

WHAT IS CLAIMED:

1. A pre-emptive pan-coronavirus recombinant vaccine composition, the composition comprising one or more large sequences, wherein each of the one or more large sequences comprise at least one of:
 - a) one or more conserved *coronavirus* B-cell target epitopes;
 - b) one or more conserved *coronavirus* CD4⁺ T cell target epitopes; and/or
 - c) one or more conserved *coronavirus* CD8⁺ T cell target epitopes;
 wherein at least one epitope is derived from a non-spike protein.
- ~~2. A pan-coronavirus recombinant vaccine composition, the composition comprising two or more large sequences, wherein each of the two or more large sequences comprise at least one of:~~
 - ~~a) one or more conserved coronavirus B-cell target epitopes;~~
 - ~~b) one or more conserved coronavirus CD4⁺ T cell target epitopes; and/or~~
 - ~~c) one or more conserved coronavirus CD8⁺ T cell target epitopes;~~
 wherein at least one epitope is derived from a non-spike protein.
- ~~3. A pan-coronavirus recombinant vaccine composition, the composition comprising whole spike protein; and one or both of:~~
 - ~~a) one or more conserved coronavirus CD4⁺ T cell target epitopes; and/or~~
 - ~~b) one or more conserved coronavirus CD8⁺ T cell target epitopes;~~
 wherein at least one epitope is derived from a non-spike protein.
- ~~4. A pan-coronavirus recombinant vaccine composition, the composition comprising at least a portion of spike protein, the portion of spike protein comprising a trimerized SARS-CoV-2 receptor-binding domain (RBD); and one or both of:~~
 - ~~(a) one or more conserved coronavirus CD4⁺ T cell target epitopes;~~
 - ~~(b) one or more conserved coronavirus CD8⁺ T cell target epitopes;~~
 wherein at least one epitope is derived from a non-spike protein.
- ~~5. A pan-coronavirus recombinant vaccine composition, the composition comprising whole spike protein; and one or more conserved coronavirus CD4⁺ T cell target epitopes; and one or more conserved coronavirus CD8⁺ T cell target epitopes; wherein at least one epitope is derived from a non-spike protein.~~
- ~~6. A pan-coronavirus recombinant vaccine composition, the composition comprising at least a portion of spike protein, the portion of spike protein comprising a trimerized SARS-CoV-2 receptor-binding domain (RBD); and one or more conserved coronavirus CD4⁺ T cell target epitopes; and one or more conserved coronavirus CD8⁺ T cell target epitopes; wherein at least one epitope is derived from a non-spike protein.~~
- ~~7.2. The composition of any of claims 1-6, wherein the non-spike protein is either encoded by ORF1ab protein, ORF3a-protein, Envelope protein, Membrane glycoprotein, ORF6-protein, ORF7a-protein, ORF7b-protein, ORF8-protein, Nucleocapsid protein and ORF10-protein, or derived from an Envelope protein, a Membrane protein, or a Nucleocapsid protein.~~
3. The composition of claim 2, wherein the non-spike protein comprises a protein encoded by

ORF1ab, ORF7a, or a Nucleocapsid protein.

- ~~8.4.~~ The composition of any one of claims 1-~~73~~, wherein the one or more large sequences are highly conserved among human and animal *coronaviruses*.
- ~~9.~~ ~~The composition of any of claims 1-8, wherein the one or more large sequences are derived from at least one of SARS-CoV-2 protein.~~
- ~~10.5.~~ The composition of any one of claims 1-~~94~~, wherein the one or more large sequences are derived from one or more of: one or more SARS-CoV-2 human strains or variants in current circulation; one or more *coronaviruses* that has caused a previous human outbreak; one or more *coronaviruses* isolated from animals selected from a group consisting of bats, pangolins, civet cats, minks, camels, and other animal receptive to coronaviruses; or one or more *coronaviruses* that cause the common cold.
- ~~11.6.~~ The composition of claim ~~105~~, wherein the one or more SARS-CoV-2 human strains or variants ~~in current circulation~~ are selected from: strain-variant B.1.177; variant strain-B.1.160, variant strain B.1.1.7; variant strain-B.1.351; variant strain-P.1; variant strain-B.1.427/B.1.429; variant strain B.1.258; variant strain-B.1.221; variant strain-B.1.367; variant strain-B.1.1.277; variant strain B.1.1.302; variant strain-B.1.525; variant strain-B.1.526, variant strain-S:677H, and variant strain S:677P; and wherein the one or more coronaviruses that cause the common cold are selected from: 229E alpha coronavirus, NL63 alpha coronavirus, OC43 beta coronavirus, and HKU1 beta coronavirus.
- ~~12.~~ The composition of claim ~~10~~, wherein the one or more *coronaviruses* that cause the common cold are selected from: 229E alpha coronavirus, NL63 alpha coronavirus, OC43 beta coronavirus, and HKU1 beta coronavirus.
- ~~13.~~ The composition of any of claims 1-~~12~~, wherein the conserved epitopes are selected from Variants Of Concern or Variants Of Interest.
- ~~14.7.~~ The composition of any one of claims 1-~~136~~, wherein the one or more large sequences are derived from a whole protein sequence expressed by SARS-CoV-2, derived from a partial protein sequence expressed by SARS-CoV-2, or a combination thereof.
- ~~15.~~ The composition of any of claims 1-~~14~~, wherein the one or more large sequences are derived from ~~a partial protein sequence expressed by SARS-CoV-2.~~
- ~~16.~~ The composition of any of claims 1-~~15~~, wherein the one or more large conserved sequences is derived from a full-length spike glycoprotein.
- ~~17.~~ The composition of any of claims 1-~~15~~, wherein the one or more large conserved sequences is derived from a partial spike glycoprotein.
- ~~18.~~ The composition of claim ~~16-17~~, wherein the spike protein has two consecutive proline substitutions at amino acid positions ~~986 and 987.~~
- ~~19.~~ The composition of any of claims ~~16-18~~, wherein the spike glycoprotein has single amino acid substitutions at amino acid positions comprising Tyr-~~83 and Tyr-489~~, Gln-~~24 and Asn-487.~~
- ~~20.~~ The composition of any of claims 1-~~19~~, wherein the one or more large sequences comprises Spike glycoprotein (S) or a portion thereof, Nucleoprotein or a portion thereof, Membrane protein or a portion thereof, and ORF1a/b or a portion thereof.

21. The composition of any of claims 1-19, wherein the one or more large sequences comprises Spike glycoprotein (S) or a portion thereof, Nucleoprotein or a portion thereof, and ORF1a/b or a portion thereof.
22. The composition of any of claims 16-19, wherein the portion of the Spike glycoprotein is RBD.
23. The composition of any of claims 1-22, wherein the one or more large sequences is selected from the group consisting of: ~~ORF1ab protein, Spike glycoprotein, ORF3a protein, Envelope protein, Membrane glycoprotein, ORF6 protein, ORF7a protein, ORF7b protein, ORF8 protein, Nucleocapsid protein and ORF10 protein.~~
24. The composition of claim 23 wherein the ORF1ab protein comprises nonstructural protein (Nsp) 1, Nsp2, Nsp3, Nsp4, Nsp5, Nsp6, Nsp7, Nsp8, Nsp9, Nsp10, Nsp11, Nsp12, Nsp13, Nsp14, Nsp15 and Nsp16.
25. The composition of any of claims 1-24, wherein one or more of the large sequences comprises a T-cell epitope restricted to a large number of human class 1 and class 2 HLA haplotypes and are not restricted to HLA-0201 for class 1 or HLA-DR for class 2.
26. The composition of any of claims 1-25, wherein the large sequences are derived from structural proteins, non-structural proteins, or a combination thereof.
- 27-8. The composition of any of claims, ~~1-26~~ 7, wherein ~~one or more of the large whole protein sequence or the partial protein sequences are derived from a protein expressed by SAR-CoV-2~~ is selected from SEQ ID NO: 182-185, SEQ ID NO: 148-159, SEQ ID NO: 186-187, and SEQ ID NO: 191-196.
28. The composition of any of claims 1-27, wherein the one or more conserved *coronavirus* CD8⁺ T cell target epitopes are selected from: spike glycoprotein, Envelope protein, ORF1ab protein, ORF7a protein, ORF8a protein, ORF10 protein, or a combination thereof.
29. The composition of any of claims 1-28, wherein the one or more conserved *coronavirus* CD8⁺ T cell target epitopes are selected from: ~~S₂₋₁₀, S₁₂₂₀₋₁₂₂₈, S₁₀₀₀₋₁₀₀₈, S₉₅₈₋₉₆₆, E₂₀₋₂₈, ORF1ab₁₆₇₅₋₁₆₈₃, ORF1ab₂₃₆₃₋₂₃₇₁, ORF1ab₃₀₁₃₋₃₀₂₁, ORF1ab₃₁₈₃₋₃₁₉₁, ORF1ab₅₄₇₀₋₅₄₇₈, ORF1ab₆₇₄₉₋₆₇₅₇, ORF7b₉₂₆₋₃₄₇, ORF8a₇₃₋₈₁, ORF10₃₋₁₁, and ORF10₅₋₁₃.~~
30. The composition of any of claims 1-29, wherein the one or more conserved *coronavirus* CD8⁺ T cell target epitopes are selected from SEQ ID NO: 2-29.
31. The composition of any of claims 1-29, wherein the one or more conserved *coronavirus* CD8⁺ T cell target epitopes are selected from SEQ ID NO: 30-57.
32. The composition of any of claims 1-31, wherein the one or more conserved *coronavirus* CD4⁺ T cell target epitopes are selected from: spike glycoprotein, Envelope protein, Membrane protein, Nucleocapsid protein, ORF1a protein, ORF1ab protein, ORF6 protein, ORF7a protein, ORF7b protein, ORF8 protein, or a combination thereof.
33. The composition of any of claims 1-32, wherein the one or more conserved *coronavirus* CD4⁺ T cell target epitopes are selected from: ~~ORF1a₁₃₅₀₋₁₃₆₅, ORF1ab₅₀₁₉₋₅₀₃₃, ORF6₁₂₋₂₆, ORF1ab₆₀₈₈₋₆₁₀₂, ORF1ab₆₄₂₀₋₆₄₃₄, ORF1a₁₈₀₁₋₁₈₁₅, S₁₋₁₃, E₂₆₋₄₀, E₂₀₋₃₄, M₁₇₆₋₁₉₀, N₃₈₈₋₄₀₃, ORF7a₃₋₁₇, ORF7a₄₁₋₁₅₇, ORF7b₈₋₂₂, ORF7a₉₈₋₁₁₂, and ORF8₁₋₁₅.~~
34. The composition of any of claims 1-33, wherein the one or more conserved *coronavirus* CD4⁺ T cell

- target epitopes are selected from SEQ ID NO: 58-73.
35. The composition of any of claims 1-33, wherein the one or more conserved coronavirus CD4⁺ T cell target epitopes are selected from SEQ ID NO: 74-105.
36. The composition of any of claims 1-35, wherein the one or more conserved coronavirus B cell target epitopes are selected from Spike glycoprotein.
37. The composition of any of claims 1-36, wherein the one or more conserved coronavirus B cell target epitopes are selected from: S₂₈₇₋₃₁₇, S₅₂₄₋₅₉₈, S₆₀₁₋₆₄₀, S₈₀₂₋₈₁₉, S₈₈₈₋₉₀₉, S₃₆₉₋₃₉₃, S₄₄₀₋₅₀₁, S₁₁₃₃₋₁₁₇₂, S₃₂₉₋₃₆₃, and S₁₃₋₃₇.
38. The composition of any of claims 1-37, wherein the one or more coronavirus B cell target epitopes are selected from SEQ ID NO: 106-116.
39. The composition of any of claims 1-37, wherein the one or more coronavirus B cell target epitopes are selected from SEQ ID NO: 117-138.
40. The composition of any of claims 1-39, wherein the one or more conserved coronavirus B cell target epitopes are in the form of a large sequence.
41. The composition of claim 40, wherein the large sequence is full length spike glycoprotein.
42. The composition of claim 40, wherein the large sequence is a partial spike glycoprotein.
43. The composition of any of claims 1-42, wherein each of the large sequences are separated by a linker.
44. The composition of claim 43, wherein the linker is from 2 to 10 amino acids in length.
- 45.9. The composition of any one of claims 1-448, further comprising a T cell attracting chemokine, wherein the T cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.
46. The composition of claim 45, wherein the T cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.
- 47.10. The composition of any one of claims 1-46-9, further comprising a composition that promotes T cell proliferation and T-cell memory, wherein the composition that promotes T cell proliferation and memory is IL-7, IL-2, or IL-15.
11. The composition of any one of claims 1-10, wherein each of the one or more large sequences has at least 25 amino acids.
48. The composition of claim 47, wherein the composition that promotes T cell proliferation is IL-7, IL-2, or IL-15.
49. The composition of any of claims 1-49 further comprising a molecular adjuvant.
50. The composition of claim 50, wherein the molecular adjuvant is CpG.
51. The composition of claim 54, wherein the molecular adjuvant is a CpG polymer.
52. The composition of claim 50, wherein the molecular adjuvant is flagellin.
53. The composition of any of claims 1-52, wherein the recombinant vaccine composition comprises a tag.
54. The composition of claim 53, wherein the tag is a His tag.
55. The composition of any of claims 1-54, further comprising a pharmaceutical carrier.
56. The composition of any of claims 1-55, wherein the composition is used to prevent a coronavirus

disease in a subject.

57. The composition of any of claims 1-56, where the composition is used to prevent a *coronavirus* infection prophylactically in a subject.
58. The composition of any of claims 1-57, wherein the composition elicits an immune response in a subject.
59. The composition of any of claims 1-58, wherein the composition prolongs an immune response induced by the multi-epitope pan-coronavirus recombinant vaccine composition and increases T-cell migration to the lungs.
60. The composition of any of claims 1-59, wherein the transmembrane anchor of the spike protein has an intact S1-S2 cleavage site.
61. The composition of any of claims 1-60, wherein the spike protein is in its stabilized conformation.
62. The composition of any of claims 1-61, wherein the spike protein is stabilized with proline substitutions at amino acid positions 986 and 987 at the top of the central helix in the S2 subunit.
- 63.12. A pre-emptive pan-coronavirus recombinant vaccine composition, according to any of claims 1-62 the composition comprising two or more large sequences, wherein each of the two or more large sequences comprise at least one of:
- a) one or more conserved coronavirus B-cell target epitopes;
 - b) one or more conserved coronavirus CD4+ T cell target epitopes; and/or
 - c) one or more conserved coronavirus CD8+ T cell target epitopes;
- full-length wherein at least one large sequence is derived from a non-spike protein and at least one large sequence is derived from a spike protein.
13. The composition of claim 12, wherein each of the two or more large sequences has at least 25 amino acids.
64. ~~A recombinant vaccine composition according to any of claims 1-62 comprising full-length spike protein or partial spike protein.~~
65. ~~The composition of any of claims 1-64, wherein the spike protein comprises Tyr-489 and Asn-487.~~
66. ~~The composition of any of claims 1-65, wherein the spike protein comprises Gln-493.~~
67. ~~The composition of any of claims 1-66, wherein the spike protein comprises Tyr-505.~~
68. ~~The composition of any of claims 1-67, comprising a trimerized SARS-CoV-2 receptor-binding domain (RBD) sequence.~~
69. ~~The composition of claim 68, wherein the trimerized SARS-CoV-2 receptor-binding domain (RBD) sequence is modified by the addition of a T4 fibrin-derived foldon trimerization domain.~~
70. ~~The composition of claim 69, wherein the addition of a T4 fibrin-derived foldon trimerization domain increases immunogenicity by multivalent display.~~
71. ~~The composition of any of claims 1-70, wherein the conserved epitopes are selected from the Variants Of Concern and Variants Of Interest.~~
72. ~~The composition of any of claims 1-71 comprising a mutation 682-RRAR-685 → 682-QQAQ-685 in the S1-S2 cleavage site.~~
73. ~~The composition of any of claims 1-72 comprising at least one proline substitution.~~
74. ~~The composition of any of claims 1-72 comprising at least two proline substitutions.~~

- ~~75. The composition of any of claims 73-74, wherein the proline substitution is at position K986 and V987.~~
- ~~76. The composition of any of claims 1-75 comprising K986P and V987P mutations.~~
- ~~77. The composition of any of claims 1-83, wherein the spike protein or a portion thereof comprises SEQ ID NO: 195.~~
- ~~78. The composition of any of claims 1-83, wherein the spike protein or a portion thereof comprises one of SEQ ID NO: 191 or SEQ ID NO: 192.~~
- ~~79.14. _____ The composition of any of claims 1-8312 or 13, wherein the at least one large sequence derived from the non-spike protein comprises one of SEQ ID NO: 182-185, SEQ ID NO: 150-159, and wherein the at least one large sequence derived from the spike protein or a portion thereof comprises one of SEQ ID NO: 148-149, SEQ ID NO: 186-187 and SEQ ID NO: 191-196.~~
15. The composition of any one of claims 12-14, wherein the non-spike proteins are either encoded by ORF1ab, ORF3a, ORF6, ORF7a, ORF7b, ORF8, ORF10, or derived from an Envelope protein, a Membrane protein, or a Nucleocapsid protein.
16. The composition of claim 15, wherein non-spike protein comprises a protein encoded by ORF1ab, ORF7a, or a Nucleocapsid protein.
17. The composition of any one of claims 12-16, further comprising a T cell attracting chemokine, wherein the T cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.
18. The composition of any one of claims 12-17, further comprising a composition that promotes T cell proliferation and T-cell memory, wherein the composition that promotes T cell proliferation and memory is IL-7, IL-2, or IL-15.
- ~~80. A pan-coronavirus recombinant vaccine composition, the composition comprising an antigen delivery system encoding one or more large sequences, wherein each of the one or more large sequences comprise at least one of:~~
- ~~a) one or more conserved coronavirus B-cell target epitopes;~~
 - ~~b) one or more conserved coronavirus CD4⁺ T cell target epitopes; and/or~~
 - ~~c) one or more conserved coronavirus CD8⁺ T cell target epitopes;~~
- ~~wherein at least one epitope is from a non-spike protein.~~
- ~~81. A pan-coronavirus recombinant vaccine composition, the composition comprising an antigen delivery system encoding two or more large sequences, wherein each of the two or more large sequences comprise at least one of:~~
- ~~a) one or more conserved coronavirus B-cell target epitopes;~~
 - ~~b) one or more conserved coronavirus CD4⁺ T cell target epitopes; and/or~~
 - ~~c) one or more conserved coronavirus CD8⁺ T cell target epitopes;~~
- ~~wherein at least one epitope is derived from a non-spike protein.~~
- ~~82. A pan-coronavirus recombinant vaccine composition, the composition comprising an antigen delivery system encoding whole spike protein; and one or both of:~~
- ~~a) one or more conserved coronavirus CD4⁺ T cell target epitopes; and/or~~
 - ~~b) one or more conserved coronavirus CD8⁺ T cell target epitopes;~~

wherein at least one epitope is derived from a non-spike protein.

83. A ~~pan-coronavirus recombinant vaccine composition, the composition comprising an antigen delivery system encoding at least a portion of spike protein, the portion of spike protein comprising a trimerized SARS-CoV-2 receptor-binding domain (RBD); and one or both of:~~

(c) ~~one or more conserved coronavirus CD4⁺ T cell target epitopes;~~

(d) ~~one or more conserved coronavirus CD8⁺ T cell target epitopes;~~

wherein at least one epitope is derived from a non-spike protein.

84. A ~~pan-coronavirus recombinant vaccine composition, the composition comprising an antigen delivery system encoding whole spike protein; and one or more conserved coronavirus CD4⁺ T cell target epitopes; and one or more conserved coronavirus CD8⁺ T cell target epitopes; wherein at least one epitope is derived from a non-spike protein.~~

85. A ~~pan-coronavirus recombinant vaccine composition, the composition comprising an antigen delivery system encoding at least a portion of spike protein, the portion of spike protein comprising a trimerized SARS-CoV-2 receptor-binding domain (RBD); and one or more conserved coronavirus CD4⁺ T cell target epitopes; and one or more conserved coronavirus CD8⁺ T cell target epitopes; wherein at least one epitope is derived from a non-spike protein.~~

86. The composition of any of claims 80-85, wherein the composition comprises two or more large sequences.

87. The composition of any of claims 80-86, wherein the delivery system is an adenovirus system.

88. The composition of claim 87, wherein the adenovirus delivery system is Ad26, Ad5, Ad35, or a combination thereof.

89. The composition of any of claims 80-88, wherein the one or more large sequences are operatively linked to a generic promoter.

90. The composition of claim 89, wherein the generic promoter is a CMV or a CAG promoter.

91. The composition of any of claims 80-88, wherein the one or more large sequences are operatively linked to a lung-specific promoter.

92. The composition of claim 91, wherein the lung-specific promoter is SpB or CD144.

93. The composition of any of claims 80-92, wherein the antigen delivery system further encodes a T cell attracting chemokine.

94. The composition of claim 93, wherein the T cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.

95. The composition of any of claims 93-94, wherein the T cell attracting chemokine is operatively linked to a lung-specific promoter.

96. The composition of any of claims 93-94, wherein the T cell attracting chemokine is operatively linked to a generic promoter.

97. The composition of any of claims 80-96, wherein the antigen delivery system further encodes a composition that promotes T cell proliferation.

98. The composition of claim 97, wherein the composition that promotes T cell proliferation is IL-7, IL-2, or IL-15.

99. The composition of any of claims 97-98, wherein the composition that promotes T cell proliferation

- is operatively linked to a lung-specific promoter.
- ~~100. The composition of any of claims 97-98, wherein the composition that promotes T cell proliferation is operatively linked to a generic promoter.~~
- ~~101. The composition of any of claims 93-100, wherein the T cell attracting chemokine and the composition that promotes T cell proliferation are driven by the same promoter.~~
- ~~102. The composition of any of claims 80-101, wherein the vaccine further encodes a peptide comprising a T cell attracting chemokine and a composition that promotes T cell proliferation.~~
- ~~103. The composition of claim 102, wherein the peptide is operatively linked to a lung-specific promoter.~~
- ~~104. The composition of claim 102 wherein the peptide is operatively linked to a generic promoter.~~
- ~~105. The composition of any of claims 80-104, wherein the antigen delivery system further encodes a molecular adjuvant.~~
- ~~106. The composition of claim 105, wherein the molecular adjuvant is CpG.~~
- ~~107. The composition of claim 106, wherein the molecular adjuvant is a CpG polymer.~~
- ~~108. The composition of claim 105, wherein the molecular adjuvant is flagellin.~~
- ~~109. The composition of any of claims 105-108, wherein the molecular adjuvant is operatively linked to a promoter.~~
- ~~110. The composition of claim 109, wherein the promoter is a lung-specific promoter or a generic promoter.~~
- ~~111. The composition of any of claims 80-110, wherein the one or more large sequences are highly conserved among human and animal coronaviruses.~~
- ~~112. The composition of any of claims 80-111, wherein the one or more large sequences are derived from at least one of SARS-CoV-2 protein.~~
- ~~113. The composition of any of claims 80-112, wherein the one or more large sequences are derived from one or more of: (a) one or more SARS-CoV-2 human strains or variants in current circulation; (b) one or more coronaviruses that has caused a previous human outbreak; (c) one or more coronaviruses isolated from animals selected from a group consisting of bats, pangolins, civet cats, minks, camels, and other animal receptive to coronaviruses; or (d) one or more coronaviruses that cause the common cold.~~
- ~~114. The composition of claim 113, wherein the one or more SARS-CoV-2 human strains or variants in current circulation are selected from: strain B.1.177; strain B.1.160; strain B.1.1.7; strain B.1.351; strain P.1; strain B.1.427/B.1.429; strain B.1.258; strain B.1.221; strain B.1.367; strain B.1.1.277; strain B.1.1.302; strain B.1.525; strain B.1.526; strain S:677H, and strain S:677P.~~
- ~~115. The composition of claim 113, wherein the one or more coronaviruses that cause the common cold are selected from: 229E alpha coronavirus, NL63 alpha coronavirus, OC43 beta coronavirus, and HKU1 beta coronavirus.~~
- ~~116. The composition of any of claims 80-115, wherein each of the large sequences are separated by a linker.~~
- ~~117. The composition of claim 116, wherein the linker is from 2 to 10 amino acids in length.~~
- ~~118. The composition of any of claims 80-117, wherein the recombinant vaccine composition~~

comprises a tag.

- ~~119. The composition of claim 118, wherein the tag is a His tag.~~
- ~~120. The composition of any of claims 80-119, wherein the large sequences are derived from structural proteins, non-structural proteins, or a combination thereof.~~
- ~~121. The composition of any of claims 80-120, wherein target epitopes are derived from a SARS-CoV-2 protein selected from a group consisting of: ORF1ab protein, Spike glycoprotein, ORF3a protein, Envelope protein, Membrane glycoprotein, ORF6 protein, ORF7a protein, ORF7b protein, ORF8 protein, Nucleocapsid protein and ORF10 protein.~~
- ~~122. The composition of claim 121, wherein the target epitope derived from the Spike glycoprotein is RBD.~~
- ~~123. The composition of claim 121, wherein the target epitope derived from the Spike glycoprotein is NTD.~~
- ~~124. The composition of claim 121, wherein the target epitope derived from the Spike glycoprotein includes both the RBD and NTD regions.~~
- ~~125. The composition of any of claims 121-124, wherein the target epitope derived from the spike glycoprotein are recognized by neutralizing and blocking antibodies.~~
- ~~126. The composition of any of claims 121-124, wherein the target epitope derived from the spike glycoprotein induces neutralizing and blocking antibodies.~~
- ~~127. The composition of any of claims 121-124, wherein the target epitope derived from the spike glycoprotein induces neutralizing and blocking antibodies that recognize and neutralize the virus.~~
- ~~128. The composition of any of claims 121-124, wherein the target epitope derived from the spike glycoprotein induces neutralizing and blocking antibodies that recognize the spike protein.~~
- ~~129. The composition of claim 121, wherein the ORF1ab protein comprises nonstructural protein (Nsp) 1, Nsp2, Nsp3, Nsp4, Nsp5, Nsp6, Nsp7, Nsp8, Nsp9, Nsp10, Nsp11, Nsp12, Nsp13, Nsp14, Nsp15 and Nsp16.~~
- ~~130. The composition of any of claims 80-129, wherein the one or more conserved coronavirus CD8⁺ T cell target epitopes are selected from: spike glycoprotein, Envelope protein, ORF1ab protein, ORF7a protein, ORF8a protein, ORF10 protein, or a combination thereof.~~
- ~~131. The composition of any of claims 80-130, wherein the one or more conserved coronavirus CD8⁺ T cell target epitopes are selected from: S₂₋₁₀, S₁₂₂₀₋₁₂₂₈, S₁₀₀₀₋₁₀₀₈, S₉₅₈₋₉₆₆, E₂₀₋₂₈, ORF1ab₁₆₇₅₋₁₆₈₃, ORF1ab₂₃₆₃₋₂₃₇₁, ORF1ab₃₀₁₃₋₃₀₂₁, ORF1ab₃₁₈₃₋₃₁₉₁, ORF1ab₅₄₇₀₋₅₄₇₈, ORF1ab₆₇₄₉₋₆₇₅₇, ORF7b₂₆₋₃₄, ORF8a₇₃₋₈₁, ORF10₃₋₁₁, and ORF10₅₋₁₃.~~
- ~~132. The composition of any of claims 80-131, wherein the one or more conserved coronavirus CD8⁺ T cell target epitopes are selected from SEQ ID NO: 2-29.~~
- ~~133. The composition of any of claims 80-131, wherein the one or more conserved coronavirus CD8⁺ T cell target epitopes are selected from SEQ ID NO: 30-57.~~
- ~~134. The composition of any of claims 80-133, wherein the one or more conserved coronavirus CD4⁺ T cell target epitopes are selected from: spike glycoprotein, Envelope protein, Membrane protein, Nucleocapsid protein, ORF1a protein, ORF1ab protein, ORF6 protein, ORF7a protein, ORF7b protein, ORF8 protein, or a combination thereof.~~

- ~~135. The composition of any of claims 80-134, wherein the one or more conserved *coronavirus* CD4⁺ T cell target epitopes are selected from: ORF1a₁₃₅₀₋₁₃₆₅, ORF1ab₅₀₁₉₋₅₀₃₃, ORF6₁₂₋₂₆, ORF1ab₆₁₀₂₋₆₁₀₇, ORF1ab₆₄₂₀₋₆₄₃₄, ORF1a₁₈₀₁₋₁₈₁₅, S₁₋₁₃, E₂₆₋₄₀, E₂₀₋₃₄, M₁₇₆₋₁₉₀, N₃₈₈₋₄₀₃, ORF7a₃₋₁₇, ORF7a₁₋₁₅, ORF7b₈₋₂₂, ORF7a₉₈₋₁₁₂, and ORF8₁₋₁₅.~~
- ~~136. The composition of any of claims 80-135, wherein the one or more conserved *coronavirus* CD4⁺ T cell target epitopes are selected from SEQ ID NO: 58-73.~~
- ~~137. The composition of any of claims 80-135, wherein the one or more conserved *coronavirus* CD4⁺ T cell target epitopes are selected from SEQ ID NO: 74-105.~~
- ~~138. The composition of any of claims 80-136, wherein the one or more conserved *coronavirus* B cell target epitopes are selected from Spike glycoprotein.~~
- ~~139. The composition of any of claims 80-137, wherein the one or more conserved *coronavirus* B cell target epitopes are selected from: S₂₈₇₋₃₁₇, S₅₂₄₋₅₉₈, S₆₀₁₋₆₄₀, S₈₀₂₋₈₁₉, S₈₈₈₋₉₀₉, S₃₆₉₋₃₉₃, S₄₄₀₋₅₀₁, S₁₁₃₃₋₁₁₇₂, S₃₂₉₋₃₆₃, and S₁₃₋₃₇.~~
- ~~140. The composition of any of claims 80-138, wherein the one or more *coronavirus* B cell target epitopes are selected from SEQ ID NO: 106-116.~~
- ~~141. The composition of any of claims 80-138, wherein the one or more *coronavirus* B cell target epitopes are selected from SEQ ID NO: 117-138.~~
- ~~142. The composition of any of claims 80-141, wherein each of the large sequences are separated by a linker.~~
- ~~143. The composition of any of claims 80-141, wherein two or more of the large sequences are separated by a linker.~~
- ~~144. The composition of claim 142-143, wherein the linker is from 2 to 10 amino acids in length.~~
- ~~145. The composition of any of claims 142-144, wherein the linker comprises T2A.~~
- ~~146. The composition of any of claims 142-144, wherein the linker is selected from T2A, E2A, and P2A.~~
- ~~147. The composition of any of claims 80-146, wherein a different linker is disposed between each open reading frame.~~
- ~~148. The composition of any of claims 80-147, wherein the recombinant vaccine composition comprises a tag.~~
- ~~149. The composition of claim 148, wherein the tag is a His tag.~~
- ~~150. The composition of any of claims 80-149, further comprising a pharmaceutical carrier.~~
- ~~151. The composition of any of claims 80-150, wherein the composition is used to prevent a *coronavirus* disease in a subject.~~
- ~~152. The composition of any of claims 80-151, where the composition is used to prevent a *coronavirus* infection prophylactically in a subject.~~
- ~~153. The composition of any of claims 80-152, wherein the composition elicits an immune response in a subject.~~
- ~~154. The composition of any of claims 80-153, wherein the composition prolongs an immune response induced by the multi-epitope pan-*coronavirus* recombinant vaccine composition and increases T-cell migration to the lungs.~~

- ~~155. The composition of any of claims 80-154, wherein the vaccine constructs are for humans.~~
- ~~156. The composition of claim 155, wherein the recombinant vaccine composition comprises human CXCL-11 and IL-7 or IL-2 or IL-15.~~
- ~~157. The compositions of any of claims 1-154, wherein the vaccine constructs are for animals.~~
- ~~158. The composition of claim 60, wherein the recombinant vaccine composition comprises animal CXCL-11 and IL-7 or IL-2 or IL-15.~~
- ~~159. The composition of claim 157-158, wherein the animals are cats and dogs.~~
- ~~160. The composition of any of claims 1-159, wherein the compositions are for use as a vaccine.~~
- ~~161. The composition of any of claims 1-160, wherein the compositions are for use as immunotherapy for the prevention and treatment of Coronaviruses infections and diseases.~~
- ~~162. A rVSV-panCoV recombinant vaccine composition according to any of claims 1-161.~~
- ~~163. A rAdV-panCoV recombinant vaccine composition according to any of claims 1-161.~~
- ~~164.19. A pan-coronavirus recombinant vaccine~~The composition of any one of claims 1-18, wherein the composition comprises any of SEQ ID NO: 139-147.
- ~~165. A method of preventing a coronavirus disease in a subject; the method comprising: administering to the subject a therapeutically effective amount of a pan-coronavirus recombinant vaccine composition according to any of claims 1-164, wherein the composition elicits an immune response in the subject.~~
- ~~166. A method of preventing a coronavirus infection prophylactically in a subject, the method comprising: administering to the subject a prophylactically effective amount of a pan-coronavirus recombinant vaccine composition according to any of claims 1-164.~~
- ~~167. A method of eliciting an immune response in a subject, comprising administering to the subject a composition according to any of claims 1-164.~~
- ~~168. A method comprising: administering to the subject a pan-coronavirus recombinant vaccine composition according to any of claims 1-164, wherein the composition prevents virus replication in the lungs, the brain, and other compartments where the virus replicates.~~
- ~~169. A method comprising: administering to the subject a pan-coronavirus recombinant vaccine composition according to any of claims 1-164, wherein the composition prevents cytokine storm in the lungs, the brain, and other compartments where the virus replicates.~~
- ~~170. A method comprising: administering to the subject a pan-coronavirus recombinant vaccine composition according to any of claims 1-164, wherein the composition prevents inflammation or inflammatory response in the lungs, the brain, and other compartments where the virus replicates.~~
- ~~171. A method comprising: administering to the subject a pan-coronavirus recombinant vaccine composition according to any of claims 1-164, wherein the composition improves homing and retention of T cells in the lungs, the brain, and other compartments where the virus replicates.~~
- ~~172. A method of preventing a coronavirus disease in a subject; the method comprising: administering to the subject a pan-coronavirus recombinant vaccine composition according to any of claims 1-164, wherein the composition induces memory B and T cells.~~
- ~~173. The method of claim 172, wherein the composition induces resident memory T cells (Trm).~~
- ~~174. A method of prolonging an immune response induced by a pan-coronavirus vaccine and~~

- increasing T cell migration to the lungs, the method comprising: co-expressing a T cell attracting chemokine, a composition that promotes T cell proliferation, and a pan-coronavirus recombinant vaccine composition according to any of claims 1-164.
175. A method of prolonging the retention of memory T-cell into the lungs induced by a pan-coronavirus vaccine and increasing virus specific tissue resident memory T cells (T_{RM} cells), the method comprising: co-expressing a T-cell attracting chemokine, a composition that promotes T cell proliferation, and a pan-coronavirus vaccine according to any of claims 1-164.
176. A method comprising: administering to the subject a pan-coronavirus recombinant vaccine composition according to any of claims 1-164, wherein the composition prevents the development of mutation and variants of a coronavirus.
177. The method of any of claims 165-176, wherein the vaccine is administered through an intravenous route (i.v.), an intranasal route (i.n.), or a sublingual route (s.l.) route.
178. The method of any of claims 165-177, wherein the recombinant vaccine composition induces efficient and powerful protection against the coronavirus disease or infection.
179. The method of any of claims 165-178, wherein the recombinant vaccine composition induces production of antibodies (Abs), CD4+ T helper (Th1) cells, and CD8+ cytotoxic T-cells (CTL).
180. The method of any of claims 165-179, wherein one or more of the T-cell attracting chemokine, the composition that promotes T cell proliferation, and the pan-coronavirus vaccine is operatively linked to a promoter.
181. The method of claim 180, wherein the promoter is a lung specific promoter.
182. The method of claim 181, wherein the lung specific promoter is SP-B or CD144.
183. The method of claim 180, wherein the promoter is a generic promoter.
184. The method of claim 183, wherein the promoter is a human cytomegalovirus immediate early enhancer/promoter (CMV).
185. The method of any of claims 165-185, wherein the composition that promotes T cell proliferation is IL-7, IL-2, or IL-15.
186. The method of any of claims 165-186, wherein the composition that promotes T cell proliferation helps to promote long term immunity.
187. The method of any of claims 165-187, wherein the T cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.
188. The method of any of claims 165-188, wherein the T-cell attracting chemokine helps pull T-cells from circulation into the lungs.
189. A method comprising:
- a. administering a first dose of a pan-coronavirus vaccine composition according to any of claims 1-164 using a first delivery system; and
 - b. administering a second dose using a second delivery system;
- wherein the first and second delivery system are different.
190. The method of claim 189, wherein the first delivery system may comprise a RNA, a modified mRNA, or a peptide delivery system.
191. The method of claim 189-190, wherein the second delivery system may comprise a RNA, a

modified mRNA, or a peptide delivery system.

~~192. The method of claim 189, wherein the peptide delivery system is an adenovirus or an adeno-associated virus.~~

~~193. The method of claim 190, wherein the adenovirus delivery system is Ad26, Ad5, Ad35, or a combination thereof.~~

~~194. The method of claim 190, wherein the adeno-associated delivery system is AAV8 or AAV9.~~

~~195. The method of any of claims 189-194 wherein the second vaccine dose is administered 14 days after the first vaccine dose.~~

~~196. A method comprising:~~

~~a) administering a pan-coronavirus recombinant vaccine composition according to any of claims 1-164; and~~

~~b) administering at least one T-cell attracting chemokine after administering the pan-coronavirus recombinant vaccine composition.~~

~~197.20. The method composition of any one of claims 196-19, wherein the recombinant vaccine composition is administered via a comprises DNA, RNA, a modified mRNA, or a peptide; and the vaccine composition is to be administered via a RNA, a modified mRNA, a peptide delivery system, or a viral vector.~~

~~198. The method of claim 196-197, wherein the T-cell attracting chemokine is administered via a RNA, a modified mRNA, or a peptide delivery system~~

~~199. The method of any of claims 196-198 wherein the peptide delivery system is an adenovirus or an adeno-associated virus.~~

~~200. The method of claim 199, wherein the adenovirus delivery system is Ad26, Ad5, Ad35, or a combination thereof.~~

~~201. The method of claim 199, wherein the adeno-associated delivery system is AAV8 or AAV9.~~

~~202. The method of any of claims 196-201, wherein the T-cell attracting chemokine is administered 14 days after administering days after the recombinant vaccine composition.~~

~~203. The method of any of claims 196-202, wherein the T-cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.~~

~~204. A method comprising:~~

~~a) administering a pan-coronavirus recombinant vaccine composition according to any of claims 1-164;~~

~~b) administering at least one T-cell attracting chemokine after administering the pan-coronavirus recombinant vaccine composition; and~~

~~c) administering at least one cytokine after administering the T-cell attracting chemokine.~~

~~205. The method of claim 204, wherein the recombinant vaccine composition is administered via a RNA, a modified mRNA, or a peptide delivery system.~~

~~206. The method of any of claims 204-205, wherein the T-cell attracting chemokine is administered via a RNA, a modified mRNA, or a peptide delivery system.~~

~~207. The method of any of claims 204-206, wherein the cytokine is administered via a RNA, a modified mRNA, or a peptide delivery system.~~

- ~~208. The method of any of claims 204-207, wherein the peptide delivery system is an adenovirus or an adeno-associated virus.~~
- ~~209. The method of claim 208, wherein the adenovirus delivery system is Ad26, Ad5, Ad35, or a combination thereof.~~
- ~~210. The method of claim 208, wherein the adeno-associated delivery system is AAV8 or AAV9.~~
- ~~211. The method of any of claims 204-210, wherein the T-cell attracting chemokine is administered 14 days after administering the recombinant vaccine composition.~~
- ~~212. The method of any of claims 204-211, wherein the T-cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.~~
- ~~213. The method of any of claims 204-212, wherein the cytokine is administered 10 days after administering the T-cell attracting chemokine.~~
- ~~214. The method of claim 16, wherein the cytokine is IL-7, IL-15, or a combination thereof.~~
- ~~215. A method comprising:~~
- ~~a) administering a pan-coronavirus recombinant vaccine composition according to any of claims 1-164;~~
 - ~~b) administering one or more T-cell attracting chemokine after administering the pan-coronavirus recombinant vaccine composition; and~~
 - ~~c) administering one or more mucosal chemokines.~~
- ~~216. The method of claim 215, wherein the recombinant vaccine composition is administered using modified RNA, adeno-associated virus, or an adenovirus.~~
- ~~217. The method of any of claims 215-216, wherein the T-cell attracting chemokine is administered via a RNA, a modified mRNA, or a peptide delivery system.~~
- ~~218. The method of any of claims 215-216, wherein the mucosal chemokine is administered via a RNA, a modified mRNA, or a peptide delivery system.~~
- ~~219. The method of claim 218, wherein the adeno-associated virus is AAV8 or AAV9.~~
- ~~220. The method of claim 218, wherein the adenovirus is Ad26, Ad5, Ad35, or a combination thereof.~~
- ~~221. The method of any of claims 215-220, wherein the T-cell attracting chemokine is administered 14 days after administering the recombinant vaccine composition.~~
- ~~222. The method of any of claims 215-221, wherein the T-cell attracting chemokine is CCL5, CXCL9, CXCL10, CXCL11, or a combination thereof.~~
- ~~223. The method of any of claims 215-222, wherein the mucosal chemokine is administered 10 days after administering the T-cell attracting chemokine.~~
- ~~224. The method of any of claims 215-223, wherein the mucosal chemokine is CCL25, CCL28, CXCL14, or CXCL17, or a combination thereof.~~
- ~~225. The method of any of claims 215-224, wherein the recombinant vaccine composition is administered via two doses.~~
- ~~226. The method of any of claims 215-225, wherein the doses are about 3 weeks apart.~~
- ~~227. A pan-coronavirus recombinant vaccine composition, the composition comprising one or more large sequences, each of the one or more large sequences comprises at least one of:~~
- ~~a) whole spike protein or a portion thereof;~~

- b) ~~one or more conserved coronavirus CD4⁺ T cell target epitope; and~~
 c) ~~one or more conserved coronavirus CD8⁺ T cell target epitope;~~
 wherein at least one epitope is derived from a non-spike protein.
228. ~~The composition of claim 227, wherein the one or more conserved epitopes are highly conserved among human and animal coronaviruses.~~
229. ~~The composition of any of claims 227-228, wherein the one or more conserved epitopes are derived from at least one of SARS-CoV-2 protein.~~
230. ~~The composition of any of claims 227-229, wherein the composition comprises 2-20 CD8⁺ T cell target epitopes.~~
231. ~~The composition of any of claims 227-230, wherein the composition comprises 2-20 CD4⁺ T cell target epitopes.~~
232. ~~The composition of any of claims 227-231, wherein the one or more conserved coronavirus CD4⁺ T cell target epitopes selected from SEQ ID NO: 58-105 (ORF1a₁₃₅₀₋₁₃₆₅, ORF1ab₅₀₁₉₋₅₀₃₃, ORF6₁₂₋₂₆, ORF1ab₆₀₈₈₋₆₁₀₂, ORF1ab₆₄₂₀₋₆₄₃₄, ORF1a₁₈₀₁₋₁₈₁₅, S₁₋₁₃, E₂₆₋₄₀, E₂₀₋₃₄, M₁₇₆₋₁₉₀, N₃₈₈₋₄₀₃, ORF7a₃₋₁₇, ORF7a₁₋₁₅, ORF7b₈₋₂₂, ORF7a₉₈₋₁₁₂, and ORF8₁₋₁₅).~~
233. ~~The composition of any of claims 227-232, wherein the one or more conserved coronavirus CD8⁺ T cell target epitopes selected from SEQ ID NO: 106-138 (S₂₈₇₋₃₁₇, S₅₂₄₋₅₉₈, S₆₀₁₋₆₄₀, S₈₀₂₋₈₁₉, S₈₈₈₋₉₀₉, S₃₆₉₋₃₉₃, S₄₄₀₋₅₀₁, S₁₁₃₃₋₁₁₇₂, S₃₂₉₋₃₆₃, and S₁₃₋₃₇).~~
234. ~~A pan-coronavirus recombinant vaccine composition, the composition comprising one or more large sequences, each of the one or more large sequences comprises at least one of:~~
 a) ~~one or more conserved coronavirus B-cell target epitope;~~
 b) ~~one or more conserved coronavirus CD4⁺ T cell target epitope; and/or~~
 c) ~~one or more conserved coronavirus CD8⁺ T cell target epitope;~~
 wherein at least one epitope is derived from a non-spike protein.
235. ~~The composition of claim 234, wherein the one or more conserved epitopes are derived from at least one of SARS-CoV-2 protein.~~
236. ~~The composition of any of claims 234-235, wherein the composition comprises 2-20 CD8⁺ T cell target epitopes.~~
237. ~~The composition of any of claims 234-236, wherein the composition comprises 2-20 CD4⁺ T cell target epitopes.~~
238. ~~The composition of any of claims 234-237, wherein the one or more conserved coronavirus CD4⁺ T cell target epitopes selected from SEQ ID NO: 58-105 (ORF1a₁₃₅₀₋₁₃₆₅, ORF1ab₅₀₁₉₋₅₀₃₃, ORF6₁₂₋₂₆, ORF1ab₆₀₈₈₋₆₁₀₂, ORF1ab₆₄₂₀₋₆₄₃₄, ORF1a₁₈₀₁₋₁₈₁₅, S₁₋₁₃, E₂₆₋₄₀, E₂₀₋₃₄, M₁₇₆₋₁₉₀, N₃₈₈₋₄₀₃, ORF7a₃₋₁₇, ORF7a₁₋₁₅, ORF7b₈₋₂₂, ORF7a₉₈₋₁₁₂, and ORF8₁₋₁₅).~~
239. ~~The composition of any of claims 234-238, wherein the one or more conserved coronavirus CD8⁺ T cell target epitopes selected from SEQ ID NO: 106-138 (S₂₈₇₋₃₁₇, S₅₂₄₋₅₉₈, S₆₀₁₋₆₄₀, S₈₀₂₋₈₁₉, S₈₈₈₋₉₀₉, S₃₆₉₋₃₉₃, S₄₄₀₋₅₀₁, S₁₁₃₃₋₁₁₇₂, S₃₂₉₋₃₆₃, and S₁₃₋₃₇).~~
240. ~~The composition of any of claims 234-239, wherein the one or more conserved coronavirus B-cell target epitopes selected from SEQ ID NO: 2-57 (S₂₋₁₀, S₁₂₂₀₋₁₂₂₈, S₁₀₀₀₋₁₀₀₈, S₉₅₈₋₉₆₆, E₂₀₋₂₈, ORF1ab₁₋₁₆₇₅₋₁₆₈₃, ORF1ab₂₃₆₃₋₂₃₇₁, ORF1ab₃₀₁₃₋₃₀₂₁, ORF1ab₃₁₈₃₋₃₁₉₁, ORF1ab₅₄₇₀₋₅₄₇₈, ORF1ab₆₇₄₉₋~~

- ~~6757, ORF7b₂₆₋₃₄, ORF8a₇₃₋₈₁, ORF10₃₋₁₁, and ORF10₅₋₁₃);~~
241. ~~A pan-coronavirus recombinant vaccine composition, the composition comprising an antigen delivery system encoding one or more large sequences, the large sequences comprise at least one of:~~
- ~~a) one or more conserved coronavirus B-cell target epitopes;~~
 - ~~b) one or more conserved coronavirus CD4⁺ T-cell target epitopes; and/or~~
 - ~~c) one or more conserved coronavirus CD8⁺ T-cell target epitopes;~~
- ~~wherein at least one epitope is derived from a non-spike protein.~~
242. ~~The composition of claim 241, wherein the antigen delivery system is an adenovirus-based antigen delivery system.~~
243. ~~The composition of claim 242, wherein the adenovirus-based antigen delivery system is Ad26, Ad5, Ad35, or a combination thereof.~~
244. ~~The composition of any of claims 241-243, wherein the antigen delivery system further encodes a T-cell attracting chemokine.~~
245. ~~The composition of any of claims 241-244, wherein the antigen delivery system further encodes a composition that promotes T-cell proliferation.~~
246. ~~The composition of any of claims 241-245, wherein the antigen delivery system further encodes a molecular adjuvant.~~
247. ~~The composition of any of claims 241-246, wherein the epitopes are operatively linked to a lung-specific promoter.~~
248. ~~The composition of any of claims 241-247, wherein the one or more conserved coronavirus B-cell target epitopes selected from SEQ ID NO: 2-57 (S₂₋₁₀, S₁₂₂₀₋₁₂₂₈, S₁₀₀₀₋₁₀₀₈, S₉₅₈₋₉₆₆, E₂₀₋₂₈, ORF1ab₁₆₇₅₋₁₆₈₃, ORF1ab₂₃₆₃₋₂₃₇₁, ORF1ab₃₀₁₃₋₃₀₂₁, ORF1ab₃₁₈₃₋₃₁₉₁, ORF1ab₅₄₇₀₋₅₄₇₈, ORF1ab₅₆₇₄₉₋₆₇₅₇, ORF7b₂₆₋₃₄, ORF8a₇₃₋₈₁, ORF10₃₋₁₁, and ORF10₅₋₁₃).~~
249. ~~The composition of any of claims 241-248, wherein the one or more conserved coronavirus CD4⁺ T-cell target epitopes selected from SEQ ID NO: 58-105 (ORF1a₁₃₅₀₋₁₃₆₅, ORF1ab₉₅₀₁₉₋₅₀₃₃, ORF6₁₂₋₂₆, ORF1ab₆₀₈₈₋₆₁₀₂, ORF1ab₆₄₂₀₋₆₄₃₄, ORF1a₁₈₀₁₋₁₈₁₅, S₁₋₁₃, E₂₆₋₄₀, E₂₀₋₃₄, M₁₇₆₋₁₉₀, N₃₈₈₋₄₀₃, ORF7a₃₋₁₇, ORF7a₁₋₁₅, ORF7b₈₋₂₂, ORF7a₉₈₋₁₁₂, and ORF8₁₋₁₅).~~
250. ~~The composition of any of claims 241-249, wherein the one or more conserved coronavirus CD8⁺ T-cell target epitopes selected from SEQ ID NO: 106-138 (S₂₈₇₋₃₁₇, S₅₂₄₋₅₉₈, S₆₀₁₋₆₄₀, S₈₀₂₋₈₁₉, S₈₈₈₋₉₀₉, S₃₆₉₋₃₉₃, S₄₄₀₋₅₀₁, S₁₁₃₃₋₁₁₇₂, S₃₂₉₋₃₆₃, and S₁₃₋₃₇).~~
251. ~~The composition of any of claims 241-250, comprising a spike protein or a partial spike protein.~~
252. ~~The composition of claim 251, wherein the partial spike protein comprises a trimerized SARS-CoV-2 receptor-binding domain (RBD).~~
253. ~~The composition of any of claims 251-252, wherein the whole spike protein or partial spike protein has an intact S1-S2 cleavage site.~~
254. ~~The composition of any of claims 251-253, wherein the spike protein is stabilized with proline substitutions at amino acid positions 986 and 987.~~
255. ~~A pan-coronavirus recombinant recombinant vaccine composition comprising one of SEQ ID NO: 139-147.~~