYLLGLYRVGRTQMPEYRKKLMDGLTNQCKMINEQFEPLVPEG
RDIFDVWGNDSNYTKIVAAVDMFFHMFKKHECASFRYGTIVSRFKDCAALATFGHLCKI
TGMSTEDVTTWILNREVADEMVQMMLPGQEIDKADSYMPYLIDFGLSSKSPYSSVKNP
AFHFWGQLTALLLRSTRARNARQPDDIEYTSLTTAGLLYAYAVGSSADLAQQFCVGDN
KYTPDDSTGGLTTNAPPQGRDVVEWLGWFEDQNRKPTPDMMQYAKRAVMSLQGLRE
KTIGKYAKSEFDKMCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGET
VNLTCDTPEEDDITWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLH
KKENGIWSTEILKNFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAV
TCGMASLSAEKVTLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTS
FFIRDIIKPDPPKNLQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKET
EEGCNQKGAFLVEKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGV
PGVGRVIPVSGPARCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTL
KTCLPLELHKNESCLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAIN
AALQNHNHQQIILDKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLH
AFSTRVVTINRVMGYLSSAGGGGSGGGGSGGGGSNTLVLFGAGFGAVITVVVIVVIIKCF
CKHRSCFRRRNEASRETNNSLTFGPEEALAEQTVFLMDNLTKVREYLKSYSRLDQAVGE
IDEIEAQRAEKSNYELFQEDGVEEHTKPSYFQAADDSDTESEPEIEDNQGLYAPDPEAEQ
VEGFIQGPLDDYADEEVDVVFTSDWKQPELESDEHGKTLRLTSPEGLSGEQKSQWLSTI
KAVVQSAKYWNLAECTFEASGEGVIMKERQITPDVYKVTPVMNTHPSQSEAVSDVWSL
SKTSMTFQPKKASLQPLTISLDELFSSRGEFISVGGDGRMSHKEAILLGLRYKKLYNQAR
VKYSLMSSLKKILGLKGKGKKSKKLGIAPPPYEEDTSMEYAPSAPIDKSYFGVDERDTY
DPNQLRYEKFFFTVKMTVRSNRPFRTYSDVAAAVSHWDHMYIGMAGKRPFYKILAFLG
SSNLKATPAVLADQGQPEYHAHCEGRAYLPHRMGKTPPMLNVPEHFRRPFNIGLYKGTI
ELTMTIYDDESLEAAPMIWDHFNSSKFSDFREKALMFGLIVEKKASGAWVLDSIGHFKM
KCLLYLAFLFIGVNCKFTIVFPHNQKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVK
MPKSHKAIQADGWMCHASKWVTTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGT
WLNPGFPPQSCGYATVTDAEAVIVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVH
NSTTWHSDYKVKGLCDSNLISMDITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKM
QYCKHWGVRLPSGVWFEMADKDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILD
YSLCQETWSKIRAGLPISPVDLSYLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSR
MVGMISGTTTERELWDDWAPYEDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSS
KAQVFEHPHIQDAASQLPDDESLFFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLF
LVLRVGIHLCIKLKHTKKRQIYTDIEMNRLGKMVSKGEELFTGVVPILVELDGDVNGHK
FSVSGEGEGDATYGKLTLKFICTTGKLPVPWPTLVTTLTYGVQCFSRYPDHMKQHDFFK
SAMPEGYVQERTIFFKDDGNYKTRAEVKFEGDTLVNRIELKGIDFKEDGNILGHKLEYN
YNSHNVYIMADKQKNGIKVNFKIRHNIEDGSVQLADHYQQNTPIGDGPVLLPDNHYLST
QSALSKDPNEKRDHMVLLEFVTAAGITLGMDELYKMEVHDFETDEFNDFNEDDYATRE
FLNPDERMTYLNHADYNLNSPLISDDIDNLIRKFNSLPIPSMWDSKNWDGVLEMLTSCQ
ANPIPTSQMHKWMGSWLMSDNHDASQGYSFLHEVDKEAEITFDVVETFIRGWGNKPIE
YIKKERWTDSFKILAYLCQKFLDLHKLTLILNAVSEVELLNLARTFKGKVRRSSHGTNIC
RIRVPSLGPTFISEGWAYFKKLDILMDRNFLLMVKDVIIGRMQTVLSMVCRIDNLFSEQD
IFSLLNIYRIGDKIVERQGNFSYDLIKMVEPICNLKLMKLARESRPLVPQFPHFENHIKTSV
DEGAKIDRGIRFLHDQIMSVKTVDLTLVIYGSFRHWGHPFIDYYTGLEKLHSQVTMKKDI
DVSYAKALASDLARIVLFQQFNDHKKWFVNGDLLPHDHPFKSHVKENTWPTAAQVQD
FGDKWHELPLIKCFEIPDLLDPSIIYSDKSHSMNRSEVLKHVRMNPNTPIPSKKVLQTML
DTKATNWKEFLKEIDEKGLDDDDLIIGLKGKERELKLAGRFFSLMSWKLREYFVITEYLI

KTHFVPMFKGLTMADDLTAVIKKMLDSSSGQGLKSYEAICIANHIDYEKWNNHQRKLS
NGPVFRVMGQFLGYPSLIERTHEFFEKSLIYYNGRPDLMRVHNNTLINSTSQRVCWQGQ
EGGLEGLRQKGWSILNLLVIQREAKIRNTAVKVLAQGDNQVICTQYKTKKSRNVVELQ
GALNQMVSNNEKIMTAIKIGTGKLGLLINDDETMQSADYLNYGKIPIFRGVIRGLETKR
WSRVTCVTNDQIPTCANIMSSVSTNALTVAHFAENPINAMIQYNYFGTFARLLLMMHDP
ALRQSLYEVQDKIPGLHSSTFKYAMLYLDPSIGGVSGMSLSRFLIRAFPDPVTESLSFWRF
IHVHARSEHLKEMSAVFGNPEIAKFRITHIDKLVEDPTSLNIAMGMSPANLLKTEVKKCLI
ESRQTIRNQVIKDATIYLYHEEDRLRSFLWSINPLFPRFLSEFKSGTFLGVADGLISLFQNS
RTIRNSFKKKYHRELDDLIVRSEVSSLTHLGKLHLRRGSCKMWTCSATHADTLRYKSW
GRTVIGTTVPHPLEMLGPQHRKETPCAPCNTSGFNYVSVHCPDGIHDVFSSRGPLPAYLG
SKTSESTSILQPWERESKVPLIKRATRLRDAISWFVEPDSKLAMTILSNIHSLTGEEWTKR
QHGFKRTGSALHRFSTSRMSHGGFASQSTAALTRLMATTDTMRDLGDQNFDFLFQATL
LYAQITTTVARDGWITSCTDHYHIACKSCLRPIEEITLDSSMDYTPPDVSHVLKTWRNGE
GSWGQEIKQIYPLEGNWKNLAPAEQSYQVGRCIGFLYGDLAYRKSTHAEDSSLFPLSIQ
GRIRGRGFLKGLLDGLMRASCCQVIHRRSLAHLKRPANAVYGGLIYLIDKLSVSPPFLSL
TRSGPIRDELETIPHKIPTSYPTSNRDMGVIVRNYFKYQCRLIEKGKYRSHYSQLWLFSDV
LSIDFIGPFSISTTLLQILYKPFLSGKDKNELRELANLSSLLRSGEGWEDIHVKFFTKDILLC
PEEIRHACKFGIAKDNNKDMSYPPWGRESRGTITTIPVYYTTTPYPKMLEMPPRIQNPLLS
GIRLGQLPTGAHYKIRSILHGMGIHYRDFLSCGDGSGGMTAALLRENVHSRGIFNSLLEL
SGSVMRGASPEPPSALETLGGDKSRCVNGETCWEYPSDLCDPRTWDYFLRLKAGLGLQI
DLIVMDMEVRDSSTSLKIETNVRNYVHRILDEQGVLIYKTYGTYICESEKNAVTILGPMF
KTVDLVQTEFSSSQTSEVYMVCKGLKKLIDEPNPDWSSINESWKNLYAFQSSEQEFARA
KKVSTYFTLTGIPSQFIPDPFVNIETMLQIFGVPTGVSHAAALKSSDRPADLLTISLFYMAII
SYYNINHIRVGPIPPNPPSDGIAQNVGIAITGISFWLSLMEKDIPLYQQCLAVIQQSFPIRWE
AVSVKGGYKQKWSTRGDGLPKDTRISDSLAPIGNWIRSLELVRNQVRLNPFNEILFNQL
CRTVDNHLKWSNLRRNTGMIEWINRRISKEDRSILMLKSDLHEENSWRD

SEQ ID NO: 148 mB7.1 (cd80) transmembrane full-length sequence (transmembrane domain + topological domain), "RRR" version, mouse, nucleic acid sequence
AACACACTTGTGCTCTTTGGGGCAGGATTCGGCGCAGTAATAACAGTCGTCGTCATC
GTTGTCATCATCAAATGCTTCTGTAAGCACAGAAGCTGTTTCAGAAGAAGAAATGAG
GCAAGCAGAGAAACAAACAACAGCCTTACCTTCGGGCCTGAAGAAGCATTAGCTGA
ACAGACCGTCTTCCTTTAG

SEQ ID NO: 149 mIgG1 D265A_mut, nucleic acid sequence
GTGCCCAGGGATTGTGGTTGTAAGCCTTGCATATGTACAGTCCCAGAAGTATCATCT
GTCTTCATCTTCCCCCCAAAGCCCAAGGATGTGCTCACCATTACTCTGACTCCTAAG
GTCACGTGTGTTGTGGTAGCCATCAGCAAGGATGATCCCGAGGTCCAGTTCAGCTGG
TTTGTAGATGATGTGGAGGTGCACACAGCTCAGACGCAACCCCGGGAGGAGCAGTT
CAACAGCACTTTCCGCTCAGTCAGTGAACTTCCCATCATGCACCAGGACTGGCTCAA
TGGCAAGGAGTTCAAATGCAGGGTCAACAGTGCAGCTTTCCCTGCCCCCATCGAGA
AAACCATCTCCAAAACCAAAGGCAGACCGAAGGCTCCACAGGTGTACACCATTCCA
CCTCCCAAGGAGCAGATGGCCAAGGATAAAGTCAGTCTGACCTGCATGATAACAGA
CTTCTTCCCTGAAGACATTACTGTGGAGTGGCAGTGGAATGGGCAGCCAGCGGAGA
ACTACAAGAACACTCAGCCCATCATGGACACAGATGGCTCTTACTTCGTCTACAGCA
AGCTCAATGTGCAGAAGAGCAACTGGGAGGCAGGAAATACTTTCACCTGCTCTGTG

TTACATGAGGGCCTGCACAACCACCATACTGAGAAGAGCCTCTCCCACTCTCCTGGT
AAA

SEQ ID NO: 150 mIgG1 D265A_mut, amino acid sequence
VPRDCGCKPCICTVPEVSSVFIFPPKPKDVLTITLTPKVTCVVVAISKDDPEVQFSWFVDD
VEVHTAQTQPREEQFNSTFRSVSELPIMHQDWLNGKEFKCRVNSAAFPAPIEKTISKTKG
RPKAPQVYTIPPPKEQMAKDKVSLTCMITDFFPEDITVEWQWNGQPAENYKNTQPIMDT
DGSYFVYSKLNVQKSNWEAGNTFTCSVLHEGLHNHHTEKSLSHSPGK

SEQ ID NO: 151 mIgG1, amino acid sequence
VPRDCGCKPCICTVPEVSSVFIFPPKPKDVLTITLTPKVTCVVVAISKDDPEVQFSWFVDD
VEVHTAQTQPREEQFNSTFRSVSELPIMHQDWLNGKEFKCRVNSAAFPAPIEKTISKTKG
RPKAPQVYTIPPPKEQMAKDKVSLTCMITDFFPEDITVEWQWNGQPDENYKNTQPIMDT
DGSYFVYSKLNVQKSNWEAGNTFTCSVLHEGLHNHHTEKSLSHSPGK

SEQ ID NO: 152 mCD4-d1-4, nucleic acid sequence
AAGACGCTGGTGCTGGGGAAGGAAGGGGAATCAGCAGAACTGCCCTGCGAGAGTTC
CCAGAAGAAGATCACAGTCTTCACCTGGAAGTTCTCTGACCAGAGGAAGATTCTGG
GGCAGCATGGCAAAGGTGTATTAATTAGAGGAGGTTCGCCTTCGCAGTTTGATCGTT
TTGATTCCAAAAAAGGGGCATGGGAGAAAGGATCGTTTCCTCTCATCATCAATAAAC
TTAAGATGGAAGACTCTCAGACTTATATCTGTGAGCTGGAGAACAGGAAAGAGGAG
GTGGAGTTGTGGGTGTTCAAAGTGACCTTCAGTCCGGGTACCAGCCTGTTGCAAGGG
CAGAGCCTGACCCTGACCTTGGATAGCAACTCTAAGGTCTCTAACCCCTTGACAGAG
TGCAAACACAAAAAGGGTAAAGTTGTCAGTGGTTCCAAAGTTCTCTCCATGTCCAAC
CTAAGGGTTCAGGACAGCGACTTCTGGAACTGCACCGTGACCCTGGACCAGAAAAA
GAACTGGTTCGGCATGACACTCTCAGTGCTGGGTTTTCAGAGCACAGCTATCACGGC
CTATAAGAGTGAGGGAGAGTCAGCGGAGTTCTCCTTCCCACTCAACTTTGCAGAGGA
AAACGGGTGGGGAGAGCTGATGTGGAAGGCAGAGAAGGATTCTTTCTTCCAGCCCT
GGATCTCCTTCTCCATAAAGAACAAAGAGGTGTCCGTACAAAAGTCCACCAAAGAC
CTCAAGCTCCAGCTGAAGGAAACGCTCCCACTCACCCTCAAGATACCCCAGGTCTCG
CTTCAGTTTGCTGGTTCTGGCAACCTGACTCTGACTCTGGACAAAGGGACACTGCAT
CAGGAAGTGAACCTGGTGGTGATGAAAGTGGCTCAGCTCAACAATACTTTGACCTGT
GAGGTGATGGGACCTACCTCTCCCAAGATGAGACTGACCCTGAAGCAGGAGAACCA
GGAGGCCAGGGTCTCTGAGGAGCAGAAAGTAGTTCAAGTGGTGGCCCCTGAGACAG
GGCTGTGGCAGTGTCTACTGAGTGAAGGTGATAAGGTCAAGATGGACTCCAGGATC
CAGGTTTTATCCAGAGGGGTGAACCAGACAGTG

SEQ ID NO: 153 mCD4-d1-4, amino acid sequence
KTLVLGKEGESAELPCESSQKKITVFTWKFSDQRKILGQHGKGVLIRGGSPSQFDRFDSK
KGAWEKGSFPLIINKLKMEDSQTYICELENRKEEVELWVFKVTFSPGTSLLQGQSLTLTL
DSNSKVSNPLTECKHKKGKVVSGSKVLSMSNLRVQDSDFWNCTVTLDQKKNWFGMTL
SVLGFQSTAITAYKSEGESAEFSFPLNFAEENGWGELMWKAEKDSFFQPWISFSIKNKEV
SVQKSTKDLKLQLKETLPLTLKIPQVSLQFAGSGNLTLTLDKGTLHQEVNLVVMKVAQL
NNTLTCEVMGPTSPKMRLTLKQENQEARVSEEQKVVQVVAPETGLWQCLLSEGDKVK
MDSRIQVLSRGVNQTV

SEQ ID NO: 154: hIL12p70, amino acid sequence
MCHQQLVISWFSLVFLASPLVAIWELKKDVYVVELDWYPDAPGEMVVLTCDTPEEDGI
TWTLDQSSEVLGSGKTLTIQVKEFGDAGQYTCHKGGEVLSHSLLLLHKKEDGIWSTDIL
KDQKEPKNKTFLRCEAKNYSGRFTCWWLTTISTDLTFSVKSSRGSSDPQGVTCGAATLS
AERVRGDNKEYEYSVECQEDSACPAAEESLPIEVMVDAVHKLKYENYTSSFFIRDIIKPD
PPKNLQLKPLKNSRQVEVSWEYPDTWSTPHSYFSLTFCVQVQGKSKREKKDRVFTDKT
SATVICRKNASISVRAQDRYYSSSWSEWASVPCSVPGVGVPGVGRNLPVATPDPGMFPC
LHHSQNLLRAVSNMLQKARQTLEFYPCTSEEIDHEDITKDKTSTVEACLPLELTKNESCL
NSRETSFITNGSCLASRKTSFMMALCLSSIYEDLKMYQVEFKTMNAKLLMDPKRQIFLD
QNMLAVIDELMQALNFNSETVPQKSSLEEPDFYKTKIKLCILLHAFRIRAVTIDRVMSYL
NAS

SEQ ID NO: 155: hIL12p70, nucleic acid sequence
atgtgtcaccagcagttggtcatctcttggttttccctggtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcg
tagaattggattggtatccggatgcccctggagaaatggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggac
cagagcagtgaggtcttaggctctggcaaaaccctgaccatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggag
gcgaggttctaagccattcgctcctgctgcttcacaaaaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaa
ataagacctttctaagatgcgaggccaagaattattctggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtc
aaaagcagcagaggctcttctgacccccaaggggtgacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaagg
agtatgagtactcagtggagtgccaggaggacagtgcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttca
caagctcaagtatgaaaactacaccagcagcttcttcatcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaa
agaattctcggcaggtggaggtcagctgggagtaccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtcc
agggcaagagcaagagagaaaagaaagatagagtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagc
gtgcgggcccaggaccgctactatagctcatcttggagcgaatgggcatctgtgccctgcagtgttcctggagtaggggtacctggagtgg
gcagaaacctccccgtggccactccagacccaggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgct
ccagaaggccagacaaactctagaattttacccttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtgg
aggcctgtttaccattggaattaaccaagaatgagagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccag
aaagacctcttttatgatggccctgtgccttagtagtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttc
tgatggatcctaagaggcagatctttctagatcaaaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgt
gccacaaaaatcctcccttgaagaaccggatttttataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactat
tgatagagtgatgagctatctgaatgcttcctaa

SEQ ID NO: 156 hIL12p40, nucleic acid sequence
atgtgtcaccagcagttggtcatctcttggttttccctggtttttctggcatctcccctcgtggccatatgggaactgaagaaagatgtttatgtcg
tagaattggattggtatccggatgcccctggagaaatggtggtcctcacctgtgacacccctgaagaagatggtatcacctggaccttggac
cagagcagtgaggtcttaggctctggcaaaaccctgaccatccaagtcaaagagtttggagatgctggccagtacacctgtcacaaaggag
gcgaggttctaagccattcgctcctgctgcttcacaaaaaggaagatggaatttggtccactgatattttaaaggaccagaaagaacccaaaa
ataagacctttctaagatgcgaggccaagaattattctggacgtttcacctgctggtggctgacgacaatcagtactgatttgacattcagtgtc
aaaagcagcagaggctcttctgacccccaaggggtgacgtgcggagctgctacactctctgcagagagagtcagaggggacaacaagg
agtatgagtactcagtggagtgccaggaggacagtgcctgcccagctgctgaggagagtctgcccattgaggtcatggtggatgccgttca
caagctcaagtatgaaaactacaccagcagcttcttcatcagggacatcatcaaacctgacccacccaagaacttgcagctgaagccattaa
agaattctcggcaggtggaggtcagctgggagtaccctgacacctggagtactccacattcctacttctccctgacattctgcgttcaggtcc
agggcaagagcaagagagaaaagaaagatagagtcttcacggacaagacctcagccacggtcatctgccgcaaaaatgccagcattagc
gtgcgggcccaggaccgctactatagctcatcttggagcgaatgggcatctgtgccctgcagt

SEQ ID NO: 157 $(VPGVG)_2$ linker, nucleotide sequence
gttcctggagtaggggtacctggagtgggc

SEQ ID NO: 158 hIL12p35, nucleotide sequence
agaaacctccccgtggccactccagacccaggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctcc
agaaggccagacaaactctagaattttacccttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggag
gcctgtttaccattggaattaaccaagaatgagagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaa
agacctcttttatgatggccctgtgccttagtagtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctg
atggatcctaagaggcagatctttctagatcaaaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgc
cacaaaaatcctcccttgaagaaccggatttttataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattg
atagagtgatgagctatctgaatgcttcctaa

SEQ ID NO: 159 mIL12p70, amino acid sequence
MCPQKLTISWFAIVLLVSPLMAMWELEKDVYVVEVDWTPDAPGETVNLTCDTPEEDDI
TWTSDQRHGVIGSGKTLTITVKEFLDAGQYTCHKGGETLSHSHLLLHKKENGIWSTEILK
NFKNKTFLKCEAPNYSGRFTCSWLVQRNMDLKFNIKSSSSSPDSRAVTCGMASLSAEKV
TLDQRDYEKYSVSCQEDVTCPTAEETLPIELALEARQQNKYENYSTSFFIRDIIKPDPPKN
LQMKPLKNSQVEVSWEYPDSWSTPHSYFSLKFFVRIQRKKEKMKETEEGCNQKGAFLV
EKTSTEVQCKGGNVCVQAQDRYYNSSCSKWACVPCRVRSVPGVGVPGVGRVIPVSGPA
RCLSQSRNLLKTTDDMVKTAREKLKHYSCTAEDIDHEDITRDQTSTLKTCLPLELHKNES
CLATRETSSTTRGSCLPPQKTSLMMTLCLGSIYEDLKMYQTEFQAINAALQNHNHQQIIL
DKGMLVAIDELMQSLNHNGETLRQKPPVGEADPYRVKMKLCILLHAFSTRVVTINRVM
GYLSSA

SEQ ID NO: 160 mIL12p70, nucleotide sequence
ATGTGTCCTCAGAAGCTAACCATCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCAC
TCATGGCCATGTGGGAGCTGGAGAAAGACGTTTATGTTGTAGAGGTGGACTGGACT
CCCGATGCCCCTGGAGAAACAGTGAACCTCACCTGTGACACGCCTGAAGAAGATGA
CATCACCTGGACCTCAGACCAGAGACATGGAGTCATAGGCTCTGGAAAGACCCTGA
CCATCACTGTCAAAGAGTTTCTAGATGCTGGCCAGTACACCTGCCACAAAGGAGGC
GAGACTCTGAGCCACTCACATCTGCTGCTCCACAAGAAGGAAAATGGAATTTGGTCC
ACTGAAATTTTAAAAAATTTCAAAAACAAGACTTTCCTGAAGTGTGAAGCACCAAAT
TACTCCGGACGGTTCACGTGCTCATGGCTGGTGCAAAGAAACATGGACTTGAAGTTC
AACATCAAGAGCAGTAGCAGTTCCCCTGACTCTCGGGCAGTGACATGTGGAATGGC
GTCTCTGTCTGCAGAGAAGGTCACACTGGACCAAAGGGACTATGAGAAGTATTCAG
TGTCCTGCCAGGAGGATGTCACCTGCCCAACTGCCGAGGAGACCCTGCCCATTGAAC
TGGCGTTGGAAGCACGGCAGCAGAATAAATATGAGAACTACAGCACCAGCTTCTTC
ATCAGGGACATCATCAAACCAGACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAA
GAACTCACAGGTGGAGGTCAGCTGGGAGTACCCTGACTCCTGGAGCACTCCCCATTC
CTACTTCTCCCTCAAGTTCTTTGTTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGA
GACAGAGGAGGGGTGTAACCAGAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCG
AAGTCCAATGCAAAGGCGGGAATGTCTGCGTGCAAGCTCAGGATCGCTATTACAAT
TCCTCATGCAGCAAGTGGGCATGTGTTCCCTGCAGAGTCCGATCGgttcctggagtaggggtac
ctggagtgggcAGGGTCATACCGGTCTCTGGACCTGCCAGGTGTCTTAGCCAGTCCCGAAA
CCTGCTGAAGACCACAGATGACATGGTGAAGACGGCCAGAGAAAAGCTGAAACATT
ATTCCTGCACTGCTGAAGACATCGATCATGAAGACATCACACGGGACCAAACCAGC

ACATTGAAGACCTGTTTACCACTGGAACTACACAAGAACGAGAGTTGCCTGGCTACT
AGAGAGACTTCTTCCACAACAAGAGGGAGCTGCCTGCCCCCACAGAAGACGTCTTT
GATGATGACCCTGTGCCTTGGTAGCATCTATGAGGACTTGAAGATGTACCAGACAGA
GTTCCAGGCCATCAACGCAGCACTTCAGAATCACAACCATCAGCAGATCATTCTAGA
CAAGGGCATGCTGGTGGCCATCGATGAGCTGATGCAGTCTCTGAATCATAATGGCG
AGACTCTGCGCCAGAAACCTCCTGTGGGAGAAGCAGACCCTTACAGAGTGAAAATG
AAGCTCTGCATCCTGCTTCACGCCTTCAGCACCCGCGTCGTGACCATCAACAGGGTG
ATGGGCTATCTGAGCTCCGCCTGA

SEQ ID NO: 161 mIL12p40, nucleotide sequence
ATGTGTCCTCAGAAGCTAACCATCTCCTGGTTTGCCATCGTTTTGCTGGTGTCTCCAC
TCATGGCCATGTGGGAGCTGGAGAAAGACGTTTATGTTGTAGAGGTGGACTGGACT
CCCGATGCCCCTGGAGAAACAGTGAACCTCACCTGTGACACGCCTGAAGAAGATGA
CATCACCTGGACCTCAGACCAGAGACATGGAGTCATAGGCTCTGGAAAGACCCTGA
CCATCACTGTCAAAGAGTTTCTAGATGCTGGCCAGTACACCTGCCACAAAGGAGGC
GAGACTCTGAGCCACTCACATCTGCTGCTCCACAAGAAGGAAAATGGAATTTGGTCC
ACTGAAATTTTAAAAAATTTCAAAAACAAGACTTTCCTGAAGTGTGAAGCACCAAAT
TACTCCGGACGGTTCACGTGCTCATGGCTGGTGCAAAGAAACATGGACTTGAAGTTC
AACATCAAGAGCAGTAGCAGTTCCCCTGACTCTCGGGCAGTGACATGTGGAATGGC
GTCTCTGTCTGCAGAGAAGGTCACACTGGACCAAAGGGACTATGAGAAGTATTCAG
TGTCCTGCCAGGAGGATGTCACCTGCCCAACTGCCGAGGAGACCCTGCCCATTGAAC
TGGCGTTGGAAGCACGGCAGCAGAATAAATATGAGAACTACAGCACCAGCTTCTTC
ATCAGGGACATCATCAAACCAGACCCGCCCAAGAACTTGCAGATGAAGCCTTTGAA
GAACTCACAGGTGGAGGTCAGCTGGGAGTACCCTGACTCCTGGAGCACTCCCCATTC
CTACTTCTCCCTCAAGTTCTTTGTTCGAATCCAGCGCAAGAAAGAAAAGATGAAGGA
GACAGAGGAGGGGTGTAACCAGAAAGGTGCGTTCCTCGTAGAGAAGACATCTACCG
AAGTCCAATGCAAAGGCGGGAATGTCTGCGTGCAAGCTCAGGATCGCTATTACAAT
TCCTCATGCAGCAAGTGGGCATGTGTTCCCTGCAGAGTCCGATCG

SEQ ID NO: 162 huIL12 p35 signal peptide, amino acid sequence
MWPPGSASQPPPSPAAATGLHPAARPVSLQCRLSMCPARSLLLVATLVLLDHLSLA

SEQ ID NO: 163 5' to 3' VSV-M51R-hIL12p70, nucleic acid sequence
ACGAAGACAAACAAACCATTATTATCATTAAAAGGCTCAGGAGAAACTTTAACAGT
AATCAAAATGTCTGTTACAGTCAAGAGAATCATTGACAACACAGTCGTAGTTCCAAA
ACTTCCTGCAAATGAGGATCCAGTGGAATACCCGGCAGATTACTTCAGAAAATCAA
AGGAGATTCCTCTTTACATCAATACTACAAAAAGTTTGTCAGATCTAAGAGGATATG
TCTACCAAGGCCTCAAATCCGGAAATGTATCAATCATACATGTCAACAGCTACTTGT
ATGGAGCATTAAAGGACATCCGGGGTAAGTTGGATAAAGATTGGTCAAGTTTCGGA
ATAAACATCGGGAAAGCAGGGGATACAATCGGAATATTTGACCTTGTATCCTTGAA
AGCCCTGGACGGCGTACTTCCAGATGGAGTATCGGATGCTTCCAGAACCAGCGCAG
ATGACAAATGGTTGCCTTTGTATCTACTTGGCTTATACAGAGTGGGCAGAACACAAA
TGCCTGAATACAGAAAAAAGCTCATGGATGGGCTGACAAATCAATGCAAAATGATC
AATGAACAGTTTGAACCTCTTGTGCCAGAAGGTCGTGACATTTTTGATGTGTGGGGA
AATGACAGTAATTACACAAAAATTGTCGCTGCAGTGGACATGTTCTTCCACATGTTC
AAAAAACATGAATGTGCCTCGTTCAGATACGGAACTATTGTTTCCAGATTCAAAGAT

TGTGCTGCATTGGCAACATTTGGACACCTCTGCAAAATAACCGGAATGTCTACAGAA
GATGTAACGACCTGGATCTTGAACCGAGAAGTTGCAGATGAAATGGTCCAAATGAT
GCTTCCAGGCCAAGAAATTGACAAGGCCGATTCATACATGCCTTATTTGATCGACTT
TGGATTGTCTTCTAAGTCTCCATATTCTTCCGTCAAAAACCCTGCCTTCCACTTCTGG
GGGCAATTGACAGCTCTTCTGCTCAGATCCACCAGAGCAAGGAATGCCCGACAGCC
TGATGACATTGAGTATACATCTCTTACTACAGCAGGTTTGTTGTACGCTTATGCAGTA
GGATCCTCTGCCGACTTGGCACAACAGTTTTGTGTTGGAGATAACAAATACACTCCA
GATGATAGTACCGGAGGATTGACGACTAATGCACCGCCACAAGGCAGAGATGTGGT
CGAATGGCTCGGATGGTTTGAAGATCAAAACAGAAAACCGACTCCTGATATGATGC
AGTATGCGAAAAGAGCAGTCATGTCACTGCAAGGCCTAAGAGAGAAGACAATTGGC
AAGTATGCTAAGTCAGAATTTGACAAATGACCCTATAATTCTCGAGTCACCTATTAT
ATATTATGCTACATATGAAAAAAACTAACAGATATCATGGATAATCTCACAAAAGTT
CGTGAGTATCTCAAGTCCTATTCTCGTCTGGATCAGGCGGTAGGAGAGATAGATGAG
ATCGAAGCACAACGAGCTGAAAAGTCCAATTATGAGTTGTTCCAAGAGGATGGAGT
GGAAGAGCATACTAAGCCCTCTTATTTTCAGGCAGCAGATGATTCTGACACAGAATC
TGAACCAGAAATTGAAGACAATCAAGGCTTGTATGCACCAGATCCAGAAGCAGAGC
AAGTTGAAGGCTTTATACAGGGGCCTTTAGATGACTATGCAGATGAGGAAGTGGAT
GTTGTATTTACTTCGGACTGGAAACAGCCTGAGCTTGAATCTGACGAGCATGGAAAG
ACCTTACGGTTGACATCGCCAGAGGGTTTAAGTGGAGAGCAGAAATCCCAGTGGCT
TTCGACGATTAAAGCAGTCGTGCAAAGTGCCAAATACTGGAATCTGGCAGAGTGCA
CATTTGAAGCATCGGGAGAAGGGGTCATTATGAAGGAGCGCCAGATAACTCCGGAT
GTATATAAGGTCACTCCAGTGATGAACACACATCCGTCCCAATCAGAAGCAGTATCA
GATGTTTGGTCTCTCTCAAAGACATCCATGACTTTCCAACCCAAGAAAGCAAGTCTT
CAGCCTCTCACCATATCCTTGGATGAATTGTTCTCATCTAGAGGAGAGTTCATCTCTG
TCGGAGGTGACGGACGAATGTCTCATAAAGAGGCCATCCTGCTCGGCCTGAGATAC
AAAAAGTTGTACAATCAGGCGAGAGTCAAATATTCTCTGTAGACTATGAAAAAAAG
TAACAGATATCACGATCTAAGTGTTACCCGGGTCCATTCATCATGAGTTCCTTAAAG
AAGATTCTCGGTCTGAAGGGGAAAGGTAAGAAATCTAAGAAATTAGGGATCGCACC
ACCCCCTTATGAAGAGGACACTAGCATGGAGTATGCTCCGAGCGCTCCAATTGACA
AATCCTATTTTGGAGTTGACGAGCGAGACACCTATGATCCGAATCAATTAAGATATG
AGAAATTCTTCTTTACAGTGAAAATGACGGTTAGATCTAATCGTCCGTTCAGAACAT
ACTCAGATGTGGCAGCCGCTGTATCCCATTGGGATCACATGTACATCGGAATGGCAG
GGAAACGTCCCTTCTACAAAATCTTGGCTTTTTTGGGTTCTTCTAATCTAAAGGCCAC
TCCAGCGGTATTGGCAGATCAAGGTCAACCAGAGTATCACGCTCACTGCGAAGGCA
GGGCTTATTTGCCACATAGGATGGGGAAGACCCCTCCCATGCTCAATGTACCAGAGC
ACTTCAGAAGACCATTCAATATAGGTCTTTACAAGGGAACGATTGAGCTCACAATGA
CCATCTACGATGATGAGTCACTGGAAGCAGCTCCTATGATCTGGGATCATTTCAATT
CTTCCAAATTTTCTGATTTCAGAGAGAAGGCCTTAATGTTTGGCCTGATTGTCGAGA
AAAAGGCATCTGGAGCGTGGGTCCTGGACTCTATCGGCCACTTCAAATGAGCTAGTC
TAACTGCATGCTTCTGAACAATCCCCGGTTTACTCAGTCTCCCCTAATTCCAGCCTCT
CGAACAACTAATATCCTGTCTTTTCTATCCCTATGAAAAAAACTAACAGAGATCGAT
CTGTTTACGCGTCACTATGAAGTGCCTTTTGTACTTAGCCTTTTTATTCATTGGGGTG
AATTGCAAGTTCACCATAGTTTTTCCACACAACCAAAAAGGAAACTGGAAAAATGTT
CCTTCTAATTACCATTATTGCCCGTCAAGCTCAGATTTAAATTGGCATAATGACTTAA
TAGGCACAGCCTTACAAGTCAAAATGCCCAAGAGTCACAAGGCTATTCAAGCAGAC
GGTTGGATGTGTCATGCTTCCAAATGGGTCACTACTTGTGATTTCCGCTGGTATGGA

CCGAAGTATATAACACATTCCATCCGATCCTTCACTCCATCTGTAGAACAATGCAAG
GAAAGCATTGAACAAACGAAACAAGGAACTTGGCTGAATCCAGGCTTCCCTCCTCA
AAGTTGTGGATATGCAACTGTGACGGATGCCGAAGCAGTGATTGTCCAGGTGACTCC
TCACCATGTGCTGGTTGATGAATACACAGGAGAATGGGTTGATTCACAGTTCATCAA
CGGAAAATGCAGCAATTACATATGCCCCACTGTCCATAACTCTACAACCTGGCATTC
TGACTATAAGGTCAAAGGGCTATGTGATTCTAACCTCATTTCCATGGACATCACCTT
CTTCTCAGAGGACGGAGAGCTATCATCCCTGGGAAAGGAGGGCACAGGGTTCAGAA
GTAACTACTTTGCTTATGAAACTGGAGGCAAGGCCTGCAAAATGCAATACTGCAAG
CATTGGGGAGTCAGACTCCCATCAGGTGTCTGGTTCGAGATGGCTGATAAGGATCTC
TTTGCTGCAGCCAGATTCCCTGAATGCCCAGAAGGGTCAAGTATCTCTGCTCCATCT
CAGACCTCAGTGGATGTAAGTCTAATTCAGGACGTTGAGAGGATCTTGGATTATTCC
CTCTGCCAAGAAACCTGGAGCAAAATCAGAGCGGGTCTTCCAATCTCTCCAGTGGAT
CTCAGCTATCTTGCTCCTAAAAACCCAGGAACCGGTCCTGCTTTCACCATAATCAAT
GGTACCCTAAAATACTTTGAGACCAGATACATCAGAGTCGATATTGCTGCTCCAATC
CTCTCAAGAATGGTCGGAATGATCAGTGGAACTACCACAGAAAGGGAACTGTGGGA
TGACTGGGCACCATATGAAGACGTGGAAATTGGACCCAATGGAGTTCTGAGGACCA
GTTCAGGATATAAGTTTCCTTTATACATGATTGGACATGGTATGTTGGACTCCGATCT
TCATCTTAGCTCAAAGGCTCAGGTGTTCGAACATCCTCACATTCAAGACGCTGCTTC
GCAACTTCCTGATGATGAGAGTTTATTTTTTGGTGATACTGGGCTATCCAAAAATCC
AATCGAGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAAGCTCTATTGCCTCTTTTTTC
TTTATCATAGGGTTAATCATTGGACTATTCTTGGTTCTCCGAGTTGGTATCCATCTTT
GCATTAAATTAAAGCACACCAAGAAAAGACAGATTTATACAGACATAGAGATGAAC
CGACTTGGAAAGTAAGCTAGCAAATCCTGCTAGGTATGAAAAAAACTAACAGATAT
CAGCTCAGCTGCCACCatgtgtcaccagcagttggtcatctcttggttttccctggttttttctggcatctcccctcgtggccatatg
ggaactgaagaaagatgtttatgtcgtagaattggattggtatccggatgcccctggagaaatggtggtcctcacctgtgacacccctgaaga
agatggtatcacctggaccttggaccagagcagtgaggtcttaggctctggcaaaaccctgaccatccaagtcaaagagtttggagatgctg
gccagtacacctgtcacaaaggaggcgaggttctaagccattcgctcctgctgcttcacaaaaaggaagatggaatttggtccactgatatttt
aaaggaccagaaagaacccaaaaataagacctttctaagatgcgaggccaagaattattctggacgtttcacctgctggtggctgacgaca
atcagtactgatttgacattcagtgtcaaaagcagcagaggctcttctgacccccaaggggtgacgtgcggagctgctacactctctgcaga
gagagtcagaggggacaacaaggagtatgagtactcagtggagtgccaggaggacagtgcctgcccagctgctgaggagagtctgccc
attgaggtcatggtggatgccgttcacaagctcaagtatgaaaactacaccagcagcttcttcatcagggacatcatcaaacctgacccaccc
aagaacttgcagctgaagccattaaagaattctcggcaggtggaggtcagctgggagtaccctgacacctggagtactccacattcctactt
ctccctgacattctgcgttcaggtccagggcaagagcaagagagaaaagaaagatagagtcttcacggacaagacctcagccacggtcat
ctgccgcaaaaatgccagcattagcgtgcgggcccaggaccgctactatagctcatcttggagcgaatgggcatctgtgccctgcagtgttc
ctggagtaggggtacctggagtgggcagaaacctccccgtggccactccagacccaggaatgttcccatgccttcaccactcccaaaacct
gctgagggccgtcagcaacatgctccagaaggccagacaaactctagaattttacccttgcacttctgaagagattgatcatgaagatatcac
aaaagataaaaccagcacagtggaggcctgtttaccattggaattaaccaagaatgagagttgcctaaattccagagagacctctttcataac
taatgggagttgcctggcctccagaaagacctcttttatgatggccctgtgccttagtagtatttatgaagacttgaagatgtaccaggtggagt
tcaagaccatgaatgcaaagcttctgatggatcctaagaggcagatctttctagatcaaaacatgctggcagttattgatgagctgatgcagg
ccctgaatttcaacagtgagactgtgccacaaaaatcctcccttgaagaaccggatttttataaaactaaaatcaagctctgcatacttcttcatg
ctttcagaattcgggcagtgactattgatagagtgatgagctatctgaatgcttcctaaGCTAAGCAAATACAACAGATTC
TTCATGTTTGGACCAAATCAACTTGTGATACCATGCTCAAAGAGGCCTCAATTATAT
TTGAGTTTTTAATTTTTATGAAAAAAACTAACAGCAATCATGGAAGTCCACGATTTT
GAGACCGACGAGTTCAATGATTTCAATGAAGATGACTATGCCACAAGAGAATTCCT
GAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATTACAACCTGAATTCTCC
TCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTCAATTCTCTTCCAATTCCC

TCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGATGTTAACGTCATGTCAA
GCCAATCCCATCCCAACATCTCAGATGCATAAATGGATGGGAAGTTGGTTAATGTCT
GATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATGAAGTGGACAAAGAGGC
AGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGCTGGGGCAACAAACCAA
TTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAAAATTCTCGCTTATTTGT
GTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTAAATGCTGTCTCTGAGG
TGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTCAGAAGAAGTTCTCAT
GGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCTACTTTTATTTCAGAA
GGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGAAACTTTCTGTTAATG
GTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCCATGGTATGTAGAAT
AGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAATATCTACAGAATTGG
AGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTGATTAAAATGGTGGA
ACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATCAAGGCCTTTAGTCC
CACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGATGAAGGGGCAAAAA
TTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGTGAAAACAGTGGATC
TCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCCTTTTATAGATTATTA
CACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAAAGATATTGATGTGT
CATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCTATTTCAACAGTTCA
ATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCATGATCATCCCTTTA
AAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGTTCAAGATTTTGGA
GATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACCCGACTTACTAGAC
CCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTCAGAGGTGTTGAAA
CATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGGTGTTGCAGACTATG
TTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAGATTGATGAGAAGGG
CTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGAGAGGGAACTGAAGT
TGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGAATACTTTGTAATTAC
CGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGCCTGACAATGGCGGA
CGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCCGGCCAAGGATTGAA
GTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGAAAAATGGAATAACC
ACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGGGCCAGTTCTTAGGTT
ATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAAGTCTTATATACTACA
ATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGATCAATTCAACCTCCC
AACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGTCTACGGCAAAAAGG
ATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAAAATCAGAAACACTGC
TGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCACACAGTATAAAACGAA
GAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATCAAATGGTTTCTAATAA
TGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAGTTAGGACTTTTGATAA
ATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTATGGAAAAATACCGATTT
TCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTCACGAGTGACTTGTGTC
ACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTCAGTTTCCACAAATGCT
CTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCATGATACAGTACAATTAT
TTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCTGCTCTTCGTCAATCAT
TGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCTACTTTCAAATACGCCA
TGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATGTCTTTGTCCAGGTTTTT
GATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCATTCTGGAGATTCATCCA
TGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCAGTATTTGGAAACCCCG

AGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGTAGAAGATCCAACCTCT
CTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAAGACTGAGGTTAAAAA
ATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGATTAAGGATGCAACCA
TATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTATGGTCAATAAATCCTC
TGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTTGGGAGTCGCAGACG
GGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTCCTTTAAGAAAAAGT
ATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATCCTCTTTGACACATT
TAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGACATGTTCAGCTACTC
ATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTATTGGGACAACTGTAC
CCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGACTCCTTGTGCACCAT
GTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGACGGGATCCATGACG
TCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAAAACATCTGAATCTAC
ATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACTGATTAAAAGAGCTA
CACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTCTAAACTAGCAATGA
CTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGACCAAAAGGCAGCATG
GGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATCTCGGATGAGCCATG
GTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGATGGCAACTACAGAC
ACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCAAGCAACGTTGCTC
TATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCACCAGTTGTACAGAT
CATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGAGATCACCCTGGAC
TCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAAGACATGGAGGAA
TGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTTTAGAAGGGAATT
GGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGATGTATAGGTTTTC
TATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGACAGTTCTCTATTTC
CTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAGGGTTGCTAGACG
GATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGTCTGGCTCATTTG
AAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATTGATAAATTGAGT
GTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAGACGAATTAGAA
ACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGTGATATGGGGGT
GATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAGGGAAAATACA
GATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATAGACTTCATTGG
ACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCATTTTTATCTGGG
AAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGCTAAGATCAGG
AGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATATTATTGTGTCC
AGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAATAATAAAGACA
TGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAACAATCCCTGTTT
ATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAGAATCCAAAATC
CCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCATTATAAAATTC
GGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAGTTGTGGAGACG
GCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATAGCAGAGGAATA
TTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCTCTCCTGAGCCC
CCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTAAATGGTGAAAC
ATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGACTATTTCCTCCG
ACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGATATGGAAGTTCG
GGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTATGTGCACCGGAT
TTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATATATTTGTGAGAG

CGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTCGACTTAGTTCA
AACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGTAAAGGTTTGAA
GAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAATCCTGGAAAAA
CCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAAGAAGGTTAGTA
CATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCTTTTGTAAACAT
TGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCATGCGGCTGCCTT
AAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTTATATGGCGATT
ATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTCCGAACCCCCCA
TCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATAAGCTTTTGGCTG
AGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCAGTTATCCAGCAA
TCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATACAAGCAGAAGTG
GAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGACTCCTTGGCCCC
AATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGTTCGTCTAAATCC
ATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAATCATTTGAAATG
GTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATAGACGAATTTCAA
AAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAGGAAAACTCTTGG
AGAGATTAAAAAATCATGAGGAGACTCCAAACTTTAAGTATGAAAAAAACTTTGAT
CCTTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCTTCGT

SEQ ID NO: 164 3' to 5' VSV-M51R-hIL12p70, nucleic acid sequence
ACGAAGACCACAAAACCAGATAAAAAATAAAAACCACAAGAGGGTCTTAAGGATC
AAAGTTTTTTTCATACTTAAAGTTTGGAGTCTCCTCATGATTTTTTAATCTCTCCAAG
AGTTTTCCTCGTGTAGGTCACTCTTCAACATCAGTATAGACCGGTCTTCTTTTGAAAT
TCGTCTATTGATCCATTCAATCATTCCTGTGTTTCTTCGCAAATTTGACCATTTCAAA
TGATTATCCACTGTACGACATAGCTGATTGAACAAGATCTCATTGAATGGATTTAGA
CGAACTTGGTTTCGGACCAATTCCAGAGATCTGATCCAGTTCCCGATTGGGGCCAAG
GAGTCTGAAATTCGGGTATCTTTTGGGAGCCCATCACCTCTAGTACTCCACTTCTGCT
TGTATCCTCCTTTTACTGAAACAGCCTCCCACCTAATCGGGAATGATTGCTGGATAA
CTGCTAAACACTGTTGATATAGTGGAATGTCTTTCTCCATCAAACTCAGCCAAAAGC
TTATACCAGTTATAGCGATCCCCACATTTTGTGCAATTCCATCTGATGGGGGGTTCG
GAGGTATCGGTCCTACTCTGATATGATTGATGTTATAATACGATATAATCGCCATAT
AAAAAAGGCTAATGGTCAATAAATCTGCAGGTCTATCAGATGATTTTAAGGCAGCC
GCATGAGACACACCCGTGGGTACTCCGAATATTTGTAGCATAGTCTCAATGTTTACA
AAAGGATCAGGAATGAATTGGGAGGGAATACCTGTCAAGGTAAAGTATGTACTAAC
CTTCTTTGCTCTGGCAAATTCCTGTTCTGATGACTGGAATGCGTACAGGTTTTTCCAG
GATTCATTGATGGAAGACCAATCGGGATTGGGTTCATCGATTAATTTCTTCAAACCT
TTACATACCATATATACTTCAGACGTTTGAGAACTACTAAATTCTGTTTGAACTAAGT
CGACCGTCTTGAACATGGGACCAAGGATTGTTACTGCATTCTTTTCGCTCTCACAAA
TATATGTTCCATAAGTCTTGTAGATTAAAACTCCTTGCTCATCCAAAATCCGGTGCAC
ATAATTTCTAACATTCGTCTCAATTTTCAGGCTAGTAGAAGAATCCCGAACTTCCAT
ATCCATTACAATTAAATCAATTTGAAGCCCCAAGCCTGCTTTGAGTCGGAGGAAATA
GTCCCAAGTCCTTGGGTCACATAAGTCAGATGGATATTCCCAACATGTTTCACCATT
TACACATCTCGATTTATCTCCTCCTAAAGTTTCTAGGGCACTGGGGGGCTCAGGAGA
GGCGCCTCGCATGACTGACCCTGATAATTCTAACAGACTATTGAATATTCCTCTGCT
ATGCACATTTTCTCGTAGTAATGCAGCAGTCATCCCTCCGGAGCCGTCTCCACAACT
CAAGAAGTCCCTGTAATGGATTCCCATTCCATGTAATATACTCCGAATTTTATAATG

AGCGCCAGTTGGTAATTGGCCCAACCTGATTCCGGACAGCAGGGGATTTTGGATTCT
TGGAGGCATCTCTAGCATCTTTGGGTAAGGGGTGGTCGTATAATAAACAGGGATTGT
TGTAATTGTCCCTCTGGATTCCCTTCCCCAAGGGGGATAGCTCATGTCTTTATTATTA
TCCTTAGCAATCCCGAACTTGCAAGCATGTCTGATTTCCTCTGGACACAATAATATG
TCCTTGGTGAAGAATTTCACATGTATGTCTTCCCACCCCTCTCCTGATCTTAGCAATG
AAGAAAGATTTGCCAGCTCTCTCAACTCATTCTTATCTTTCCCAGATAAAAATGGCTT
GTATAGGATTTGCAAGAGGGTGGTGGAAATAGAGAATGGTCCAATGAAGTCTATGG
ATAAGACATCTGAGAATAACCATAATTGTGAATAATGTGATCTGTATTTTCCCTTTTC
AATTAGACGGCATTGGTATTTGAAGTAATTTCTGACAATCACCCCCATATCACGGTT
GCTTGTCGGATAGGAGGTTGGGATCTTGTGGGGAATCGTTTCTAATTCGTCTCTAAT
AGGTCCTGATCTAGTAAGAGAAAGGAATGGAGGTGATACACTCAATTTATCAATCA
AGTAAATCAAACCTCCGTACACTGCGTTGGCCGGCCTCTTCAAATGAGCCAGACTTC
TCCGGTGTATTACTTGGCAGCAACTTGCTCTCATTAATCCGTCTAGCAACCCTTTTAA
GAAACCTCGACCTCTAATACGACCTTGTATAGATAGAGGAAATAGAGAACTGTCCTC
GGCATGAGTAGATTTTCTATACGCCAAGTCTCCATATAGAAAACCTATACATCTGCC
GACTTGATAGGATTGCTCTGCAGGTGCTAAATTCTTCCAATTCCCTTCTAAAGGATA
GATCTGTTTTATCTCTTGTCCCCACGAACCTTCCCCATTCCTCCATGTCTTCAGCACA
TGGGATACATCTGGGGGCGTGTAGTCCATACTTGAGTCCAGGGTGATCTCTTCTATG
GGTCTCAAACAGGACTTACAGGCAATATGATAATGATCTGTACAACTGGTGATCCAT
CCGTCTCTTGCAACAGTGGTGGTAATTTGAGCATAGAGCAACGTTGCTTGGAATAAA
AAGTCGAAATTCTGATCTCCCAGATCCCTCATGGTGTCTGTAGTTGCCATCAACCTG
GTCAATGCTGCAGTGCTCTGAGATGCGAACCCACCATGGCTCATCCGAGATGTCGAA
AACCTATGAAGGGCAGACCCTGTTCTTTTGAACCCATGCTGCCTTTTGGTCCATTCTT
CGCCTGTTAAAGAGTGGATGTTAGAAAGTATAGTCATTGCTAGTTTAGAGTCGGGTT
CAACAAACCAAGAGATAGCATCTCTAAGACGTGTAGCTCTTTTAATCAGTGGGACTT
TGCTTTCCCTTTCCCAAGGCTGCAAAATAGATGTAGATTCAGATGTTTTAGACCCTA
GATAAGCAGGCAATGGTCCCCGTGAACTAAAGACGTCATGGATCCCGTCTGGACAA
TGCACAGAAACATAATTGAACCCTGATGTGTTACATGGTGCACAAGGAGTCTCTTTT
CGATGTTGTGGACCCAACATTTCTAATGGATGGGGTACAGTTGTCCCAATAACTGTA
CGGCCCCAGGATTTGTATCTTAATGTGTCAGCATGAGTAGCTGAACATGTCCACATT
TTACATGATCCCCTTCTCAAATGAAGTTTCCCTAAATGTGTCAAAGAGGATACCTCA
CTCCTCACAATCAAATCATCCAATTCCCTATGATACTTTTTCTTAAAGGAGTTCCGAA
TAGTACGAGAATTTTGAAATAGACTGATGAGCCCGTCTGCGACTCCCAAAAAAGTG
CCTGATTTGAATTCACTTAAAAATCTAGGGAACAGAGGATTTATTGACCATAAGAAA
CTTCTGAGCCGATCCTCTTCATGATACAAATATATGGTTGCATCCTTAATCACCTGGT
TCCTGATGGTTTGTCTTGATTCGATTAAGCATTTTTTAACCTCAGTCTTTAACAAGTT
CGCTGGACTCATTCCCATAGCGATGTTCAGAGAGGTTGGATCTTCTACTAGCTTGTCT
ATGTGAGTTATTCGAAACTTGGCTATCTCGGGGTTTCCAAATACTGCACTCATCTCCT
TCAGATGCTCACTTCGAGCATGTACATGGATGAATCTCCAGAATGAGAGACTTTCTG
TTACGGGATCTGGGAAGGCTCTAATCAAAAACCTGGACAAAGACATGCCCGACACT
CCTCCAATGGAAGGGTCCAAATACAACATGGCGTATTTGAAAGTAGAACTGTGCAA
GCCCGGTATCTTATCTTGAACTTCATACAATGATTGACGAAGAGCAGGATCATGCAT
CATCAACAAGAGTCTAGCAAATGTCCCAAAATAATTGTACTGTATCATGGCATTGAT
TGGGTTCTCAGCAAAATGAGCTACGGTGAGAGCATTTGTGGAAACTGAGCTCATTAT
ATTAGCACAAGTGGGTATTTGGTCATTGGTGACACAAGTCACTCGTGACCATCTCTT
GGTCTCTAACCCTCTAATCACTCCACGGAAAATCGGTATTTTTCCATAATTCAAGTA

ATCTGCAGATTGCATAGTCTCATCGTCATTTATCAAAAGTCCTAACTTCCCTGTCCCT
ATTTTGATTGCAGTCATAATTTTCTCATTATTAGAAACCATTTGATTGAGAGCACCCT
GTAATTCTACAACGTTTCTCGATTTCTTCGTTTTATACTGTGTGCAAATAACTTGATT
ATCACCTTGTGCCAAGACTTTGACAGCAGTGTTTCTGATTTTAGCCTCTCTTTGAATA
ACCAGTAGATTGAGGATACTCCATCCTTTTTGCCGTAGACCTTCCAGTCCACCCTCTT
GTCCTTGCCAACAAACTCGTTGGGAGGTTGAATTGATCAGTGTGTTGTTGTGAACAC
GCATCAAGTCTGGTCTTCCATTGTAGTATATAAGACTTTTCTCAAAAAATTCATGAGT
TCTCTCGATTAAGGATGGATAACCTAAGAACTGGCCCATAACTCGGAACACTGGGCC
GTTTGATAACTTCCTTTGGTGGTTATTCCATTTTTCGTAATCAATGTGATTGGCTATG
CAAATTGCCTCATATGACTTCAATCCTTGGCCGGATGAGGAATCTAACATCTTTTTA
ATGACTGCAGTTAGATCGTCCGCCATTGTCAGGCCTTTAAACATAGGGACGAAATGA
GTCTTTATCAAATATTCGGTAATTACAAAGTATTCTCGCAATTTCCAAGACATTAGG
GAGAAAAATCTACCTGCCAACTTCAGTTCCCTCTCCTTTCCTTTAAGACCAATAATTA
GATCATCATCATCTAAGCCCTTCTCATCAATCTCTTTAAGAAATTCTTTCCAATTGGT
AGCCTTTGTGTCCAACATAGTCTGCAACACCTTTTTACTAGGGATAGGAGTGTTCGG
ATTCATTCGGACATGTTTCAACACCTCTGACCTATTCATTGAATGACTTTTGTCAGAG
TATATTATCGATGGGTCTAGTAAGTCGGGTATTTCAAAACATTTAATCAGCGGAAGT
TCATGCCATTTATCTCCAAAATCTTGAACTTGAGCAGCTGTGGGCCATGTATTTTCTT
TAACATGACTTTTAAAGGGATGATCATGAGGGAGCAAGTCTCCATTCACGAACCACT
TTTTATGATCATTGAACTGTTGAAATAGAACAATCCGAGCTAAATCACTTGCAAGTG
CTTTTGCATATGACACATCAATATCTTTCTTCATGGTTACTTGGGAATGTAATTTTTC
TAGTCCAGTGTAATAATCTATAAAAGGATGACCCCAATGTCTGAACGATCCATAAAT
CACCAGTGTGAGATCCACTGTTTTCACACTCATTATCTGATCATGGAGGAATCTTAT
ACCTCGGTCAATTTTTGCCCCTTCATCAACAGAAGTCTTGATATGATTTTCAAAATGA
GGGAATTGTGGGACTAAAGGCCTTGATTCTCTTGCTAATTTCATCAGCTTCAAGTTG
CATATCGGTTCCACCATTTTAATCAAGTCATAAGAAAAATTTCCCTGCCTCTCCACA
ATTTTATCTCCAATTCTGTAGATATTTAGAAGGGAGAAGATGTCTTGCTCTGAGAAC
AGGTTGTCTATTCTACATACCATGGATAGCACCGTTTGCATCCTCCCTATAATCACAT
CTTTGACCATTAACAGAAAGTTTCGGTCCATTAGAATATCAAGTTTCTTGAAGTAAG
CCCATCCTTCTGAAATAAAAGTAGGACCCAAGCTGGGAACCCTAATCCTGCATATGT
TCGTTCCATGAGAACTTCTTCTGACTTTGCCTTTGAAAGTCCTCGCCAAGTTGAGCAA
TTCCACCTCAGAGACAGCATTTAAGATTAATGTCAACTTGTGTAAGTCCAAAAACTT
TTGACACAAATAAGCGAGAATTTTGAATGAGTCAGTCCATCTTTCCTTTTTGATGTAT
TCAATTGGTTTGTTGCCCCAGCCGCGGATGAAGGTCTCCACCACGTCAAATGTTATT
TCTGCCTCTTTGTCCACTTCATGTAAAAAACTATACCCTTGACTGGCATCATGATTAT
CAGACATTAACCAACTTCCCATCCATTTATGCATCTGAGATGTTGGGATGGGATTGG
CTTGACATGACGTTAACATCTCAAGAACTCCATCCCAGTTCTTACTATCCCACATCG
AGGGAATTGGAAGAGAATTGAATTTCCTGATTAAATTGTCAATATCATCACTAATTA
GAGGAGAATTCAGGTTGTAATCAGCATGATTCAAGTACGTCATGCGCTCATCGGGAT
TCAGGAATTCTCTTGTGGCATAGTCATCTTCATTGAAATCATTGAACTCGTCGGTCTC
AAAATCGTGGACTTCCATGATTGCTGTTAGTTTTTTTCATAAAAATTAAAAACTCAA
ATATAATTGAGGCCTCTTTGAGCATGGTATCACAAGTTGATTTGGTCCAAACATGAA
GAATCTGTTGTATTTGCTTAGCttaggaagcattcagatagctcatcactctatcaatagtcactgcccgaattctgaaag
catgaagaagtatgcagagcttgattttagttttataaaaatccggttcttcaagggaggatttttgtggcacagtctcactgttgaaattcaggg
cctgcatcagctcatcaataactgccagcatgttttgatctagaaagatctgcctcttaggatccatcagaagctttgcattcatggtcttgaact
ccacctggtacatcttcaagtcttcataaatactactaaggcacagggccatcataaaagaggtctttctggaggccaggcaactcccattagt

tatgaaagaggtctctctggaatttaggcaactctcattcttggttaattccaatggtaaacaggcctccactgtgctggttttatcttttgtgatatc
ttcatgatcaatctcttcagaagtgcaagggtaaaattctagagtttgtctggccttctggagcatgttgctgacggccctcagcaggttttggg
agtggtgaaggcatgggaacattcctgggtctggagtggccacggggaggtttctgcccactccaggtacccctactccaggaacactgc
agggcacagatgcccattcgctccaagatgagctatagtagcggtcctgggcccgcacgctaatgctggcatttttgcggcagatgaccgt
ggctgaggtcttgtccgtgaagactctatctttcttttctctcttgctcttgccctggacctgaacgcagaatgtcagggagaagtaggaatgtg
gagtactccaggtgtcagggtactcccagctgacctccacctgccgagaattctttaatggcttcagctgcaagttcttgggtgggtcaggttt
gatgatgtccctgatgaagaagctgctggtgtagttttcatacttgagcttgtgaacggcatccaccatgacctcaatgggcagactctcctca
gcagctgggcaggcactgtcctcctggcactccactgagtactcatactccttgttgtcccctctgactctctctgcagagagtgtagcagctc
cgcacgtcaccccttgggggtcagaagagcctctgctgcttttgacactgaatgtcaaatcagtactgattgtcgtcagccaccagcaggtga
aacgtccagaataattcttggcctcgcatcttagaaaggtcttatttttgggttctttctggtcctttaaaatatcagtggaccaaattccatcttcctt
tttgtgaagcagcaggagcgaatggcttagaacctcgcctcctttgtgacaggtgtactggccagcatctccaaactctttgacttggatggtc
agggttttgccagagcctaagacctcactgctctggtccaaggtccaggtgataccatcttcttcaggggtgtcacaggtgaggaccaccatt
tctccaggggcatccggataccaatccaattctacgacataaacatctttcttcagttcccatatggccacgaggggagatgccagaaaaacc
agggaaaaccaagagatgaccaactgctggtgacacatGGTGGCAGCTGAGCTGATATCTGTTAGTTTTTT
TCATACCTAGCAGGATTTGCTAGCTTACTTTCCAAGTCGGTTCATCTCTATGTCTGTA
TAAATCTGTCTTTTCTTGGTGTGCTTTAATTTAATGCAAAGATGGATACCAACTCGGA
GAACCAAGAATAGTCCAATGATTAACCCTATGATAAAGAAAAAAGAGGCAATAGAG
CTTTTCCAACTACTGAACCAACCTTCTACAAGCTCGATTGGATTTTTGGATAGCCCAG
TATCACCAAAAAATAAACTCTCATCATCAGGAAGTTGCGAAGCAGCGTCTTGAATGT
GAGGATGTTCGAACACCTGAGCCTTTGAGCTAAGATGAAGATCGGAGTCCAACATA
CCATGTCCAATCATGTATAAAGGAAACTTATATCCTGAACTGGTCCTCAGAACTCCA
TTGGGTCCAATTTCCACGTCTTCATATGGTGCCCAGTCATCCCACAGTTCCCTTTCTG
TGGTAGTTCCACTGATCATTCCGACCATTCTTGAGAGGATTGGAGCAGCAATATCGA
CTCTGATGTATCTGGTCTCAAAGTATTTTAGGGTACCATTGATTATGGTGAAAGCAG
GACCGGTTCCTGGGTTTTTAGGAGCAAGATAGCTGAGATCCACTGGAGAGATTGGA
AGACCCGCTCTGATTTTGCTCCAGGTTTCTTGGCAGAGGGAATAATCCAAGATCCTC
TCAACGTCCTGAATTAGACTTACATCCACTGAGGTCTGAGATGGAGCAGAGATACTT
GACCCTTCTGGGCATTCAGGGAATCTGGCTGCAGCAAAGAGATCCTTATCAGCCATC
TCGAACCAGACACCTGATGGGAGTCTGACTCCCCAATGCTTGCAGTATTGCATTTTG
CAGGCCTTGCCTCCAGTTTCATAAGCAAAGTAGTTACTTCTGAACCCTGTGCCCTCCT
TTCCCAGGGATGATAGCTCTCCGTCCTCTGAGAAGAAGGTGATGTCCATGGAAATGA
GGTTAGAATCACATAGCCCTTTGACCTTATAGTCAGAATGCCAGGTTGTAGAGTTAT
GGACAGTGGGGCATATGTAATTGCTGCATTTTCCGTTGATGAACTGTGAATCAACCC
ATTCTCCTGTGTATTCATCAACCAGCACATGGTGAGGAGTCACCTGGACAATCACTG
CTTCGGCATCCGTCACAGTTGCATATCCACAACTTTGAGGAGGGAAGCCTGGATTCA
GCCAAGTTCCTTGTTTCGTTTGTTCAATGCTTTCCTTGCATTGTTCTACAGATGGAGT
GAAGGATCGGATGGAATGTGTTATATACTTCGGTCCATACCAGCGGAAATCACAAG
TAGTGACCCATTTGGAAGCATGACACATCCAACCGTCTGCTTGAATAGCCTTGTGAC
TCTTGGGCATTTTGACTTGTAAGGCTGTGCCTATTAAGTCATTATGCCAATTTAAATC
TGAGCTTGACGGGCAATAATGGTAATTAGAAGGAACATTTTTCCAGTTTCCTTTTTG
GTTGTGTGGAAAAACTATGGTGAACTTGCAATTCACCCCAATGAATAAAAAGGCTA
AGTACAAAAGGCACTTCATAGTGACGCGTAAACAGATCGATCTCTGTTAGTTTTTTT
CATAGGGATAGAAAAGACAGGATATTAGTTGTTCGAGAGGCTGGAATTAGGGGAGA
CTGAGTAAACCGGGGATTGTTCAGAAGCATGCAGTTAGACTAGCTCATTTGAAGTGG
CCGATAGAGTCCAGGACCCACGCTCCAGATGCCTTTTTCTCGACAATCAGGCCAAAC
ATTAAGGCCTTCTCTCTGAAATCAGAAAATTTGGAAGAATTGAAATGATCCCAGATC

ATAGGAGCTGCTTCCAGTGACTCATCATCGTAGATGGTCATTGTGAGCTCAATCGTT
CCCTTGTAAAGACCTATATTGAATGGTCTTCTGAAGTGCTCTGGTACATTGAGCATG
GGAGGGGTCTTCCCCATCCTATGTGGCAAATAAGCCCTGCCTTCGCAGTGAGCGTGA
TACTCTGGTTGACCTTGATCTGCCAATACCGCTGGAGTGGCCTTTAGATTAGAAGAA
CCCAAAAAAGCCAAGATTTTGTAGAAGGGACGTTTCCCTGCCATTCCGATGTACATG
TGATCCCAATGGGATACAGCGGCTGCCACATCTGAGTATGTTCTGAACGGACGATTA
GATCTAACCGTCATTTTCACTGTAAAGAAGAATTTCTCATATCTTAATTGATTCGGAT
CATAGGTGTCTCGCTCGTCAACTCCAAAATAGGATTTGTCAATTGGAGCGCTCGGAG
CATACTCCATGCTAGTGTCCTCTTCATAAGGGGGTGGTGCGATCCCTAATTTCTTAGA
TTTCTTACCTTTCCCCTTCAGACCGAGAATCTTCTTTAAGGAACTCATGATGAATGGA
CCCGGGTAACACTTAGATCGTGATATCTGTTACTTTTTTTCATAGTCTACAGAGAATA
TTTGACTCTCGCCTGATTGTACAACTTTTTGTATCTCAGGCCGAGCAGGATGGCCTCT
TTATGAGACATTCGTCCGTCACCTCCGACAGAGATGAACTCTCCTCTAGATGAGAAC
AATTCATCCAAGGATATGGTGAGAGGCTGAAGACTTGCTTTCTTGGGTTGGAAAGTC
ATGGATGTCTTTGAGAGAGACCAAACATCTGATACTGCTTCTGATTGGGACGGATGT
GTGTTCATCACTGGAGTGACCTTATATACATCCGGAGTTATCTGGCGCTCCTTCATAA
TGACCCCTTCTCCCGATGCTTCAAATGTGCACTCTGCCAGATTCCAGTATTTGGCACT
TTGCACGACTGCTTTAATCGTCGAAAGCCACTGGGATTTCTGCTCTCCACTTAAACCC
TCTGGCGATGTCAACCGTAAGGTCTTTCCATGCTCGTCAGATTCAAGCTCAGGCTGT
TTCCAGTCCGAAGTAAATACAACATCCACTTCCTCATCTGCATAGTCATCTAAAGGC
CCCTGTATAAAGCCTTCAACTTGCTCTGCTTCTGGATCTGGTGCATACAAGCCTTGAT
TGTCTTCAATTTCTGGTTCAGATTCTGTGTCAGAATCATCTGCTGCCTGAAAATAAGA
GGGCTTAGTATGCTCTTCCACTCCATCCTCTTGGAACAACTCATAATTGGACTTTTCA
GCTCGTTGTGCTTCGATCTCATCTATCTCTCCTACCGCCTGATCCAGACGAGAATAGG
ACTTGAGATACTCACGAACTTTTGTGAGATTATCCATGATATCTGTTAGTTTTTTTCA
TATGTAGCATAATATATAATAGGTGACTCGAGAATTATAGGGTCATTTGTCAAATTC
TGACTTAGCATACTTGCCAATTGTCTTCTCTCTTAGGCCTTGCAGTGACATGACTGCT
CTTTTCGCATACTGCATCATATCAGGAGTCGGTTTTCTGTTTTGATCTTCAAACCATC
CGAGCCATTCGACCACATCTCTGCCTTGTGGCGGTGCATTAGTCGTCAATCCTCCGG
TACTATCATCTGGAGTGTATTTGTTATCTCCAACACAAAACTGTTGTGCCAAGTCGG
CAGAGGATCCTACTGCATAAGCGTACAACAAACCTGCTGTAGTAAGAGATGTATAC
TCAATGTCATCAGGCTGTCGGGCATTCCTTGCTCTGGTGGATCTGAGCAGAAGAGCT
GTCAATTGCCCCCAGAAGTGGAAGGCAGGGTTTTTGACGGAAGAATATGGAGACTT
AGAAGACAATCCAAAGTCGATCAAATAAGGCATGTATGAATCGGCCTTGTCAATTTC
TTGGCCTGGAAGCATCATTTGGACCATTTCATCTGCAACTTCTCGGTTCAAGATCCA
GGTCGTTACATCTTCTGTAGACATTCCGGTTATTTTGCAGAGGTGTCCAAATGTTGCC
AATGCAGCACAATCTTTGAATCTGGAAACAATAGTTCCGTATCTGAACGAGGCACAT
TCATGTTTTTTGAACATGTGGAAGAACATGTCCACTGCAGCGACAATTTTTGTGTAA
TTACTGTCATTTCCCCACACATCAAAAATGTCACGACCTTCTGGCACAAGAGGTTCA
AACTGTTCATTGATCATTTTGCATTGATTTGTCAGCCCATCCATGAGCTTTTTTCTGT
ATTCAGGCATTTGTGTTCTGCCCACTCTGTATAAGCCAAGTAGATACAAAGGCAACC
ATTTGTCATCTGCGCTGGTTCTGGAAGCATCCGATACTCCATCTGGAAGTACGCCGT
CCAGGGCTTTCAAGGATACAAGGTCAAATATTCCGATTGTATCCCCTGCTTTCCCGA
TGTTTATTCCGAAACTTGACCAATCTTTATCCAACTTACCCCGGATGTCCTTTAATGC
TCCATACAAGTAGCTGTTGACATGTATGATTGATACATTTCCGGATTTGAGGCCTTG
GTAGACATATCCTCTTAGATCTGACAAACTTTTTGTAGTATTGATGTAAAGAGGAAT

CTCCTTTGATTTTCTGAAGTAATCTGCCGGGTATTCCACTGGATCCTCATTTGCAGGA
AGTTTTGGAACTACGACTGTGTTGTCAATGATTCTCTTGACTGTAACAGACATTTTGA
TTACTGTTAAAGTTTCTCCTGAGCCTTTTAATGATAATAATGGTTTGTTTGTCTTCGT

SEQ ID NO: 165 5' to 3' VSV leader Sequence, nucleic acid sequence
ACGAAGACAAACAAACCATTATTATCATTAAAAGGCTCAGGAGAAACTTTAACAGT
AATCAAA

SEQ ID NO: 166 3' to 5' VSV leader Sequence, nucleic acid sequence
TTTGATTACTGTTAAAGTTTCTCCTGAGCCTTTTAATGATAATAATGGTTTGTTTGTCT
TCGT

SEQ ID NO: 167 3' to 5' N Protein, nucleic acid sequence
TCATTTGTCAAATTCTGACTTAGCATACTTGCCAATTGTCTTCTCTCTTAGGCCTTGC
AGTGACATGACTGCTCTTTTCGCATACTGCATCATATCAGGAGTCGGTTTTCTGTTTT
GATCTTCAAACCATCCGAGCCATTCGACCACATCTCTGCCTTGTGGCGGTGCATTAG
TCGTCAATCCTCCGGTACTATCATCTGGAGTGTATTTGTTATCTCCAACACAAAACTG
TTGTGCCAAGTCGGCAGAGGATCCTACTGCATAAGCGTACAACAAACCTGCTGTAGT
AAGAGATGTATACTCAATGTCATCAGGCTGTCGGGCATTCCTTGCTCTGGTGGATCT
GAGCAGAAGAGCTGTCAATTGCCCCCAGAAGTGGAAGGCAGGGTTTTTGACGGAAG
AATATGGAGACTTAGAAGACAATCCAAAGTCGATCAAATAAGGCATGTATGAATCG
GCCTTGTCAATTTCTTGGCCTGGAAGCATCATTTGGACCATTTCATCTGCAACTTCTC
GGTTCAAGATCCAGGTCGTTACATCTTCTGTAGACATTCCGGTTATTTTGCAGAGGT
GTCCAAATGTTGCCAATGCAGCACAATCTTTGAATCTGGAAACAATAGTTCCGTATC
TGAACGAGGCACATTCATGTTTTTTGAACATGTGGAAGAACATGTCCACTGCAGCGA
CAATTTTTGTGTAATTACTGTCATTTCCCCACACATCAAAAATGTCACGACCTTCTGG
CACAAGAGGTTCAAACTGTTCATTGATCATTTTGCATTGATTTGTCAGCCCATCCATG
AGCTTTTTTCTGTATTCAGGCATTTGTGTTCTGCCCACTCTGTATAAGCCAAGTAGAT
ACAAAGGCAACCATTTGTCATCTGCGCTGGTTCTGGAAGCATCCGATACTCCATCTG
GAAGTACGCCGTCCAGGGCTTTCAAGGATACAAGGTCAAATATTCCGATTGTATCCC
CTGCTTTCCCGATGTTTATTCCGAAACTTGACCAATCTTTATCCAACTTACCCCGGAT
GTCCTTTAATGCTCCATACAAGTAGCTGTTGACATGTATGATTGATACATTTCCGGAT
TTGAGGCCTTGGTAGACATATCCTCTTAGATCTGACAAACTTTTTGTAGTATTGATGT
AAAGAGGAATCTCCTTTGATTTTCTGAAGTAATCTGCCGGGTATTCCACTGGATCCT
CATTTGCAGGAAGTTTTGGAACTACGACTGTGTTGTCAATGATTCTCTTGACTGTAAC
AGACA

SEQ ID NO: 168 3' to 5' P Protein, nucleic acid sequence
CTACAGAGAATATTTGACTCTCGCCTGATTGTACAACTTTTTGTATCTCAGGCCGAGC
AGGATGGCCTCTTTATGAGACATTCGTCCGTCACCTCCGACAGAGATGAACTCTCCT
CTAGATGAGAACAATTCATCCAAGGATATGGTGAGAGGCTGAAGACTTGCTTTCTTG
GGTTGGAAAGTCATGGATGTCTTTGAGAGAGACCAAACATCTGATACTGCTTCTGAT
TGGGACGGATGTGTGTTCATCACTGGAGTGACCTTATATACATCCGGAGTTATCTGG
CGCTCCTTCATAATGACCCCTTCTCCCGATGCTTCAAATGTGCACTCTGCCAGATTCC
AGTATTTGGCACTTTGCACGACTGCTTTAATCGTCGAAAGCCACTGGGATTTCTGCTC
TCCACTTAAACCCTCTGGCGATGTCAACCGTAAGGTCTTTCCATGCTCGTCAGATTCA

AGCTCAGGCTGTTTCCAGTCCGAAGTAAATACAACATCCACTTCCTCATCTGCATAG
TCATCTAAAGGCCCCTGTATAAAGCCTTCAACTTGCTCTGCTTCTGGATCTGGTGCAT
ACAAGCCTTGATTGTCTTCAATTTCTGGTTCAGATTCTGTGTCAGAATCATCTGCTGC
CTGAAAATAAGAGGGCTTAGTATGCTCTTCCACTCCATCCTCTTGGAACAACTCATA
ATTGGACTTTTCAGCTCGTTGTGCTTCGATCTCATCTATCTCTCCTACCGCCTGATCC
AGACGAGAATAGGACTTGAGATACTCACGAACTTTTGTGAGATTATCCAT

SEQ ID NO: 169 3' to 5' M Protein, nucleic acid sequence
TCATTTGAAGTGGCCGATAGAGTCCAGGACCCACGCTCCAGATGCCTTTTTCTCGAC
AATCAGGCCAAACATTAAGGCCTTCTCTCTGAAATCAGAAAATTTGGAAGAATTGA
AATGATCCCAGATCATAGGAGCTGCTTCCAGTGACTCATCATCGTAGATGGTCATTG
TGAGCTCAATCGTTCCCTTGTAAAGACCTATATTGAATGGTCTTCTGAAGTGCTCTGG
TACATTGAGCATGGGAGGGGTCTTCCCCATCCTATGTGGCAAATAAGCCCTGCCTTC
GCAGTGAGCGTGATACTCTGGTTGACCTTGATCTGCCAATACCGCTGGAGTGGCCTT
TAGATTAGAAGAACCCAAAAAAGCCAAGATTTTGTAGAAGGGACGTTTCCCTGCCA
TTCCGATGTACATGTGATCCCAATGGGATACAGCGGCTGCCACATCTGAGTATGTTC
TGAACGGACGATTAGATCTAACCGTCATTTTCACTGTAAAGAAGAATTTCTCATATC
TTAATTGATTCGGATCATAGGTGTCTCGCTCGTCAACTCCAAAATAGGATTTGTCAA
TTGGAGCGCTCGGAGCATACTCCATGCTAGTGTCCTCTTCATAAGGGGGTGGTGCGA
TCCCTAATTTCTTAGATTTCTTACCTTTCCCCTTCAGACCGAGAATCTTCTTTAAGGA
ACTCAT

SEQ ID NO: 170 3' to 5' GSP, nucleic acid sequence
CTTACTTTCCAAGTCGGTTCATCTCTATGTCTGTATAAATCTGTCTTTTCTTGGTGTGC
TTTAATTTAATGCAAAGATGGATACCAACTCGGAGAACCAAGAATAGTCCAATGATT
AACCCTATGATAAAGAAAAAAGAGGCAATAGAGCTTTTCCAACTACTGAACCAACC
TTCTACAAGCTCGATTGGATTTTTGGATAGCCCAGTATCACCAAAAAATAAACTCTC
ATCATCAGGAAGTTGCGAAGCAGCGTCTTGAATGTGAGGATGTTCGAACACCTGAG
CCTTTGAGCTAAGATGAAGATCGGAGTCCAACATACCATGTCCAATCATGTATAAAG
GAAACTTATATCCTGAACTGGTCCTCAGAACTCCATTGGGTCCAATTTCCACGTCTTC
ATATGGTGCCCAGTCATCCCACAGTTCCCTTTCTGTGGTAGTTCCACTGATCATTCCG
ACCATTCTTGAGAGGATTGGAGCAGCAATATCGACTCTGATGTATCTGGTCTCAAAG
TATTTTAGGGTACCATTGATTATGGTGAAAGCAGGACCGGTTCCTGGGTTTTTAGGA
GCAAGATAGCTGAGATCCACTGGAGAGATTGGAAGACCCGCTCTGATTTTGCTCCAG
GTTTCTTGGCAGAGGGAATAATCCAAGATCCTCTCAACGTCCTGAATTAGACTTACA
TCCACTGAGGTCTGAGATGGAGCAGAGATACTTGACCCTTCTGGGCATTCAGGGAAT
CTGGCTGCAGCAAAGAGATCCTTATCAGCCATCTCGAACCAGACACCTGATGGGAG
TCTGACTCCCCAATGCTTGCAGTATTGCATTTTGCAGGCCTTGCCTCCAGTTTCATAA
GCAAAGTAGTTACTTCTGAACCCTGTGCCCTCCTTTCCCAGGGATGATAGCTCTCCGT
CCTCTGAGAAGAAGGTGATGTCCATGGAAATGAGGTTAGAATCACATAGCCCTTTG
ACCTTATAGTCAGAATGCCAGGTTGTAGAGTTATGGACAGTGGGGCATATGTAATTG
CTGCATTTTCCGTTGATGAACTGTGAATCAACCCATTCTCCTGTGTATTCATCAACCA
GCACATGGTGAGGAGTCACCTGGACAATCACTGCTTCGGCATCCGTCACAGTTGCAT
ATCCACAACTTTGAGGAGGGAAGCCTGGATTCAGCCAAGTTCCTTGTTTCGTTTGTT
CAATGCTTTCCTTGCATTGTTCTACAGATGGAGTGAAGGATCGGATGGAATGTGTTA
TATACTTCGGTCCATACCAGCGGAAATCACAAGTAGTGACCCATTTGGAAGCATGAC

ACATCCAACCGTCTGCTTGAATAGCCTTGTGACTCTTGGGCATTTTGACTTGTAAGGC
TGTGCCTATTAAGTCATTATGCCAATTTAAATCTGAGCTTGACGGGCAATAATGGTA
ATTAGAAGGAACATTTTTCCAGTTTCCTTTTTGGTTGTGTGGAAAAACTATGGTGAA
CTTGCAATTCACCCCAATGAATAAAAAGGCTAAGTACAAAAGGCACTTCAT

SEQ ID NO: 171 5' to 3' G Protein, nucleic acid sequence
AAGTTCACCATAGTTTTTCCACACAACCAAAAAGGAAACTGGAAAAATGTTCCTTCT
AATTACCATTATTGCCCGTCAAGCTCAGATTTAAATTGGCATAATGACTTAATAGGC
ACAGCCTTACAAGTCAAAATGCCCAAGAGTCACAAGGCTATTCAAGCAGACGGTTG
GATGTGTCATGCTTCCAAATGGGTCACTACTTGTGATTTCCGCTGGTATGGACCGAA
GTATATAACACATTCCATCCGATCCTTCACTCCATCTGTAGAACAATGCAAGGAAAG
CATTGAACAAACGAAACAAGGAACTTGGCTGAATCCAGGCTTCCCTCCTCAAAGTTG
TGGATATGCAACTGTGACGGATGCCGAAGCAGTGATTGTCCAGGTGACTCCTCACCA
TGTGCTGGTTGATGAATACACAGGAGAATGGGTTGATTCACAGTTCATCAACGGAA
AATGCAGCAATTACATATGCCCCACTGTCCATAACTCTACAACCTGGCATTCTGACT
ATAAGGTCAAAGGGCTATGTGATTCTAACCTCATTTCCATGGACATCACCTTCTTCTC
AGAGGACGGAGAGCTATCATCCCTGGGAAAGGAGGGCACAGGGTTCAGAAGTAACT
ACTTTGCTTATGAAACTGGAGGCAAGGCCTGCAAAATGCAATACTGCAAGCATTGG
GGAGTCAGACTCCCATCAGGTGTCTGGTTCGAGATGGCTGATAAGGATCTCTTTGCT
GCAGCCAGATTCCCTGAATGCCCAGAAGGGTCAAGTATCTCTGCTCCATCTCAGACC
TCAGTGGATGTAAGTCTAATTCAGGACGTTGAGAGGATCTTGGATTATTCCCTCTGC
CAAGAAACCTGGAGCAAAATCAGAGCGGGTCTTCCAATCTCTCCAGTGGATCTCAG
CTATCTTGCTCCTAAAAACCCAGGAACCGGTCCTGCTTTCACCATAATCAATGGTAC
CCTAAAATACTTTGAGACCAGATACATCAGAGTCGATATTGCTGCTCCAATCCTCTC
AAGAATGGTCGGAATGATCAGTGGAACTACCACAGAAAGGGAACTGTGGGATGACT
GGGCACCATATGAAGACGTGGAAATTGGACCCAATGGAGTTCTGAGGACCAGTTCA
GGATATAAGTTTCCTTTATACATGATTGGACATGGTATGTTGGACTCCGATCTTCATC
TTAGCTCAAAGGCTCAGGTGTTCGAACATCCTCACATTCAAGACGCTGCTTCGCAAC
TTCCTGATGATGAGAGTTTATTTTTTGGTGATACTGGGCTATCCAAAAATCCAATCG
AGCTTGTAGAAGGTTGGTTCAGTAGTTGGAAAAGCTCTATTGCCTCTTTTTTCTTTAT
CATAGGGTTAATCATTGGACTATTCTTGGTTCTCCGAGTTGGTATCCATCTTTGCATT
AAATTAAAGCACACCAAGAAAAGACAGATTTATACAGACATAGAGATGAACCGACT
TGGAAAGTAA

SEQ ID NO: 172 3' to 5' G Protein, nucleic acid sequence
CTTACTTTCCAAGTCGGTTCATCTCTATGTCTGTATAAATCTGTCTTTTCTTGGTGTGC
TTTAATTTAATGCAAAGATGGATACCAACTCGGAGAACCAAGAATAGTCCAATGATT
AACCCTATGATAAAGAAAAAAGAGGCAATAGAGCTTTTCCAACTACTGAACCAACC
TTCTACAAGCTCGATTGGATTTTTGGATAGCCCAGTATCACCAAAAAATAAACTCTC
ATCATCAGGAAGTTGCGAAGCAGCGTCTTGAATGTGAGGATGTTCGAACACCTGAG
CCTTTGAGCTAAGATGAAGATCGGAGTCCAACATACCATGTCCAATCATGTATAAAG
GAAACTTATATCCTGAACTGGTCCTCAGAACTCCATTGGGTCCAATTTCCACGTCTTC
ATATGGTGCCCAGTCATCCCACAGTTCCCTTTCTGTGGTAGTTCCACTGATCATTCCG
ACCATTCTTGAGAGGATTGGAGCAGCAATATCGACTCTGATGTATCTGGTCTCAAAG
TATTTTAGGGTACCATTGATTATGGTGAAAGCAGGACCGGTTCCTGGGTTTTTAGGA
GCAAGATAGCTGAGATCCACTGGAGAGATTGGAAGACCCGCTCTGATTTTGCTCCAG

GTTTCTTGGCAGAGGGAATAATCCAAGATCCTCTCAACGTCCTGAATTAGACTTACA
TCCACTGAGGTCTGAGATGGAGCAGAGATACTTGACCCTTCTGGGCATTCAGGGAAT
CTGGCTGCAGCAAAGAGATCCTTATCAGCCATCTCGAACCAGACACCTGATGGGAG
TCTGACTCCCCAATGCTTGCAGTATTGCATTTTGCAGGCCTTGCCTCCAGTTTCATAA
GCAAAGTAGTTACTTCTGAACCCTGTGCCCTCCTTTCCCAGGGATGATAGCTCTCCGT
CCTCTGAGAAGAAGGTGATGTCCATGGAAATGAGGTTAGAATCACATAGCCCTTTG
ACCTTATAGTCAGAATGCCAGGTTGTAGAGTTATGGACAGTGGGGCATATGTAATTG
CTGCATTTTCCGTTGATGAACTGTGAATCAACCCATTCTCCTGTGTATTCATCAACCA
GCACATGGTGAGGAGTCACCTGGACAATCACTGCTTCGGCATCCGTCACAGTTGCAT
ATCCACAACTTTGAGGAGGGAAGCCTGGATTCAGCCAAGTTCCTTGTTTCGTTTGTT
CAATGCTTTCCTTGCATTGTTCTACAGATGGAGTGAAGGATCGGATGGAATGTGTTA
TATACTTCGGTCCATACCAGCGGAAATCACAAGTAGTGACCCATTTGGAAGCATGAC
ACATCCAACCGTCTGCTTGAATAGCCTTGTGACTCTTGGGCATTTTGACTTGTAAGGC
TGTGCCTATTAAGTCATTATGCCAATTTAAATCTGAGCTTGACGGGCAATAATGGTA
ATTAGAAGGAACATTTTTCCAGTTTCCTTTTTGGTTGTGTGGAAAAACTATGGTGAA
CTT

SEQ ID NO: 173 G Protein, amino acid sequence
KFTIVFPHNQKGNWKNVPSNYHYCPSSSDLNWHNDLIGTALQVKMPKSHKAIQADGW
MCHASKWVTTCDFRWYGPKYITHSIRSFTPSVEQCKESIEQTKQGTWLNPGFPPQSCGY
ATVTDAEAVIVQVTPHHVLVDEYTGEWVDSQFINGKCSNYICPTVHNSTTWHSDYKVK
GLCDSNLISMDITFFSEDGELSSLGKEGTGFRSNYFAYETGGKACKMQYCKHWGVRLPS
GVWFEMADKDLFAAARFPECPEGSSISAPSQTSVDVSLIQDVERILDYSLCQETWSKIRA
GLPISPVDLSYLAPKNPGTGPAFTIINGTLKYFETRYIRVDIAAPILSRMVGMISGTTTERE
LWDDWAPYEDVEIGPNGVLRTSSGYKFPLYMIGHGMLDSDLHLSSKAQVFEHPHIQDA
ASQLPDDESLFFGDTGLSKNPIELVEGWFSSWKSSIASFFFIIGLIIGLFLVLRVGIHLCIKL
KHTKKRQIYTDIEMNRLGK

SEQ ID NO: 174 5' to 3' Intravirion tail-VSVG, nucleic acid sequence
TGCATTAAATTAAAGCACACCAAGAAAAGACAGATTTATACAGACATAGAGATGAA
CCGACTTGGAAAGTAA

SEQ ID NO: 175 3' to 5' Intravirion tail-VSVG, nucleic acid sequence
TTACTTTCCAAGTCGGTTCATCTCTATGTCTGTATAAATCTGTCTTTTCTTGGTGTGCT
TTAATTTAATGC

SEQ ID NO: 176 Intravirion tail-VSVG Protein, amino acid sequence
CIKLKHTKKRQIYTDIEMNRLGK

SEQ ID NO: 177 3' to 5' hIL12p70, nucleic acid sequence
ttaggaagcattcagatagctcatcactctatcaatagtcactgcccgaattctgaaagcatgaagaagtatgcagagcttgattttagttttata
aaaatccggttcttcaagggaggatttttgtggcacagtctcactgttgaaattcagggcctgcatcagctcatcaataactgccagcatgtttt
gatctagaaagatctgcctcttaggatccatcagaagctttgcattcatggtcttgaactccacctggtacatcttcaagtcttcataaatactact
aaggcacagggccatcataaaagaggtctttctggaggccaggcaactcccattagttatgaaagaggtctctctggaatttaggcaactctc
attcttggttaattccaatggtaaacaggcctccactgtgctggttttatcttttgtgatatcttcatgatcaatctcttcagaagtgcaagggtaaa
attctagagtttgtctggccttctggagcatgttgctgacggccctcagcaggttttgggagtggtgaaggcatgggaacattcctgggtctgg

agtggccacggggaggtttctgcccactccaggtacccctactccaggaacactgcagggcacagatgcccattcgctccaagatgagct
atagtagcggtcctgggcccgcacgctaatgctggcatttttgcggcagatgaccgtggctgaggtcttgtccgtgaagactctatctttctttt
ctctcttgctcttgccctggacctgaacgcagaatgtcagggagaagtaggaatgtggagtactccaggtgtcagggtactcccagctgacc
tccacctgccgagaattctttaatggcttcagctgcaagttcttgggtgggtcaggtttgatgatgtccctgatgaagaagctgctggtgtagttt
tcatacttgagcttgtgaacggcatccaccatgacctcaatgggcagactctcctcagcagctgggcaggcactgtcctcctggcactccact
gagtactcatactccttgttgtcccctctgactctctctgcagagagtgtagcagctccgcacgtcacccctgggggtcagaagagcctctg
ctgcttttgacactgaatgtcaaatcagtactgattgtcgtcagccaccagcaggtgaaacgtccagaataattcttggcctcgcatcttagaaa
ggtcttatttttgggttctttctggtcctttaaaatatcagtggaccaaattccatcttccttttttgtgaagcagcaggagcgaatggcttagaacct
cgcctcctttgtgacaggtgtactggccagcatctccaaactctttgacttggatggtcagggttttgccagagcctaagacctcactgctctg
gtccaaggtccaggtgataccatcttcttcaggggtgtcacaggtgaggaccaccatttctccaggggcatccggataccaatccaattctac
gacataaacatctttcttcagttcccatatggccacgaggggagatgccag

SEQ ID NO: 178 3' to 5' hIL12p40, nucleic acid sequence
actgcagggcacagatgcccattcgctccaagatgagctatagtagcggtcctgggcccgcacgctaatgctggcatttttgcggcagatg
accgtggctgaggtcttgtccgtgaagactctatctttcttttctctcttgctcttgccctggacctgaacgcagaatgtcagggagaagtagga
atgtggagtactccaggtgtcagggtactcccagctgacctccacctgccgagaattctttaatggcttcagctgcaagttcttgggtgggtca
ggtttgatgatgtccctgatgaagaagctgctggtgtagttttcatacttgagcttgtgaacggcatccaccatgacctcaatgggcagactctc
ctcagcagctgggcaggcactgtcctcctggcactccactgagtactcatactccttgttgtcccctctgactctctctgcagagagtgtagca
gctccgcacgtcacccctgggggtcagaagagcctctgctgcttttgacactgaatgtcaaatcagtactgattgtcgtcagccaccagcag
gtgaaacgtccagaataattcttggcctcgcatcttagaaaggtcttatttttgggttctttctggtcctttaaaatatcagtggaccaaattccatct
tccttttgtgaagcagcaggagcgaatggcttagaacctcgcctcctttgtgacaggtgtactggccagcatctccaaactctttgacttggat
ggtcagggttttgccagagcctaagacctcactgctctggtccaaggtccaggtgataccatcttcttcaggggtgtcacaggtgaggacca
ccatttctccaggggcatccggataccaatccaattctacgacataaacatctttcttcagttcccatatggccacgaggggagatgccagaa
aaaccagggaaaaccaagagatgaccaactgctggtgacacat

SEQ ID NO: 179 5' to 3' linker, nucleic acid sequence
gttcctggagtaggggtacctggagtgggca

SEQ ID NO: 180 3' to 5' linker, nucleic acid sequence
tgcccactccaggtacccctactccaggaac

SEQ ID NO: 181 5' to 3' hIL12p35, nucleic acid sequence
gaaacctccccgtggccactccagacccaggaatgttcccatgccttcaccactcccaaaacctgctgagggccgtcagcaacatgctcca
gaaggccagacaaactctagaattttacccttgcacttctgaagagattgatcatgaagatatcacaaaagataaaaccagcacagtggagg
cctgtttaccattggaattaaccaagaatgagagttgcctaaattccagagagacctctttcataactaatgggagttgcctggcctccagaaa
gacctcttttatgatggccctgtgccttagtagtatttatgaagacttgaagatgtaccaggtggagttcaagaccatgaatgcaaagcttctgat
ggatcctaagaggcagatctttctagatcaaaacatgctggcagttattgatgagctgatgcaggccctgaatttcaacagtgagactgtgcc
acaaaaatcctcccttgaagaaccggatttttataaaactaaaatcaagctctgcatacttcttcatgctttcagaattcgggcagtgactattgat
agagtgatgagctatctgaatgcttcctaa

SEQ ID NO: 182 3' to 5' hIL12p35, nucleic acid sequence
ttaggaagcattcagatagctcatcactctatcaatagtcactgcccgaattctgaaagcatgaagaagtatgcagagcttgattttagttttata
aaaatccggttcttcaagggaggatttttgtggcacagtctcactgttgaaattcagggcctgcatcagctcatcaataactgccagcatgtttt
gatctagaaagatctgcctcttaggatccatcagaagctttgcattcatggtcttgaactccacctggtacatcttcaagtcttcataaatactact
aaggcacagggccatcataaaagaggtctttctggaggccaggcaactcccattagttatgaaagaggtctctctggaatttaggcaactctc
attcttggttaattccaatggtaaacaggcctccactgtgctggttttatcttttgtgatatcttcatgatcaatctcttcagaagtgcaagggtaaa

attctagagtttgtctggccttctggagcatgttgctgacggccctcagcaggttttgggagtggtgaaggcatgggaacattcctgggtctgg
agtggccacggggaggtttc

SEQ ID NO: 183 5' to 3' L Protein, nucleic acid sequence

TGGAAGTCCACGATTTTGAGACCGACGAGTTCAATGATTTCAATGAAGATGACTATG
CCACAAGAGAATTCCTGAATCCCGATGAGCGCATGACGTACTTGAATCATGCTGATT
ACAACCTGAATTCTCCTCTAATTAGTGATGATATTGACAATTTAATCAGGAAATTCA
ATTCTCTTCCAATTCCCTCGATGTGGGATAGTAAGAACTGGGATGGAGTTCTTGAGA
TGTTAACGTCATGTCAAGCCAATCCCATCCCAACATCTCAGATGCATAAATGGATGG
GAAGTTGGTTAATGTCTGATAATCATGATGCCAGTCAAGGGTATAGTTTTTTACATG
AAGTGGACAAAGAGGCAGAAATAACATTTGACGTGGTGGAGACCTTCATCCGCGGC
TGGGGCAACAAACCAATTGAATACATCAAAAAGGAAAGATGGACTGACTCATTCAA
AATTCTCGCTTATTTGTGTCAAAAGTTTTTGGACTTACACAAGTTGACATTAATCTTA
AATGCTGTCTCTGAGGTGGAATTGCTCAACTTGGCGAGGACTTTCAAAGGCAAAGTC
AGAAGAAGTTCTCATGGAACGAACATATGCAGGATTAGGGTTCCCAGCTTGGGTCCT
ACTTTTATTTCAGAAGGATGGGCTTACTTCAAGAAACTTGATATTCTAATGGACCGA
AACTTTCTGTTAATGGTCAAAGATGTGATTATAGGGAGGATGCAAACGGTGCTATCC
ATGGTATGTAGAATAGACAACCTGTTCTCAGAGCAAGACATCTTCTCCCTTCTAAAT
ATCTACAGAATTGGAGATAAAATTGTGGAGAGGCAGGGAAATTTTTCTTATGACTTG
ATTAAAATGGTGGAACCGATATGCAACTTGAAGCTGATGAAATTAGCAAGAGAATC
AAGGCCTTTAGTCCCACAATTCCCTCATTTTGAAAATCATATCAAGACTTCTGTTGAT
GAAGGGGCAAAAATTGACCGAGGTATAAGATTCCTCCATGATCAGATAATGAGTGT
GAAAACAGTGGATCTCACACTGGTGATTTATGGATCGTTCAGACATTGGGGTCATCC
TTTTATAGATTATTACACTGGACTAGAAAAATTACATTCCCAAGTAACCATGAAGAA
AGATATTGATGTGTCATATGCAAAAGCACTTGCAAGTGATTTAGCTCGGATTGTTCT
ATTTCAACAGTTCAATGATCATAAAAAGTGGTTCGTGAATGGAGACTTGCTCCCTCA
TGATCATCCCTTTAAAAGTCATGTTAAAGAAAATACATGGCCCACAGCTGCTCAAGT
TCAAGATTTTGGAGATAAATGGCATGAACTTCCGCTGATTAAATGTTTTGAAATACC
CGACTTACTAGACCCATCGATAATATACTCTGACAAAAGTCATTCAATGAATAGGTC
AGAGGTGTTGAAACATGTCCGAATGAATCCGAACACTCCTATCCCTAGTAAAAAGG
TGTTGCAGACTATGTTGGACACAAAGGCTACCAATTGGAAAGAATTTCTTAAAGAG
ATTGATGAGAAGGGCTTAGATGATGATGATCTAATTATTGGTCTTAAAGGAAAGGA
GAGGGAACTGAAGTTGGCAGGTAGATTTTTCTCCCTAATGTCTTGGAAATTGCGAGA
ATACTTTGTAATTACCGAATATTTGATAAAGACTCATTTCGTCCCTATGTTTAAAGGC
CTGACAATGGCGGACGATCTAACTGCAGTCATTAAAAAGATGTTAGATTCCTCATCC
GGCCAAGGATTGAAGTCATATGAGGCAATTTGCATAGCCAATCACATTGATTACGA
AAAATGGAATAACCACCAAAGGAAGTTATCAAACGGCCCAGTGTTCCGAGTTATGG
GCCAGTTCTTAGGTTATCCATCCTTAATCGAGAGAACTCATGAATTTTTTGAGAAAA
GTCTTATATACTACAATGGAAGACCAGACTTGATGCGTGTTCACAACAACACACTGA
TCAATTCAACCTCCCAACGAGTTTGTTGGCAAGGACAAGAGGGTGGACTGGAAGGT
CTACGGCAAAAAGGATGGAGTATCCTCAATCTACTGGTTATTCAAAGAGAGGCTAA
AATCAGAAACACTGCTGTCAAAGTCTTGGCACAAGGTGATAATCAAGTTATTTGCAC
ACAGTATAAAACGAAGAAATCGAGAAACGTTGTAGAATTACAGGGTGCTCTCAATC
AAATGGTTTCTAATAATGAGAAAATTATGACTGCAATCAAAATAGGGACAGGGAAG
TTAGGACTTTTGATAAATGACGATGAGACTATGCAATCTGCAGATTACTTGAATTAT
GGAAAAATACCGATTTTCCGTGGAGTGATTAGAGGGTTAGAGACCAAGAGATGGTC

ACGAGTGACTTGTGTCACCAATGACCAAATACCCACTTGTGCTAATATAATGAGCTC
AGTTTCCACAAATGCTCTCACCGTAGCTCATTTTGCTGAGAACCCAATCAATGCCAT
GATACAGTACAATTATTTTGGGACATTTGCTAGACTCTTGTTGATGATGCATGATCCT
GCTCTTCGTCAATCATTGTATGAAGTTCAAGATAAGATACCGGGCTTGCACAGTTCT
ACTTTCAAATACGCCATGTTGTATTTGGACCCTTCCATTGGAGGAGTGTCGGGCATG
TCTTTGTCCAGGTTTTTGATTAGAGCCTTCCCAGATCCCGTAACAGAAAGTCTCTCAT
TCTGGAGATTCATCCATGTACATGCTCGAAGTGAGCATCTGAAGGAGATGAGTGCA
GTATTTGGAAACCCCGAGATAGCCAAGTTTCGAATAACTCACATAGACAAGCTAGT
AGAAGATCCAACCTCTCTGAACATCGCTATGGGAATGAGTCCAGCGAACTTGTTAAA
GACTGAGGTTAAAAAATGCTTAATCGAATCAAGACAAACCATCAGGAACCAGGTGA
TTAAGGATGCAACCATATATTTGTATCATGAAGAGGATCGGCTCAGAAGTTTCTTAT
GGTCAATAAATCCTCTGTTCCCTAGATTTTTAAGTGAATTCAAATCAGGCACTTTTTT
GGGAGTCGCAGACGGGCTCATCAGTCTATTTCAAAATTCTCGTACTATTCGGAACTC
CTTTAAGAAAAAGTATCATAGGGAATTGGATGATTTGATTGTGAGGAGTGAGGTATC
CTCTTTGACACATTTAGGGAAACTTCATTTGAGAAGGGGATCATGTAAAATGTGGAC
ATGTTCAGCTACTCATGCTGACACATTAAGATACAAATCCTGGGGCCGTACAGTTAT
TGGGACAACTGTACCCCATCCATTAGAAATGTTGGGTCCACAACATCGAAAAGAGA
CTCCTTGTGCACCATGTAACACATCAGGGTTCAATTATGTTTCTGTGCATTGTCCAGA
CGGGATCCATGACGTCTTTAGTTCACGGGGACCATTGCCTGCTTATCTAGGGTCTAA
AACATCTGAATCTACATCTATTTTGCAGCCTTGGGAAAGGGAAAGCAAAGTCCCACT
GATTAAAAGAGCTACACGTCTTAGAGATGCTATCTCTTGGTTTGTTGAACCCGACTC
TAAACTAGCAATGACTATACTTTCTAACATCCACTCTTTAACAGGCGAAGAATGGAC
CAAAAGGCAGCATGGGTTCAAAAGAACAGGGTCTGCCCTTCATAGGTTTTCGACATC
TCGGATGAGCCATGGTGGGTTCGCATCTCAGAGCACTGCAGCATTGACCAGGTTGAT
GGCAACTACAGACACCATGAGGGATCTGGGAGATCAGAATTTCGACTTTTTATTCCA
AGCAACGTTGCTCTATGCTCAAATTACCACCACTGTTGCAAGAGACGGATGGATCAC
CAGTTGTACAGATCATTATCATATTGCCTGTAAGTCCTGTTTGAGACCCATAGAAGA
GATCACCCTGGACTCAAGTATGGACTACACGCCCCCAGATGTATCCCATGTGCTGAA
GACATGGAGGAATGGGGAAGGTTCGTGGGGACAAGAGATAAAACAGATCTATCCTT
TAGAAGGGAATTGGAAGAATTTAGCACCTGCAGAGCAATCCTATCAAGTCGGCAGA
TGTATAGGTTTTCTATATGGAGACTTGGCGTATAGAAAATCTACTCATGCCGAGGAC
AGTTCTCTATTTCCTCTATCTATACAAGGTCGTATTAGAGGTCGAGGTTTCTTAAAAG
GGTTGCTAGACGGATTAATGAGAGCAAGTTGCTGCCAAGTAATACACCGGAGAAGT
CTGGCTCATTTGAAGAGGCCGGCCAACGCAGTGTACGGAGGTTTGATTTACTTGATT
GATAAATTGAGTGTATCACCTCCATTCCTTTCTCTTACTAGATCAGGACCTATTAGAG
ACGAATTAGAAACGATTCCCCACAAGATCCCAACCTCCTATCCGACAAGCAACCGT
GATATGGGGGTGATTGTCAGAAATTACTTCAAATACCAATGCCGTCTAATTGAAAAG
GGAAAATACAGATCACATTATTCACAATTATGGTTATTCTCAGATGTCTTATCCATA
GACTTCATTGGACCATTCTCTATTTCCACCACCCTCTTGCAAATCCTATACAAGCCAT
TTTTATCTGGGAAAGATAAGAATGAGTTGAGAGAGCTGGCAAATCTTTCTTCATTGC
TAAGATCAGGAGAGGGGTGGGAAGACATACATGTGAAATTCTTCACCAAGGACATA
TTATTGTGTCCAGAGGAAATCAGACATGCTTGCAAGTTCGGGATTGCTAAGGATAAT
AATAAAGACATGAGCTATCCCCCTTGGGGAAGGGAATCCAGAGGGACAATTACAAC
AATCCCTGTTTATTATACGACCACCCCTTACCCAAAGATGCTAGAGATGCCTCCAAG
AATCCAAAATCCCCTGCTGTCCGGAATCAGGTTGGGCCAATTACCAACTGGCGCTCA
TTATAAAATTCGGAGTATATTACATGGAATGGGAATCCATTACAGGGACTTCTTGAG

TTGTGGAGACGGCTCCGGAGGGATGACTGCTGCATTACTACGAGAAAATGTGCATA
GCAGAGGAATATTCAATAGTCTGTTAGAATTATCAGGGTCAGTCATGCGAGGCGCCT
CTCCTGAGCCCCCCAGTGCCCTAGAAACTTTAGGAGGAGATAAATCGAGATGTGTA
AATGGTGAAACATGTTGGGAATATCCATCTGACTTATGTGACCCAAGGACTTGGGAC
TATTTCCTCCGACTCAAAGCAGGCTTGGGGCTTCAAATTGATTTAATTGTAATGGAT
ATGGAAGTTCGGGATTCTTCTACTAGCCTGAAAATTGAGACGAATGTTAGAAATTAT
GTGCACCGGATTTTGGATGAGCAAGGAGTTTTAATCTACAAGACTTATGGAACATAT
ATTTGTGAGAGCGAAAAGAATGCAGTAACAATCCTTGGTCCCATGTTCAAGACGGTC
GACTTAGTTCAAACAGAATTTAGTAGTTCTCAAACGTCTGAAGTATATATGGTATGT
AAAGGTTTGAAGAAATTAATCGATGAACCCAATCCCGATTGGTCTTCCATCAATGAA
TCCTGGAAAAACCTGTACGCATTCCAGTCATCAGAACAGGAATTTGCCAGAGCAAA
GAAGGTTAGTACATACTTTACCTTGACAGGTATTCCCTCCCAATTCATTCCTGATCCT
TTTGTAAACATTGAGACTATGCTACAAATATTCGGAGTACCCACGGGTGTGTCTCAT
GCGGCTGCCTTAAAATCATCTGATAGACCTGCAGATTTATTGACCATTAGCCTTTTTT
ATATGGCGATTATATCGTATTATAACATCAATCATATCAGAGTAGGACCGATACCTC
CGAACCCCCCATCAGATGGAATTGCACAAAATGTGGGGATCGCTATAACTGGTATA
AGCTTTTGGCTGAGTTTGATGGAGAAAGACATTCCACTATATCAACAGTGTTTAGCA
GTTATCCAGCAATCATTCCCGATTAGGTGGGAGGCTGTTTCAGTAAAAGGAGGATAC
AAGCAGAAGTGGAGTACTAGAGGTGATGGGCTCCCAAAAGATACCCGAATTTCAGA
CTCCTTGGCCCCAATCGGGAACTGGATCAGATCTCTGGAATTGGTCCGAAACCAAGT
TCGTCTAAATCCATTCAATGAGATCTTGTTCAATCAGCTATGTCGTACAGTGGATAA
TCATTTGAAATGGTCAAATTTGCGAAGAAACACAGGAATGATTGAATGGATCAATA
GACGAATTTCAAAAGAAGACCGGTCTATACTGATGTTGAAGAGTGACCTACACGAG
GAAAACTCTTGGAGAGATTAA

SEQ ID NO: 184 3' to 5' L Protein, nucleic acid sequence
TTAATCTCTCCAAGAGTTTTCCTCGTGTAGGTCACTCTTCAACATCAGTATAGACCGG
TCTTCTTTTGAAATTCGTCTATTGATCCATTCAATCATTCCTGTGTTTCTTCGCAAATT
TGACCATTTCAAATGATTATCCACTGTACGACATAGCTGATTGAACAAGATCTCATT
GAATGGATTTAGACGAACTTGGTTTCGGACCAATTCCAGAGATCTGATCCAGTTCCC
GATTGGGGCCAAGGAGTCTGAAATTCGGGTATCTTTTGGGAGCCCATCACCTCTAGT
ACTCCACTTCTGCTTGTATCCTCCTTTTACTGAAACAGCCTCCCACCTAATCGGGAAT
GATTGCTGGATAACTGCTAAACACTGTTGATATAGTGGAATGTCTTTCTCCATCAAA
CTCAGCCAAAAGCTTATACCAGTTATAGCGATCCCCACATTTTGTGCAATTCCATCT
GATGGGGGGTTCGGAGGTATCGGTCCTACTCTGATATGATTGATGTTATAATACGAT
ATAATCGCCATATAAAAAAGGCTAATGGTCAATAAATCTGCAGGTCTATCAGATGAT
TTTAAGGCAGCCGCATGAGACACACCCGTGGGTACTCCGAATATTTGTAGCATAGTC
TCAATGTTTACAAAAGGATCAGGAATGAATTGGGAGGGAATACCTGTCAAGGTAAA
GTATGTACTAACCTTCTTTGCTCTGGCAAATTCCTGTTCTGATGACTGGAATGCGTAC
AGGTTTTTCCAGGATTCATTGATGGAAGACCAATCGGGATTGGGTTCATCGATTAAT
TTCTTCAAACCTTTACATACCATATATACTTCAGACGTTTGAGAACTACTAAATTCTG
TTTGAACTAAGTCGACCGTCTTGAACATGGGACCAAGGATTGTTACTGCATTCTTTTC
GCTCTCACAAATATATGTTCCATAAGTCTTGTAGATTAAAACTCCTTGCTCATCCAAA
ATCCGGTGCACATAATTTCTAACATTCGTCTCAATTTTCAGGCTAGTAGAAGAATCC
CGAACTTCCATATCCATTACAATTAAATCAATTTGAAGCCCCAAGCCTGCTTTGAGT
CGGAGGAAATAGTCCCAAGTCCTTGGGTCACATAAGTCAGATGGATATTCCCAACAT

GTTTCACCATTTACACATCTCGATTTATCTCCTCCTAAAGTTTCTAGGGCACTGGGGG
GCTCAGGAGAGGCGCCTCGCATGACTGACCCTGATAATTCTAACAGACTATTGAATA
TTCCTCTGCTATGCACATTTTCTCGTAGTAATGCAGCAGTCATCCCTCCGGAGCCGTC
TCCACAACTCAAGAAGTCCCTGTAATGGATTCCCATTCCATGTAATATACTCCGAAT
TTTATAATGAGCGCCAGTTGGTAATTGGCCCAACCTGATTCCGGACAGCAGGGGATT
TTGGATTCTTGGAGGCATCTCTAGCATCTTTGGGTAAGGGGTGGTCGTATAATAAAC
AGGGATTGTTGTAATTGTCCCTCTGGATTCCCTTCCCCAAGGGGGATAGCTCATGTCT
TTATTATTATCCTTAGCAATCCCGAACTTGCAAGCATGTCTGATTTCCTCTGGACACA
ATAATATGTCCTTGGTGAAGAATTTCACATGTATGTCTTCCCACCCCTCTCCTGATCT
TAGCAATGAAGAAAGATTTGCCAGCTCTCTCAACTCATTCTTATCTTTCCCAGATAA
AAATGGCTTGTATAGGATTTGCAAGAGGGTGGTGGAAATAGAGAATGGTCCAATGA
AGTCTATGGATAAGACATCTGAGAATAACCATAATTGTGAATAATGTGATCTGTATT
TTCCCTTTTCAATTAGACGGCATTGGTATTTGAAGTAATTTCTGACAATCACCCCCAT
ATCACGGTTGCTTGTCGGATAGGAGGTTGGGATCTTGTGGGGAATCGTTTCTAATTC
GTCTCTAATAGGTCCTGATCTAGTAAGAGAAAGGAATGGAGGTGATACACTCAATTT
ATCAATCAAGTAAATCAAACCTCCGTACACTGCGTTGGCCGGCCTCTTCAAATGAGC
CAGACTTCTCCGGTGTATTACTTGGCAGCAACTTGCTCTCATTAATCCGTCTAGCAAC
CCTTTTAAGAAACCTCGACCTCTAATACGACCTTGTATAGATAGAGGAAATAGAGAA
CTGTCCTCGGCATGAGTAGATTTTCTATACGCCAAGTCTCCATATAGAAAACCTATA
CATCTGCCGACTTGATAGGATTGCTCTGCAGGTGCTAAATTCTTCCAATTCCCTTCTA
AAGGATAGATCTGTTTTATCTCTTGTCCCCACGAACCTTCCCCATTCCTCCATGTCTT
CAGCACATGGGATACATCTGGGGGCGTGTAGTCCATACTTGAGTCCAGGGTGATCTC
TTCTATGGGTCTCAAACAGGACTTACAGGCAATATGATAATGATCTGTACAACTGGT
GATCCATCCGTCTCTTGCAACAGTGGTGGTAATTTGAGCATAGAGCAACGTTGCTTG
GAATAAAAAGTCGAAATTCTGATCTCCCAGATCCCTCATGGTGTCTGTAGTTGCCAT
CAACCTGGTCAATGCTGCAGTGCTCTGAGATGCGAACCCACCATGGCTCATCCGAGA
TGTCGAAAACCTATGAAGGGCAGACCCTGTTCTTTTGAACCCATGCTGCCTTTTGGT
CCATTCTTCGCCTGTTAAAGAGTGGATGTTAGAAAGTATAGTCATTGCTAGTTTAGA
GTCGGGTTCAACAAACCAAGAGATAGCATCTCTAAGACGTGTAGCTCTTTTAATCAG
TGGGACTTTGCTTTCCCTTTCCCAAGGCTGCAAAATAGATGTAGATTCAGATGTTTTA
GACCCTAGATAAGCAGGCAATGGTCCCCGTGAACTAAAGACGTCATGGATCCCGTC
TGGACAATGCACAGAAACATAATTGAACCCTGATGTGTTACATGGTGCACAAGGAG
TCTCTTTTCGATGTTGTGGACCCAACATTTCTAATGGATGGGGTACAGTTGTCCCAAT
AACTGTACGGCCCCAGGATTTGTATCTTAATGTGTCAGCATGAGTAGCTGAACATGT
CCACATTTTACATGATCCCCTTCTCAAATGAAGTTTCCCTAAATGTGTCAAAGAGGA
TACCTCACTCCTCACAATCAAATCATCCAATTCCCTATGATACTTTTTCTTAAAGGAG
TTCCGAATAGTACGAGAATTTTGAAATAGACTGATGAGCCCGTCTGCGACTCCCAAA
AAAGTGCCTGATTTGAATTCACTTAAAAATCTAGGGAACAGAGGATTTATTGACCAT
AAGAAACTTCTGAGCCGATCCTCTTCATGATACAAATATATGGTTGCATCCTTAATC
ACCTGGTTCCTGATGGTTTGTCTTGATTCGATTAAGCATTTTTTAACCTCAGTCTTTA
ACAAGTTCGCTGGACTCATTCCCATAGCGATGTTCAGAGAGGTTGGATCTTCTACTA
GCTTGTCTATGTGAGTTATTCGAAACTTGGCTATCTCGGGGTTTCCAAATACTGCACT
CATCTCCTTCAGATGCTCACTTCGAGCATGTACATGGATGAATCTCCAGAATGAGAG
ACTTTCTGTTACGGGATCTGGGAAGGCTCTAATCAAAAACCTGGACAAAGACATGCC
CGACACTCCTCCAATGGAAGGGTCCAAATACAACATGGCGTATTTGAAAGTAGAAC
TGTGCAAGCCCGGTATCTTATCTTGAACTTCATACAATGATTGACGAAGAGCAGGAT

CATGCATCATCAACAAGAGTCTAGCAAATGTCCCAAAATAATTGTACTGTATCATGG
CATTGATTGGGTTCTCAGCAAAATGAGCTACGGTGAGAGCATTTGTGGAAACTGAGC
TCATTATATTAGCACAAGTGGGTATTTGGTCATTGGTGACACAAGTCACTCGTGACC
ATCTCTTGGTCTCTAACCCTCTAATCACTCCACGGAAAATCGGTATTTTTCCATAATT
CAAGTAATCTGCAGATTGCATAGTCTCATCGTCATTTATCAAAAGTCCTAACTTCCCT
GTCCCTATTTTGATTGCAGTCATAATTTTCTCATTATTAGAAACCATTTGATTGAGAG
CACCCTGTAATTCTACAACGTTTCTCGATTTCTTCGTTTTATACTGTGTGCAAATAAC
TTGATTATCACCTTGTGCCAAGACTTTGACAGCAGTGTTTCTGATTTTAGCCTCTCTT
TGAATAACCAGTAGATTGAGGATACTCCATCCTTTTTGCCGTAGACCTTCCAGTCCA
CCCTCTTGTCCTTGCCAACAAACTCGTTGGGAGGTTGAATTGATCAGTGTGTTGTTGT
GAACACGCATCAAGTCTGGTCTTCCATTGTAGTATATAAGACTTTTCTCAAAAAATT
CATGAGTTCTCTCGATTAAGGATGGATAACCTAAGAACTGGCCCATAACTCGGAACA
CTGGGCCGTTTGATAACTTCCTTTGGTGGTTATTCCATTTTTCGTAATCAATGTGATT
GGCTATGCAAATTGCCTCATATGACTTCAATCCTTGGCCGGATGAGGAATCTAACAT
CTTTTTAATGACTGCAGTTAGATCGTCCGCCATTGTCAGGCCTTTAAACATAGGGAC
GAAATGAGTCTTTATCAAATATTCGGTAATTACAAAGTATTCTCGCAATTTCCAAGA
CATTAGGGAGAAAAATCTACCTGCCAACTTCAGTTCCCTCTCCTTTCCTTTAAGACCA
ATAATTAGATCATCATCATCTAAGCCCTTCTCATCAATCTCTTTAAGAAATTCTTTCC
AATTGGTAGCCTTTGTGTCCAACATAGTCTGCAACACCTTTTTACTAGGGATAGGAG
TGTTCGGATTCATTCGGACATGTTTCAACACCTCTGACCTATTCATTGAATGACTTTT
GTCAGAGTATATTATCGATGGGTCTAGTAAGTCGGGTATTTCAAAACATTTAATCAG
CGGAAGTTCATGCCATTTATCTCCAAAATCTTGAACTTGAGCAGCTGTGGGCCATGT
ATTTTCTTTAACATGACTTTTAAAGGGATGATCATGAGGGAGCAAGTCTCCATTCAC
GAACCACTTTTTATGATCATTGAACTGTTGAAATAGAACAATCCGAGCTAAATCACT
TGCAAGTGCTTTTGCATATGACACATCAATATCTTTCTTCATGGTTACTTGGGAATGT
AATTTTTCTAGTCCAGTGTAATAATCTATAAAAGGATGACCCCAATGTCTGAACGAT
CCATAAATCACCAGTGTGAGATCCACTGTTTTCACACTCATTATCTGATCATGGAGG
AATCTTATACCTCGGTCAATTTTTGCCCCTTCATCAACAGAAGTCTTGATATGATTTT
CAAAATGAGGGAATTGTGGGACTAAAGGCCTTGATTCTCTTGCTAATTTCATCAGCT
TCAAGTTGCATATCGGTTCCACCATTTTAATCAAGTCATAAGAAAAATTTCCCTGCCT
CTCCACAATTTTATCTCCAATTCTGTAGATATTTAGAAGGGAGAAGATGTCTTGCTCT
GAGAACAGGTTGTCTATTCTACATACCATGGATAGCACCGTTTGCATCCTCCCTATA
ATCACATCTTTGACCATTAACAGAAAGTTTCGGTCCATTAGAATATCAAGTTTCTTG
AAGTAAGCCCATCCTTCTGAAATAAAAGTAGGACCCAAGCTGGGAACCCTAATCCT
GCATATGTTCGTTCCATGAGAACTTCTTCTGACTTTGCCTTTGAAAGTCCTCGCCAAG
TTGAGCAATTCCACCTCAGAGACAGCATTTAAGATTAATGTCAACTTGTGTAAGTCC
AAAAACTTTTGACACAAATAAGCGAGAATTTTGAATGAGTCAGTCCATCTTTCCTTT
TTGATGTATTCAATTGGTTTGTTGCCCCAGCCGCGGATGAAGGTCTCCACCACGTCA
AATGTTATTTCTGCCTCTTTGTCCACTTCATGTAAAAAACTATACCCTTGACTGGCAT
CATGATTATCAGACATTAACCAACTTCCCATCCATTTATGCATCTGAGATGTTGGGA
TGGGATTGGCTTGACATGACGTTAACATCTCAAGAACTCCATCCCAGTTCTTACTAT
CCCACATCGAGGGAATTGGAAGAGAATTGAATTTCCTGATTAAATTGTCAATATCAT
CACTAATTAGAGGAGAATTCAGGTTGTAATCAGCATGATTCAAGTACGTCATGCGCT
CATCGGGATTCAGGAATTCTCTTGTGGCATAGTCATCTTCATTGAAATCATTGAACTC
GTCGGTCTCAAAATCGTGGACTTCCA

SEQ ID NO: 185 5' to 3' VSV trailer sequence, nucleic acid sequence
TTAAGACCCTCTTGTGGTTTTTATTTTTTATCTGGTTTTGTGGTCTTCGT

SEQ ID NO: 186 3' to 5' VSV trailer sequence, nucleic acid sequence
ACGAAGACCACAAAACCAGATAAAAAATAAAAACCACAAGAGGGTCTTAA

SEQ ID NO: 187 PY motif, amino acid sequence
PPPY

SEQ ID NO: 188 PY motif, amino acid sequence
APPY

SEQ ID NO: 189 PY motif, amino acid sequence
AAPY

SEQ ID NO: 190 PY motif, amino acid sequence
PPAY

SEQ ID NO: 191 PY motif, amino acid sequence
APPA

SEQ ID NO: 192 PY motif, amino acid sequence
AAPA

SEQ ID NO: 193 PY motif, amino acid sequence
PPPA

SEQ ID NO: 194 PS motif, amino acid sequence
PSAP

SEQ ID NO: 195 linker (rigid), H4-2, amino acid sequence
A(EAAAK)4ALEA(EAAAK)4A

SEQ ID NO: 196 VSV-nucleoprotein (52-59), amino acid sequence
RGYVYQGL

SEQ ID NO: 197 G protein signal peptide (GSP), amino acid sequence
MKCLLYLAFLFIGVNC

SEQ ID NO: 198 G protein signal peptide (GSP) 5' to 3', nucleic acid sequence
ATGAAGTGCCTTTTGTACTTAGCCTTTTTATTCATTGGGGTGAATTGC

SEQ ID NO: 199 G protein signal peptide (GSP) 3' to 5', nucleic acid sequence
TACTTCACGGAAAACATGAATCGGAAAAATAAGTAACCCCACTTAACG

CLAIMS

What is claimed is:

1. A recombinant rhabdovirus comprising a nucleotide sequence encoding a recombinant protein, wherein the recombinant protein comprises an IL-12 polypeptide, or a functional fragment or derivative thereof.

2. The recombinant rhabdovirus of claim 1, wherein the recombinant rhabdovirus comprises a rhabdovirus genome, said rhabdovirus genome comprising a gene encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a gene encoding a large protein (L) polypeptide, or a functional fragment or derivative thereof, and wherein the nucleotide sequence encoding the recombinant protein is positioned between the gene encoding the fusogenic polypeptide, or a functional fragment or derivative thereof, and the gene encoding the L polypeptide, or a functional fragment or derivative thereof.

3. The recombinant rhabdovirus of claim 1 or 2, wherein the nucleotide sequence encoding the recombinant protein is a template for a positive sense transcript encoding said recombinant protein.

4. The recombinant rhabdovirus of any one of claims 1-3, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

5. The recombinant rhabdovirus of claim 4, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

6. The recombinant rhabdovirus of any one of claims 1-4, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

7. The recombinant rhabdovirus of any one of claims 4-6, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

8. The recombinant rhabdovirus of claim 7, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

9. The recombinant rhabdovirus of claim 8, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

10. The recombinant rhabdovirus of any one of claims 4-6, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

11. The recombinant rhabdovirus of claim 10, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

12. The recombinant rhabdovirus of claim 11, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

13. The recombinant rhabdovirus of any one of claims 5-12, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

14. The recombinant rhabdovirus of claim 13, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

15. The recombinant rhabdovirus of claim 14, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

16. The recombinant rhabdovirus of claims 5-12, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

17. The recombinant rhabdovirus of claim 16, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

18. The recombinant rhabdovirus of claim 17, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

19. The recombinant rhabdovirus of any one of claims 5-18, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a linker.

20. The recombinant rhabdovirus of claim 19, wherein the linker is from about 5 amino acids to about 30 amino acids in length.

21. The recombinant rhabdovirus of claim 20, wherein the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

22. The recombinant rhabdovirus of claim 21, wherein the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

23. The recombinant rhabdovirus of any one of claims 5-22, wherein the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

24. The recombinant rhabdovirus of claim 23, wherein the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, and/or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

25. The recombinant rhabdovirus of claim 24, wherein the signal peptide is operably linked to

the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

26. The recombinant rhabdovirus of claim 25, wherein the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

27. The recombinant rhabdovirus of claim 26, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

28. The recombinant rhabdovirus of claim 27, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

29. The recombinant rhabdovirus of claim 28, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

30. The recombinant rhabdovirus of claims 26-29, wherein the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

31. The recombinant rhabdovirus of claim 30, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

32. The recombinant rhabdovirus of claim 25, wherein the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

33. The recombinant rhabdovirus of claim 32, wherein the IL-12 p40 subunit precursor, or the

functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

34. The recombinant rhabdovirus of claim 33, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

35. The recombinant rhabdovirus of claim 34, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

36. The recombinant rhabdovirus of any one of claims 32-35, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

37. The recombinant rhabdovirus of claim 36, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

38. The recombinant rhabdovirus of any one of claims 24-27, wherein the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

39. The recombinant rhabdovirus of claim 38, wherein the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

40. The recombinant rhabdovirus of claim 38, wherein the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

41. The recombinant rhabdovirus of any one of claims 1-40, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

42. The recombinant rhabdovirus of claim 41, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

43. The recombinant rhabdovirus of claim 42, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

44. The recombinant rhabdovirus of any one of claims 1-40, wherein the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

45. The recombinant rhabdovirus of claim 44, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

46. The recombinant rhabdovirus of claim 45, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

47. A recombinant rhabdovirus comprising a nucleotide encoding a recombinant protein comprising an IL-12 polypeptide, wherein the IL-12 polypeptide comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof, and an IL-12 p35 subunit, or a functional fragment or derivative thereof, wherein the IL-12 p40 subunit, or a functional fragment or derivative thereof, and the IL-12 p35 subunit, or a functional fragment or derivative thereof, are connected by a linker, wherein the recombinant rhabdovirus comprises a rhabdovirus genome, said rhabdovirus genome comprising a gene encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, and a gene encoding a large protein (L) polypeptide, or a functional fragment or derivative thereof, and wherein the nucleotide sequence encoding the recombinant protein is positioned between the gene encoding the fusogenic polypeptide, or a functional fragment or derivative thereof, and the

gene encoding the L polypeptide, or a functional fragment or derivative thereof.

48. The recombinant rhabdovirus of claim 47, wherein the nucleotide sequence encoding the recombinant protein is a template for a positive sense transcript encoding said recombinant protein.

49. The recombinant rhabdovirus of claim 47 or 48, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

50. The recombinant rhabdovirus of claim 49, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

51. The recombinant rhabdovirus of claim 50, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

52. The recombinant rhabdovirus of claim 47 or 48, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

53. The recombinant rhabdovirus of claim 52, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

54. The recombinant rhabdovirus of claim 53, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

55. The recombinant rhabdovirus of any one of claims 47-54, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

56. The recombinant rhabdovirus of claim 55, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

57. The recombinant rhabdovirus of claim 56, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

58. The recombinant rhabdovirus of any one of claims 47-54, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

59. The recombinant rhabdovirus of claim 58, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

60. The recombinant rhabdovirus of claim 59, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

61. The recombinant rhabdovirus of any one of claims 47-60, wherein the linker is from about 5 amino acids to about 30 amino acids in length.

62. The recombinant rhabdovirus of claim 61, wherein the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

63. The recombinant rhabdovirus of claim 62, wherein the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

64. The recombinant rhabdovirus of any one of claims 47-63, wherein the recombinant protein further comprises a signal peptide operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

65. The recombinant rhabdovirus of claim 64, wherein the signal peptide operably linked to

the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

66. The recombinant rhabdovirus of claim 65, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

67. The recombinant rhabdovirus of claim 66, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

68. The recombinant rhabdovirus of claim 67, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

69. The recombinant rhabdovirus of any one of claims 65-68, wherein the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

70. The recombinant rhabdovirus of claim 69, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

71. The recombinant rhabdovirus of claim 64, wherein the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

72. The recombinant rhabdovirus of claim 71, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

73. The recombinant rhabdovirus of claim 72, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

74. The recombinant rhabdovirus of claim 73, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

75. The recombinant rhabdovirus of any one of claims 71-74, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

76. The recombinant rhabdovirus of claim 75, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

77. The recombinant rhabdovirus of any one of claims 47-76, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

78. The recombinant rhabdovirus of claim 77, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

79. The recombinant rhabdovirus of claim 78, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

80. The recombinant rhabdovirus of any one of claims 47-76, wherein the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

81. The recombinant rhabdovirus of claim 80, wherein the IL-12 polypeptide, or the functional

fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

82. The recombinant rhabdovirus of claim 81, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

83. The recombinant rhabdovirus of any one of claims 1-82, wherein the recombinant rhabdovirus is a vesiculovirus.

84. The recombinant rhabdovirus of claim 83, wherein the vesiculovirus is a vesicular stomatitis virus (VSV).

85. The recombinant rhabdovirus of claim 84, wherein the rhabdovirus genome further comprises a gene encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof.

86. The recombinant rhabdovirus of any one of claims 83-85, wherein the rhabdovirus genome further comprises a gene encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof.

87. The recombinant rhabdovirus of any one of claims 83-86, wherein the rhabdovirus genome further comprises a gene encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof.

88. The recombinant rhabdovirus of any one of claims 83-87, wherein the L polypeptide is a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof.

89. The recombinant rhabdovirus of claim 88, wherein the rhabdovirus genome comprises a gene encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof, a gene encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof, a gene encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, a gene encoding a fusogenic polypeptide, or a functional

fragment or derivative thereof, and a gene encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof.

90. The recombinant rhabdovirus of claim 89, wherein the recombinant rhabdovirus comprises an RNA molecule, wherein the RNA molecule comprises a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, and a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein.

91. The recombinant rhabdovirus of claim 90, wherein the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or the functional fragment or derivative thereof.

92. The recombinant rhabdovirus of claim 91, wherein the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein comprises, from the 3' end to the 5' end of said nucleotide sequence, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for

a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

93. The recombinant rhabdovirus of any one of claims 87-92, wherein the VSV M polypeptide is a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

94. The recombinant rhabdovirus of claim 93, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

95. The recombinant rhabdovirus of claim 94, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3.

96. The recombinant rhabdovirus of claim 95, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 3.

97. The recombinant rhabdovirus of any one of claims 87-92, wherein the VSV M polypeptide is a mutant VSV M polypeptide, or a functional fragment or derivative thereof.

98. The recombinant rhabdovirus of claim 97, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises an amino acid change at position M51 of the amino acid sequence of SEQ ID NO: 3.

99. The recombinant rhabdovirus of claim 98, wherein the amino acid change comprises a methionine (M) substitution.

100. The recombinant rhabdovirus of claim 99, wherein the methionine (M) substitution comprises a methionine (M) to an arginine (R) substitution (M51R).

101. The recombinant rhabdovirus of any one of claims 97-100, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5, or an amino acid sequence that has at least 80% sequence identity thereto.

102. The recombinant rhabdovirus of claim 101, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5.

103. The recombinant rhabdovirus of claim 102, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 5.

104. The recombinant rhabdovirus of any one of claims 89-103, wherein the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

105. The recombinant rhabdovirus of any one of claims 47-104, wherein the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49, or an amino acid sequence that has at least 80% sequence identity thereto.

106. The recombinant rhabdovirus of claim 105, wherein the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

107. The recombinant rhabdovirus of claim 106, wherein the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 49.

108. The recombinant rhabdovirus of any one of claims 47-104, wherein the recombinant

rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113, or an amino acid sequence that has at least 80% sequence identity thereto.

109. The recombinant rhabdovirus of claim 108, wherein the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113.

110. The recombinant rhabdovirus of claim 109, wherein the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 113.

111. The recombinant rhabdovirus of any one of claims 1-110, wherein upon infection of a cell with the recombinant rhabdovirus, the cell expresses the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof.

112. The recombinant rhabdovirus of claim 111, wherein the cell is a human cell.

113. The recombinant rhabdovirus of claim 111 or 112, wherein the cell is a cancer cell.

114. The recombinant rhabdovirus of any one of claims 1-113, wherein the recombinant rhabdovirus is a replication-competent virus.

115. The recombinant rhabdovirus of any one of claims 1-113, wherein the recombinant rhabdovirus is a non-replicative.

116. The recombinant rhabdovirus of any one of claims 1-115, wherein the recombinant rhabdovirus is an oncolytic virus.

117. A recombinant polynucleotide comprising:

i. a nucleotide sequence encoding a vesicular stomatitis virus (VSV) nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

ii. a nucleotide sequence encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

iii. a nucleotide sequence encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

iv. a nucleotide sequence encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

v. a nucleotide sequence encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and

vi. a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof.

118. The recombinant polynucleotide of claim 117, wherein the nucleotide sequence encoding the recombinant protein is positioned between the nucleotide sequence encoding the fusogenic polypeptide, or a functional fragment or derivative thereof, and the nucleotide sequence encoding the L polypeptide, or a functional fragment or derivative thereof.

119. The recombinant polynucleotide of claim 117 or 118, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

120. The recombinant polynucleotide of claim 119, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

121. The recombinant polynucleotide of any one of claims 117-119, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

122. The recombinant polynucleotide of any one of claims 119-121, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

123. The recombinant polynucleotide of claim 122, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

124. The recombinant polynucleotide of claim 123, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

125. The recombinant polynucleotide of any one of claims 119-121, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

126. The recombinant polynucleotide of claim 125, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

127. The recombinant polynucleotide of claim 126, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

128. The recombinant polynucleotide of any one of claims 120-127, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

129. The recombinant polynucleotide of claim 128, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

130. The recombinant polynucleotide of claim 129, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

131. The recombinant polynucleotide of any one of claims 120-127, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

132. The recombinant polynucleotide of claim 131, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

133. The recombinant polynucleotide of claim 132, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

134. The recombinant polynucleotide of any one of claims 120-133, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a linker.

135. The recombinant polynucleotide of claim 134, wherein the linker is from about 5 amino acids to about 30 amino acids in length.

136. The recombinant polynucleotide of claim 135, wherein the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

137. The recombinant polynucleotide of claim 136, wherein the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

138. The recombinant polynucleotide of any one of claims 120-137, wherein the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

139. The recombinant polynucleotide of claim 138, wherein the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, and/or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

140. The recombinant polynucleotide of claim 139, wherein the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

141. The recombinant polynucleotide of claim 140, wherein the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

142. The recombinant polynucleotide of claim 141, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

143. The recombinant polynucleotide of claim 142, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

144. The recombinant polynucleotide of claim 143, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

145. The recombinant polynucleotide of any one of claims 141-144, wherein the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

146. The recombinant polynucleotide of claim 145, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

147. The recombinant polynucleotide of claim 140, wherein the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an

amino acid sequence that has at least 80% sequence identity thereto.

148. The recombinant polynucleotide of claim 147, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

149. The recombinant polynucleotide of claim 148, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

150. The recombinant polynucleotide of claim 149, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

151. The recombinant polynucleotide of any one of claims 147-150, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

152. The recombinant polynucleotide of claim 151, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

153. The recombinant polynucleotide of any one of claims 139-152, wherein the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

154. The recombinant polynucleotide of claim 153, wherein the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

155. The recombinant polynucleotide of claim 153, wherein the signal peptide operably linked

to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

156. The recombinant polynucleotide of any one of claims 117-155, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

157. The recombinant polynucleotide of claim 156, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

158. The recombinant polynucleotide of claim 157, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

159. The recombinant polynucleotide of any one of claims 117-155, wherein the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

160. The recombinant polynucleotide of claim 159, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

161. The recombinant polynucleotide of claim 160, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

162. The recombinant polynucleotide of any one of claims 117-161, comprising a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N

polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, the recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof.

163. The recombinant polynucleotide of any one of claims 117-162, wherein the VSV M polypeptide is a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

164. The recombinant polynucleotide of claim 163, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

165. The recombinant polynucleotide of claim 164, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3.

166. The recombinant polynucleotide of claim 165, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 3.

167. The recombinant polynucleotide of any one of claims 117-162, wherein the VSV M polypeptide is a mutant VSV M polypeptide, or a functional fragment or derivative thereof.

168. The recombinant polynucleotide of claim 167, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises an amino acid change at position M51 of the amino acid sequence of SEQ ID NO: 3.

169. The recombinant polynucleotide of claim 168, wherein the amino acid change comprises a methionine (M) substitution.

170. The recombinant polynucleotide of claim 169, wherein the methionine (M) substitution comprises a methionine (M) to an arginine (R) substitution (M51R).

171. The recombinant polynucleotide of any one of claims 167-170, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5, or an amino acid sequence that has at least 80% sequence identity thereto.

172. The recombinant polynucleotide of claim 171, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5.

173. The recombinant polynucleotide of claim 172, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 5.

174. The recombinant polynucleotide of any one of claims 117-173, wherein the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

175. The recombinant polynucleotide of any one of claims 117-174, wherein the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49, or an amino acid sequence that has at least 80% sequence identity thereto.

176. The recombinant polynucleotide of claim 175, wherein the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

177. The recombinant polynucleotide of claim 176, wherein the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 49.

178. The recombinant polynucleotide of any one of claims 117-174, wherein the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113, or an amino acid sequence that has at least 80% sequence identity thereto.

179. The recombinant polynucleotide of claim 178, wherein the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 113.

180. The recombinant polynucleotide of claim 179, wherein the recombinant rhabdovirus consists of the amino acid sequence of SEQ ID NO: 113.

181. The recombinant polynucleotide of any one of claims 117-180, wherein the polynucleotide is DNA.

182. The recombinant polynucleotide of claim 181, wherein the recombinant polynucleotide comprises the nucleotide sequence of SEQ ID NO: 50, or a nucleotide sequence which has at least 65% sequence identity thereto.

183. The recombinant polynucleotide of claim 182, wherein the recombinant polynucleotide comprises the amino acid sequence of SEQ ID NO: 50.

184. The recombinant polynucleotide of claim 183, wherein the recombinant polynucleotide consists of the amino acid sequence of SEQ ID NO: 50.

185. The recombinant polynucleotide of claim 181, wherein the recombinant polynucleotide comprises the nucleotide sequence of SEQ ID NO: 112, or a nucleotide sequence which has at least 65% sequence identity thereto.

186. The recombinant polynucleotide of claim 185, wherein the recombinant polynucleotide comprises the amino acid sequence of SEQ ID NO: 112.

187. The recombinant polynucleotide of claim 186, wherein the recombinant polynucleotide

consists of the amino acid sequence of SEQ ID NO: 112.

188. The recombinant polynucleotide of any one of claims 117-180, wherein the polynucleotide is RNA.

189. A recombinant polynucleotide, comprising a nucleotide sequence encoding, from the 5' end to the 3' end of said nucleotide sequence, a VSV N polypeptide, or a functional fragment or derivative thereof, a VSV P polypeptide, or a functional fragment or derivative thereof, a VSV M polypeptide, or a functional fragment or derivative thereof, a fusogenic polypeptide, or a functional fragment or derivative thereof, a recombinant protein, and a VSV L polypeptide, or a functional fragment or derivative thereof, wherein:

i. the VSV M polypeptide, or the functional fragment or derivative thereof, is a mutant VSV M polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising the amino acid sequence of SEQ ID NO: 5;

ii. the fusogenic polypeptide, or the functional fragment thereof, is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof; and

iii. the recombinant protein comprises an IL-12 polypeptide, or a functional fragment or derivative thereof, said IL-12 polypeptide comprising the amino acid sequence of SEQ ID NO: 159 or SEQ ID NO: 154.

190. The recombinant polynucleotide of claim 189, wherein the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 159, and the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

191. The recombinant polynucleotide of claim 189, wherein the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 154, and the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113.

192. A recombinant polynucleotide, wherein the recombinant polynucleotide is an RNA

molecule comprising:

i. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV nucleoprotein (N) polypeptide, or a functional fragment or derivative thereof;

ii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV phosphoprotein (P) polypeptide, or a functional fragment or derivative thereof;

iii. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV matrix (M) polypeptide, or a functional fragment or derivative thereof;

iv. a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof;

v. a nucleotide sequence that is a template for a positive sense transcript encoding a VSV large protein (L) polypeptide, or a functional fragment or derivative thereof; and

vi. a nucleotide sequence that is a template for a positive sense transcript encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof.

193. The recombinant polynucleotide of claim 192, wherein the nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein is positioned between the nucleotide sequence that is a template for a positive sense transcript encoding the fusogenic polypeptide, or the functional fragment or derivative thereof, and the nucleotide sequence that is a template for a positive sense transcript encoding the VSV L polypeptide, or a functional fragment or derivative thereof.

194. The recombinant polynucleotide of claim 192 or 193, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p40 subunit, or a functional fragment or derivative thereof.

195. The recombinant polynucleotide of claim 194, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, further comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

196. The recombinant polynucleotide of any one of claims 192-194, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises an IL-12 p35 subunit, or a functional fragment or derivative thereof.

197. The recombinant polynucleotide of any one of claims 194- 196, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69, or an amino acid sequence which has at least 80% sequence identity thereto.

198. The recombinant polynucleotide of claim 197, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 69.

199. The recombinant polynucleotide of claim 198, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 69.

200. The recombinant polynucleotide of any one of claims 194-196, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61, or an amino acid sequence which has at least 80% sequence identity thereto.

201. The recombinant polynucleotide of claim 200, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 61.

202. The recombinant polynucleotide of claim 201, wherein the IL-12 p40 subunit consists of the amino acid sequence of SEQ ID NO: 61.

203. The recombinant polynucleotide of any one of claims 195-202, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid

sequence of SEQ ID NO: 71, or an amino acid sequence which has at least 80% sequence identity thereto.

204. The recombinant polynucleotide of claim 203, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 71.

205. The recombinant polynucleotide of claim 204, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 71.

206. The recombinant polynucleotide of any one of claims 195-202, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63, or an amino acid sequence which has at least 80% sequence identity thereto.

207. The recombinant polynucleotide of claim 206, wherein the IL-12 p35 subunit, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 63.

208. The recombinant polynucleotide of claim 207, wherein the IL-12 p35 subunit consists of the amino acid sequence of SEQ ID NO: 63.

209. The recombinant polynucleotide of any one of claims 195-208, wherein the IL-12 p40 subunit, or the functional fragment or derivative thereof, and the IL-12 p35 subunit, or the functional fragment or derivative thereof, are connected by a linker.

210. The recombinant polynucleotide of claim 209, wherein the linker is from about 5 amino acids to about 30 amino acids in length.

211. The recombinant polynucleotide of claim 210, wherein the linker comprises the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

212. The recombinant polynucleotide of claim 211, wherein the linker consists of the amino acid sequence $(VPGVG)_2$ (SEQ ID NO: 17).

213. The recombinant polynucleotide of any one of claims 195-212, wherein the recombinant protein further comprises a signal peptide operably linked to the IL-12 polypeptide.

214. The recombinant polynucleotide of claim 213, wherein the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, and/or the IL-12 p35 subunit, or the functional fragment or derivative thereof.

215. The recombinant polynucleotide of claim 214, wherein the signal peptide is operably linked to the IL-12 p40 subunit, or the functional fragment or derivative thereof, to form an IL-12 p40 subunit precursor, or a functional fragment or derivative thereof.

216. The recombinant polynucleotide of claim 215, wherein the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 31, or an amino acid sequence that has at least 80% sequence identity thereto.

217. The recombinant polynucleotide of claim 216, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27, or an amino acid sequence that has at least 80% sequence identity thereto.

218. The recombinant polynucleotide of claim 217, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 27.

219. The recombinant polynucleotide of claim 218, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 27.

220. The recombinant polynucleotide of any one of claims 216-219, wherein the IL-12 p40 subunit precursor, or a functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 27.

221. The recombinant polynucleotide of claim 220, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

222. The recombinant polynucleotide of claim 215, wherein the signal peptide operably linked to the IL-12 p40 subunit comprises the amino acid sequence of SEQ ID NO: 65, or an amino acid sequence that has at least 80% sequence identity thereto.

223. The recombinant polynucleotide of claim 222, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12, or an amino acid sequence that has at least 80% sequence identity thereto.

224. The recombinant polynucleotide of claim 223, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 12.

225. The recombinant polynucleotide of claim 224, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 12.

226. The recombinant polynucleotide of any one of claims 222-225, wherein the IL-12 p40 subunit precursor, or the functional fragment or derivative thereof, comprises one or more amino acid changes at positions E81, F82, K106, or K217 of the amino acid sequence of SEQ ID NO: 12.

227. The recombinant polynucleotide of claim 226, wherein the one or more amino acid changes comprises one or more alanine (A) substitutions.

228. The recombinant polynucleotide of any one of claims 214-227, wherein the signal peptide is operably linked to the IL-12 p35 subunit, or the functional fragment or derivative thereof, to form an IL-12 p35 subunit precursor, or a functional fragment or derivative thereof.

229. The recombinant polynucleotide of claim 228, wherein the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 33, or an amino acid sequence that has at least 80% sequence identity thereto.

230. The recombinant polynucleotide of claim 228, wherein the signal peptide operably linked to the IL-12 p35 subunit comprises the amino acid sequence of SEQ ID NO: 67, or an amino acid sequence that has at least 80% sequence identity thereto.

231. The recombinant polynucleotide of any one of claims 192-230, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159, or an amino acid sequence that has at least 80% sequence identity thereto.

232. The recombinant polynucleotide of claim 231, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 159.

233. The recombinant polynucleotide of claim 232, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 159.

234. The recombinant polynucleotide of any one of claims 192-230, wherein the IL-12 polypeptide, or a functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154, or an amino acid sequence that has at least 80% sequence identity thereto.

235. The recombinant polynucleotide of claim 234, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 154.

236. The recombinant polynucleotide of claim 235, wherein the IL-12 polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 154.

237. The recombinant polynucleotide of any one of claims 192-236, wherein the recombinant polynucleotide comprises, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding the recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof.

238. The recombinant polynucleotide of any one of claims 192-237, wherein the VSV M polypeptide is a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

239. The recombinant polynucleotide of claim 238, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 3, or an amino acid sequence that has at least 80% sequence identity thereto.

240. The recombinant polynucleotide of claim 239, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ

ID NO: 3.

241. The recombinant polynucleotide of claim 240, wherein the wild-type VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 3.

242. The recombinant polynucleotide of any one of claims 192-237, wherein the VSV M polypeptide is a mutant VSV M polypeptide, or a functional fragment or derivative thereof.

243. The recombinant polynucleotide of claim 242, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises an amino acid change at position M51 of the amino acid sequence of SEQ ID NO: 3.

244. The recombinant polynucleotide of claim 243, wherein the amino acid change comprises a methionine (M) substitution.

245. The recombinant polynucleotide of claim 244, wherein the methionine (M) substitution comprises a methionine (M) to an arginine (R) substitution (M51R).

246. The recombinant polynucleotide of any one of claims 242-245, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5, or an amino acid sequence that has at least 80% sequence identity thereto.

247. The recombinant polynucleotide of claim 246, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, comprises the amino acid sequence of SEQ ID NO: 5.

248. The recombinant polynucleotide of claim 247, wherein the mutant VSV M polypeptide, or the functional fragment or derivative thereof, consists of the amino acid sequence of SEQ ID NO: 5.

249. The recombinant polynucleotide of any one of claims 192-248, wherein the fusogenic polypeptide is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof.

250. The recombinant polynucleotide of any one of claims 192-249, wherein the recombinant protein comprises the amino acid sequence of SEQ ID NO: 49, or an amino acid sequence that has at least 80% sequence identity thereto.

251. The recombinant polynucleotide of claim 250, wherein the recombinant protein comprises the amino acid sequence of SEQ ID NO: 49.

252. The recombinant polynucleotide of claim 251, wherein the recombinant protein consists of the amino acid sequence of SEQ ID NO: 49.

253. The recombinant polynucleotide of any one of claims 192-249, wherein the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113, or an amino acid sequence that has at least 80% sequence identity thereto.

254. The recombinant polynucleotide of claim 253, wherein the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113.

255. The recombinant polynucleotide of claim 254, wherein the recombinant protein consists of the amino acid sequence of SEQ ID NO: 113.

256. A recombinant polynucleotide, wherein the recombinant polynucleotide is an RNA molecule comprising, from the 3' end to the 5' end of said recombinant polynucleotide, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV N polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a VSV P polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense

transcript encoding a VSV M polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a fusogenic polypeptide, or a functional fragment or derivative thereof, a nucleotide sequence that is a template for a positive sense transcript encoding a recombinant protein, and a nucleotide sequence that is a template for a positive sense transcript encoding a VSV L polypeptide, or a functional fragment or derivative thereof, wherein:

i. the VSV M polypeptide, or the functional fragment or derivative thereof, is a mutant VSV M polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising the amino acid sequence of SEQ ID NO: 5;

ii. the fusogenic polypeptide, or the functional fragment thereof, is a VSV glycoprotein (G) polypeptide, or a functional fragment or derivative thereof; and

iii. the recombinant protein comprises an IL-12 polypeptide, or a functional fragment or derivative thereof, said IL-12 polypeptide comprising the amino acid sequence of SEQ ID NO: 159 or SEQ ID NO: 154.

257. The recombinant polynucleotide of claim 256, wherein the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 159, and the recombinant rhabdovirus comprises the amino acid sequence of SEQ ID NO: 49.

258. The recombinant polynucleotide of claim 256, wherein the IL-12 polypeptide comprises the amino acid sequence of SEQ ID NO: 154, and the recombinant protein comprises the amino acid sequence of SEQ ID NO: 113.

259. A vector comprising the recombinant polynucleotide of any one of claims 117-258.

260. A recombinant vesicular stomatitis virus (VSV) comprising the recombinant polynucleotide of any one of claims 117-258.

261. A composition comprising the recombinant rhabdovirus of any one of claims 1-116, and a

carrier and/or excipient.

262. A composition comprising the recombinant polynucleotide of any one of claims 117-258, and a pharmaceutically acceptable carrier and/or a pharmaceutically acceptable excipient.

263. A product of manufacture comprising the recombinant rhabdovirus of any one of claims 1-116 or the composition of claim 261 or 262 in a sterile vial, ampoule or syringe.

264. A host cell comprising the recombinant rhabdovirus of any one of claims 1-116.

265. A host cell comprising the recombinant polynucleotide of any one of claims 117-258.

266. A method of treating a cancer in a subject in need thereof, the method comprising administering to the subject a therapeutically effective amount of the recombinant rhabdovirus of any one of claims 1-116 or the composition of claim 262.

267. The method of claim 266, wherein the administration of the recombinant rhabdovirus or composition to the subject is under conditions wherein the recombinant rhabdovirus infects cancer cells of the subject to form infected cancer cells, wherein the infected cancer cells express the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and wherein the number of cancer cells within the subject is reduced following the administration.

268. The method of claim 266, wherein the administration of the recombinant rhabdovirus or composition to the subject is under conditions wherein the recombinant rhabdovirus infects cancer cells of the subject to form infected cancer cells, wherein the infected cancer cells express the recombinant protein comprising the IL-12 polypeptide, or the functional fragment or derivative thereof, and wherein the number of cancer cells within the subject does not increase following the administration.

269. A method for inducing a cancer regression in a subject in need thereof, the method

comprising administering to the subject a therapeutically effective amount of the recombinant rhabdovirus of any one of claims 1-116 or the composition of claim 262.

270. The method of claim 269, wherein the cancer regression produces a reduced tumor size.

271. The method of any one of claims 266-270, wherein the recombinant rhabdovirus or composition is administered via local delivery.

272. The method of claim 271, wherein the local delivery is intratumoral delivery.

273. The method of claim 271 or 272, wherein the recombinant rhabdovirus or composition is administered at a dose of from about $1x10^6$/mL $TCID_{50}$/mL to about $1x10^{11}$ $TCID_{50}$/mL.

274. The method of claim 273, wherein the recombinant rhabdovirus or composition is administered at a dose of from about $1x10^7$ $TCID_{50}$/mL to about $1x10^{10}$ $TCID_{50}$/mL.

275. The method of claim 273 or 274, wherein the recombinant rhabdovirus or composition is administered at a dose of about $1x10^7$ $TCID_{50}$/mL, about $3x10^7$ $TCID_{50}$/mL, about $1x10^8$ $TCID_{50}$/mL, about $3x10^8$ $TCID_{50}$/mL, about $1x10^9$ $TCID_{50}$/mL, about $3x10^9$ $TCID_{50}$/mL, or about $1x10^{10}$ $TCID_{50}$/mL.

276. The method of claim 275, wherein the recombinant rhabdovirus or composition is administered at a dose of about $1x10^{10}$ $TCID_{50}$/mL.

277. The method of any one of claims 266-276, wherein the recombinant rhabdovirus comprises a nucleotide sequence encoding a mutant VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising a methionine (M) to an arginine (R) substitution at position M51 of the amino acid sequence of SEQ ID NO: 3, and wherein the administration of the recombinant rhabdovirus to the subject produces a reduced serum interferon gamma (IFN-γ) release in the subject as compared to a control recombinant rhabdovirus comprising a nucleotide sequence encoding a wild-type

VSV M polypeptide, or a functional fragment or derivative thereof.

278. The method of any one of claims 266-277, wherein the recombinant rhabdovirus comprises a nucleotide sequence encoding a mutant VSV matrix (M) polypeptide, or a functional fragment or derivative thereof, said mutant VSV M polypeptide comprising a methionine (M) to an arginine (R) substitution at position M51 of the amino acid sequence of SEQ ID NO: 3, and wherein the administration of the recombinant rhabdovirus to the subject produces a maintained or increased body weight in the subject as compared to a control recombinant rhabdovirus comprising a nucleotide sequence encoding a wild-type VSV M polypeptide, or a functional fragment or derivative thereof.

279. The method of any one of claims 266-278, wherein the administration of the recombinant rhabdovirus to the subject produces an enhanced tumor-specific CD8 T cell response in the subject as compared to a control recombinant rhabdovirus which does not comprise a nucleotide sequence encoding a recombinant protein comprising an IL-12 polypeptide, or a functional fragment or derivative thereof.

280. The method of claim 266, wherein the enhanced tumor-specific CD8 T cell response comprises an increased serum interferon gamma (IFN-γ) release.

281. The method of any one of claims 266-280, wherein the cancer is selected from head and neck cancer, colon cancer, lung cancer, prostate cancer, ovarian cancer, hepatocellular carcinoma, pancreatic cancer, kidney cancer, melanoma, brain cancer, lymphoma, myeloma, lymphocytic leukemia, myelogenous leukemia, and breast cancer.

282. The method of any one of claims 266-281, wherein the method further comprises administering to the subject a therapeutically effective amount of one or more immune checkpoint inhibitors.

283. The method of claim 282, wherein the immune checkpoint inhibitors comprise one of more of an anti-PD-1 antibody, an anti-PDL1 antibody, or an anti-CTLA-4 antibody.

284. The method of claim 283, wherein the immune checkpoint inhibitor comprises an anti-PD-1 antibody.

285. The method of any one of claims 282-284, wherein the immune checkpoint inhibitor is administered via systemic delivery.

286. The method of claim 285, wherein the immune checkpoint inhibitor is administered via parenteral delivery.

287. The method of claim 286, wherein the parenteral delivery is subcutaneous, intraperitoneal, intradermal, intramuscular, or intravenous delivery.

288. The method of claim 287, wherein the parenteral delivery is intravenous delivery.

289. The method of any one of claims 285-288, wherein the immune checkpoint inhibitor is administered at a dose from about 200 mg to about 400 mg.

290. The method of claim 289, wherein the immune checkpoint inhibitor is administered at a dose of about 350 mg.

291. The method of any one of claims 266-290, wherein the subject is human.