capable of eliciting a T cell that maximizes the ability to fuse a large number of antigens or antigenic fragments thereof.

Summary

In a first aspect of the disclosure the disclosure relates to a polypeptide comprising:

(a) a fragment of an invariant chain (INV) of a *Teleostei* comprising or consisting of between 16 to 27 contiguous amino acids of the membrane proximal domain (MPD) of an INV of the *Teleostei*, wherein the fragment has T cell response enhancer activity and the MPD is characterized by an amino acid sequence selected from:

(i) $NQRX_1DIKSLEEQX_2SX_3LX_4X_5X_6X_7TX_8GRSX_9X_{10}$ (SEQ ID NO: 001)

wherein

X_1 is G or N, X_2 is H or N, X_3 is G or N, X_4 is N or Q, X_5 is E or A, X_6 is Q or E, X_7 is L or M, X_8 is K or R, X_9 is A or V and X_{10} is S or A;

and wherein the fragment is preferably at least 60% identical to SEQ ID NO: 3; or

(ii) $DQKQQIQZ_1LQZ_2Z_3NQRZ_4EKQZ_5Z_6Z_7RZ_8RZ_9S$ (SEQ ID NO: 8)

wherein

Z_1 is G or D, Z_2 is T or A, Z_3 is T or S, Z_4 is L or M, Z_5 is M or V, Z_6 is G or S, Z_7 is Q or L, Z_8 is P or S, and Z_9 is E or V;

and wherein the fragment is preferably at least 60% identical to SEQ ID NO: 10;

and optionally one or more antigens and/or one or more antigenic fragments thereof;

or

(b) a full length *Teleostei* INV selected from SEQ ID NO: 2, 5, 9 or 12, or variants thereof, which has T cell response enhancer activity, wherein the amino acid sequence of the MPD of the variant is at least 60% identical to SEQ ID NO: 3 or 10, and one or more antigens and/or one or more antigenic fragments thereof.

In a second aspect the disclosure further relates to a polynucleotide encoding the polypeptide according to the first aspect of the disclosure, wherein the polynucleotide is DNA or RNA, preferably DNA.

In a third aspect the disclosure relates to a vector comprising the polynucleotide according to the second aspect of the disclosure.

In a fourth aspect the disclosure relates to a collection of two or more different vectors, wherein the different vectors each comprise a polynucleotide according to the second aspect of the disclosure encoding a different polypeptide according to the first aspect of the disclosure.

In a fifth aspect the disclosure relates to a pharmaceutical composition comprising the polypeptide of the first aspect of the disclosure, the polynucleotide of the second aspect of the disclosure, or a vector/vector collection of the third or fourth aspect of the disclosure, a pharmaceutically acceptable excipient and optionally one or more adjuvants.

In a sixth aspect the disclosure relates to a kit of parts comprising the pharmaceutical composition of the fifth aspect of the disclosure and separately packaged at least one immunomodulatory, or at least one polynucleotide encoding the immunomodulator, or a vector comprising the polynucleotide encoding the immunomodulator.

In a seventh aspect the disclosure relates to a polypeptide according to the first aspect, a polynucleotide according to the second aspect, a vector or a collection of vectors according to the third or fourth aspect, or a pharmaceutical composition or kits comprising such pharmaceutical compositions according to fifth or sixth aspect for use in preventing or treating a proliferative disease, preferably cancer, viral disease, fungal disease or bacterial disease.

In an eighth aspect the disclosure relates to use of the polypeptide as described herein, the polynucleotide as described herein, the vector or collection of vectors as described herein, or the pharmaceutical composition or kits comprising such pharmaceutical compositions as described herein in the manufacture of a medicament for preventing or treating a proliferative disease, preferably cancer, viral disease, fungal disease or bacterial disease.

In a nineth aspect the disclosure relates to use of the polypeptide as described herein, the polynucleotide as described herein, the vector or collection of vectors as described herein, or the pharmaceutical composition or kits comprising such pharmaceutical compositions as described herein in the manufacture of a medicament for use in combinatorial therapy for preventing or treating a proliferative disease, wherein said medicament is to be administered prior to, concomitantly with or subsequently to at least one immunomodulator, or at least one polynucleotide encoding the immunomodulator, or a vector or liposomal particle comprising the polynucleotide encoding the immunomodulator.

List of Figures

In the following, the content of the figures comprised in this specification is described. In this context please also refer to the detailed description of the invention above and/or below.

Figure 1*:* Immunogenicity of GAd-penta (penta) and GAd vectors encoding for BP and PO full-length invariant chain (BP_INV FL [SEQ ID NO: 9] and PO_INV_FL [SEQ ID NO: 2]) or fragments FRAG_A (BP_INV FRAG_A [SEQ ID NO: 10] and PO_INV FRAG_A [SEQ ID NO: 3]) and FRAG_B (BP_INV FRAG_B [SEQ ID NO: 11] and PO_INV FRAG_B [SEQ ID NO: 4] thereof) linked to the N-terminus of the penta antigen. Mice (n=5-6/group) were immunized with 10^8 vp of each vector and 2 weeks later immune responses were measured by ELISpot assay on spleen. Shown are the average responses (number of T cells producing IFNγ per millions of splenocytes) to a pool of 5 synthetic peptides corresponding to the sequences of the neoantigens encoded in pentatope. Values shown are mean +/-SEM from measurements performed on 5-6 mice/group.

Claims

1. A polypeptide comprising:

(a) a fragment of an invariant chain (INV) of a *Teleostei* comprising or consisting of between 16 to 27 contiguous amino acids of the membrane proximal domain (MPD) of an INV of the *Teleostei,* wherein the fragment has T cell response enhancer activity and the MPD is characterized by an amino acid sequence selected from:

(i) $NQRX_1DIKSLEEQX_2SX_3LX_4X_5X_6X_7TX_8GRSX_9X_{10}$ (SEQ ID NO: 1)

wherein

X_1 is G or N, X_2 is H or N, X_3 is G or N, X_4 is N or Q, X_5 is E or A, X_6 is Q or E, X_7 is L or M, X_8 is K or R, X_9 is A or V and X_{10} is S or A;

and wherein the fragment is preferably at least 60% identical to SEQ ID NO: 003;

or

(ii) $DQKQQIQZ_1LQZ_2Z_3NQRZ_4EKQZ_5Z_6Z_7RZ_8RZ_9S$ (SEQ ID NO: 8)

wherein

Z_1 is G or D, Z_2 is T or A, Z_3 is T or S, Z_4 is L or M, Z_5 is M or V, Z_6 is G or S, Z_7 is Q or L, Z_8 is P or S, and Z_9 is E or V;

and wherein the fragment is preferably at least 60% identical to SEQ ID NO: 10;

and optionally one or more antigens and/or one or more antigenic fragments thereof;

or

(b) a full length *Teleostei* INV selected from SEQ ID NO: 2, 5, 9 or 12, or variants thereof, which has T cell response enhancer activity, wherein the amino acid sequence of the MPD of the variant is at least 60% identical to SEQ ID NO: 3 or 10, and one or more antigens and/or one or more antigenic fragments thereof.

2. The polypeptide of claim 1, wherein the amino acid sequence of:

(a) the MPD according to alternative (a) (i) of claim 1 is any one of SEQ ID NOs: 3 and 6;

(b) the MPD according to alternative (a) (ii) of claim 1 is any one of SEQ ID NOs: 10 and 013; and/or

(c) the *Teleostei* invariant chain according to alternative (b) of claim 1 is any one of SEQ ID NOs: 2 and 9.

3. The polypeptide of claim 1 (a) or claim 2 (a) or (b), wherein the fragment consists of at least 16 to 27 N-terminal amino acids of the MPD and 1 to 26 consecutive amino acids of the transmembrane domain (TMD) of an INV of a *Teleostei* immediately N-terminal of the MPD, wherein the TMD of the INV of the *Teleostei* is preferably characterized by the following amino acid sequence (SEQ ID NO: 15)

$$AB_1KB_2B_3GB_4TB_5LB_6CB_7LB_8B_9B_{10}QB_{11}B_{12}B_{13}B_{14}YB_{15}B_{16}B_{17}$$

wherein

B_1 is V, L or Y, B_2 is V or I, B_3 is V or A, B_4 is L, I or F, B_5 is V, T or L, B_6 is A or V, B_7 is V or L, B_8 is V or I, B_9 is M, S or A, B_{10} is S, A or G, B_{11} is A or V, B_{12} is M or F, B_{13} is I or T, B_{14} is I or A, B_{15} is F or M, B_{16} is L, M or V, B_{17} is V, F or L.

4. The polypeptide according to any one of claims 1 to 3, wherein the antigen in each case is independently selected from the group consisting of a cancer-specific antigen, a cancer specific neoantigen, a viral protein, a bacterial protein or a fungal protein, wherein preferably:

   (i) the polypeptide comprises at least five different antigens and/or antigenic fragments thereof;

   and/or

   (ii) the one or more antigens and/or one or more antigenic fragments thereof are C-terminally of the fragment of the INV according to alternative (a) of claim 1 or the full length INV according to alternative (b) of claim 1.

5. A polynucleotide encoding the polypeptide according to any one of claims 1 to 4, wherein the polynucleotide is DNA or RNA, preferably DNA.

6. A vector comprising the polynucleotide according to claim 5.

7. A collection of two or more different vectors, wherein the different vectors each comprise a polynucleotide according to claim 5 encoding a different polypeptide according to claims 1 to 4.

8. The vector of claim 6 or the collection of vectors of claim 7, wherein the vector in each case is independently selected from the group consisting of a plasmid; a cosmid; a liposomal particle, a viral vector or a virus like particle; preferably an alphavirus vector, a venezuelan equine encephalitis (VEE) virus vector, a sindbis (SIN) virus vector, a semliki forest virus (SFV) virus vector, a simian or human cytomegalovirus (CMV) vector, a Lymphocyte choriomeningitis virus (LCMV) vector, a retroviral vector, a lentiviral vector, an adenoviral vector, an adeno-associated virus vector, a poxvirus vector, a vaccinia virus vector or a modified vaccinia ankara (MVA) vector, wherein the adenoviral vector is preferably a Great Apes adenoviral vector, more preferably a chimpanzee or bonobo or gorilla adenoviral vector.

9. A pharmaceutical composition comprising the polypeptide of any one of claims 1 to 4, polynucleotide of claim 5, or a vector/vector collection of claims 6 to 8, a pharmaceutically acceptable excipient and optionally one or more adjuvants.

10. The pharmaceutical composition of claim 9 comprising at least one immunomodulatory, or at least one polynucleotide encoding the immunomodulatory, or a vector or liposomal particle comprising the polynucleotide encoding the immunomodulatory.

11. A kit of parts comprising the pharmaceutical composition of any one of claims 9 and 10 and separately packaged at least one immunomodulatory, or at least one polynucleotide encoding the immunomodulator, or a vector comprising the polynucleotide encoding the immunomodulator.

12. The pharmaceutical composition of claims 9 to 10 or the kit of parts of claim 11, wherein:
(i) the immunomodulator is a MCM and is selected from the group consisting of:
(a) an agonist of a tumor necrosis factor (TNF) receptor superfamily member, preferably of CD27, CD40, OX40, GITR or CD137; and/or
(b) an antagonist of PD-1, CD274, A2AR, B7-H3, B7-H4, BTLA, CTLA-4, IDO, KIR, LAG3, TIM-3, or VISTA or an antagonist of a B7-CD28 superfamily member, preferably of CD28 or ICOS or an antagonist of a ligand thereof;

and/or

(ii) the immunomodulator is a T cell growth factor, preferably IL-2, IL-12, or IL-15.

13. A polypeptide according to claims 1 to 4, a polynucleotide according to claim 5, a vector or a collection of vectors according to claim 6 to 8, or a pharmaceutical composition or kits comprising such pharmaceutical compositions according to claims 9 to 12 for use in preventing or treating a proliferative disease, preferably cancer, viral disease, fungal disease or bacterial disease.

14. Use of the polypeptide according to claims 1 to 4, the polynucleotide according to claim 5, the vector or collection of vectors according to claim 6 to 8, or the pharmaceutical composition or kits comprising such pharmaceutical compositions according to claims 9 to 12 in the manufacture of a medicament for preventing or treating a proliferative disease, preferably cancer, viral disease, fungal disease or bacterial disease.

15. The polypeptide according to claims 1 to 4, the polynucleotide according to claim 5, the vector or collection of vectors according to claim 6 to 8, or the pharmaceutical composition or kits comprising such pharmaceutical compositions according to claims 9 to 12, or the use according to claim 14, wherein the cancer is selected from the group consisting of malignant neoplasms of lip, oral cavity, pharynx, a digestive organ, respiratory organ, intrathoracic organ, bone, articular cartilage, skin, mesothelial tissue, soft tissue, breast, female genital organs, male genital organs, urinary tract, brain and other parts of central nervous system, thyroid gland, endocrine glands, lymphoid tissue, and haematopoietic tissue.

16. Use of the polypeptide according to claims 1 to 4, the polynucleotide according to claim 5, the vector or collection of vectors according to claims 6 to 8, or the pharmaceutical composition or kits comprising such pharmaceutical compositions according to claims 9 to 12 in the manufacture of a medicament for use in combinatorial therapy for preventing or treating a proliferative disease, wherein said medicament is to be administered prior to, concomitantly with or subsequently to at least one immunomodulator, or at least one polynucleotide encoding the immunomodulator, or a vector or liposomal particle comprising the polynucleotide encoding the immunomodulator.