

CLAIMS

What is claimed is:

1. A chimeric protein of a general structure of:

N terminus – (a) – (b) – (c) – C terminus,

5 wherein:

(a) is a first domain comprising an extracellular domain of a Type I transmembrane protein, the transmembrane protein being TIGIT,

(b) is a linker comprising at least one cysteine residue capable of forming a disulfide bond, and

10 (c) is a second domain comprising an extracellular domain of Type II transmembrane protein, the transmembrane protein being selected from 4-1BBL, GITRL, TL1A, and LIGHT, wherein:

the linker connects the first domain and the second domain and optionally comprises one or more joining linkers, such joining linkers being selected from SEQ ID NOs: 49-95.

2. The chimeric protein of claim 1, wherein the second domain is 4-1BBL.

3. The chimeric protein of claim 1, wherein the second domain is GITRL.

- 15 4. The chimeric protein of claim 1, wherein the second domain is TL1A.

5. The chimeric protein of claim 1, wherein the second domain is LIGHT.

6. A chimeric protein of a general structure of:

N terminus – (a) – (b) – (c) – C terminus,

wherein:

20 (a) is a first domain comprising an extracellular domain of a Type I transmembrane protein, the transmembrane protein being selected from PD-1, CD172a(SIRPα), and TIGIT,

(b) is a linker comprising at least one cysteine residue capable of forming a disulfide bond, and

(c) is a second domain comprising an extracellular domain of Type II transmembrane protein, the transmembrane protein being LIGHT, wherein:

25 the linker connects the first domain and the second domain and optionally comprises one or more joining linkers, such joining linkers being selected from SEQ ID NOs: 49-95.

7. The chimeric protein of claim 6, wherein the first domain is PD-1.

8. The chimeric protein of claim 6, wherein the first domain is CD172a(SIRPα).

9. The chimeric protein of claim 6, wherein the first domain is TIGIT.

10. The chimeric protein of any one of claims 1 to 9, wherein the linker is a polypeptide selected from a flexible amino acid sequence, an IgG hinge region, or an antibody sequence.
11. The chimeric protein of any one of claims 1 to 10, wherein the linker comprises hinge-CH2-CH3 Fc domain derived from IgG4.
- 5 12. The chimeric protein of claim 11, wherein the hinge-CH2-CH3 Fc domain is derived from human IgG4.
13. The chimeric protein of claim 11 or claim 12, wherein the linker comprises an amino acid sequence that is at least 95% identical to the amino acid sequence of SEQ ID NO: 46 or SEQ ID NO: 47.
- 10 14. The chimeric protein of claim 11 or claim 12, wherein the linker comprises an amino acid sequence that is at least 95% identical to the amino acid sequence of SEQ ID NO: 48.
15. The chimeric protein of any one of claims 10 to 14, wherein the linker comprises one or more joining linkers, such joining linkers independently selected from SEQ ID NOs: 49-95.
- 15 16. The chimeric protein of claim 15, wherein the linker comprises two or more joining linkers each joining linker independently selected from SEQ ID NOs: 49-95; wherein one joining linker is N terminal to the hinge-CH2-CH3 Fc domain and another joining linker is C terminal to the hinge-CH2-CH3 Fc domain.
17. The chimeric protein of any one of claims 1 to 16, wherein the chimeric protein is a recombinant fusion protein.
- 20 18. The chimeric protein of any one of claims 1 to 17, wherein the chimeric protein is capable of forming a stable synapse between cells.
19. The chimeric protein of claim 18, wherein the stable synapse between cells provides spatial orientation that favors tumor reduction.
20. The chimeric protein of claim 18 or claim 19, wherein the spatial orientation positions T cells to attack tumor cells and/or sterically prevents a tumor cell from delivering negative signals, including negative signals beyond those masked by the chimeric protein of the invention.
- 25 21. The chimeric protein of any one of claims 1 to 20, wherein binding of either or both of the extracellular domains to its respective binding partner occurs with slow off rates (K_{off}), which provides a long interaction of a receptor and its ligand.
- 30 22. The chimeric protein of claim 21, wherein the long interaction provides sustained negative signal masking effect.
23. The chimeric protein of claim 21 or claim 22, wherein the long interaction delivers a longer positive signal effect.

24. The chimeric protein of claim 23, wherein the longer positive signal effect allows an effector cell to be adequately stimulated for an anti-tumor effect.
25. The chimeric protein of any one of claims 21 to 24, wherein the long interaction provides T cell proliferation and allows for anti-tumor attack.
- 5 26. The chimeric protein of any one of claims 21 to 25, wherein the long interaction allows sufficient signal transmission to provide release of stimulatory signals.
27. The chimeric protein of claim 26, wherein the stimulatory signal is a cytokine.
28. The chimeric protein of claim 1, wherein the chimeric protein has an amino acid sequence that is at least 95% identical to the amino acid sequence of one of SEQ ID NOs: 14, 17, or 20.
- 10 29. The chimeric protein of claim 6, wherein the chimeric protein has an amino acid sequence that is at least 95% identical to the amino acid sequence of one of SEQ ID NOs: 5, 8, or 11.
30. An expression vector, comprising a nucleic acid encoding the chimeric protein of any one of claims 1 to 29.
31. A host cell, comprising the expression vector of claim 30.
- 15 32. A pharmaceutical composition, comprising a therapeutically effective amount of the chimeric protein of any one of claims 1 to 29.
33. A method of treating cancer or an inflammatory disease, comprising administering an effective amount of a pharmaceutical composition of claim 32 to a subject in need thereof.
34. A method of modulating a patient's immune response, comprising administering an effective
20 amount of a pharmaceutical composition of claim 32 to a subject in need thereof.
35. The method of claim 33 or claim 34, wherein the patient's T cells are activated.
36. The method of any one of claims 33 to 35, wherein the patient has a tumor and one or more tumor cells are prevented from transmitting an immunosuppressive signal.
37. A method for treating cancer or an inflammatory disease comprising administering an effective
25 amount of a pharmaceutical composition to a subject in need thereof, the pharmaceutical composition comprising a chimeric protein comprising:
- (a) a first domain comprising an extracellular domain of a Type I transmembrane protein, the transmembrane protein being TIGIT,
- (b) a linker comprising at least one cysteine residue capable of forming a disulfide bond, and
- 30 (c) a second domain comprising an extracellular domain of a Type II transmembrane protein, the transmembrane protein selected from 4-1BBL, GITRL, TL1A, and LIGHT.

38. A method for treating cancer or an inflammatory disease comprising administering an effective amount of a pharmaceutical composition to a subject in need thereof, the pharmaceutical composition comprising a chimeric protein comprising:
- 5 (a) a first domain comprising an extracellular domain of a Type I transmembrane protein, the transmembrane protein selected from PD-1, CD172a(SIRPα), and TIGIT,
- (b) a linker comprising at least one cysteine residue capable of forming a disulfide bond, and
- (c) a second domain comprising an extracellular domain of Type II transmembrane protein, the transmembrane protein being LIGHT.
39. The method of claims 37 or 38, wherein the subject's T cells are activated when bound by the second domain of the chimeric protein and:
- 10 (a) one or more tumor cells are prevented from transmitting an immunosuppressive signal when bound by the first domain of the chimeric protein,
- (b) a quantifiable cytokine response in the peripheral blood of the subject is achieved, and/or
- (c) tumor growth is reduced in the subject in need thereof as compared to a subject treated with antibodies directed to the Type I or Type II protein, or their respective ligands or receptors.
- 15 40. The method of any of claims 33 to 39, wherein the method stimulates signaling of one or more of LIGHT, 4-1BBL, GITRL, and TL1A and activates antigen-presenting cells.
41. The method of any of claims 33 to 40, wherein the method reduces the amount or activity of regulatory T cells (Tregs) as compared to untreated subjects or subjects treated with antibodies directed to the Type I or Type II protein, or their respective ligands or receptors.
- 20 42. The method of any of claims 33 to 41, wherein the method increases priming of effector T cells in draining lymph nodes of the subject as compared to untreated subjects or subjects treated with antibodies directed to the Type I or Type II protein, or their respective ligands or receptors.
43. The method of any of claims 33 to 42, wherein the method causes an overall decrease in immunosuppressive cells and a shift toward a more inflammatory tumor environment as compared to untreated subjects or subjects treated with antibodies directed to the Type I or Type II protein, or their respective ligands or receptors.
- 25 44. The chimeric protein of any one of claims 1 to 29, for use as a medicament.
45. The chimeric protein of any one of claims 1 to 29, for use in the treatment of cancer.
- 30 46. The chimeric protein of any one of claims 1 to 29, for use in the treatment of an inflammatory disease.
47. Use of the chimeric protein of any one of claims 1 to 29, in the manufacture of a medicament.