

WHAT IS CLAIMED IS:

1. A protein comprising a transmembrane domain of an alpha chain of interleukin-7 receptor, with one or more modifications, wherein the transmembrane domain with one or more modifications has a sequence of SEQ ID NO: 2, 4, 6 or 8.
2. The protein of claim 1, wherein the protein further comprises an intracellular domain of an alpha chain of interleukin-7 receptor.
3. The protein of claim 2, wherein the intracellular domain comprises a sequence of SEQ ID NO: 45.
4. The protein of claim 1, wherein the protein further comprises an extracellular domain of an alpha chain of interleukin-7 receptor.
5. The protein of claim 4, wherein the extracellular domain comprises a sequence of SEQ ID NO: 11.
6. The protein of claim 1, further comprising an extracellular interleukin-15 domain; and an extracellular sushi domain from an alpha chain of interleukin-15 receptor.
7. The protein of claim 6, wherein the extracellular interleukin-15 domain comprises a sequence of SEQ ID NO: 22 or SEQ ID NO: 24.
8. The protein of claim 6, wherein the extracellular sushi domain of the alpha chain of interleukin-15 receptor comprises SEQ ID NO: 36 or SEQ ID NO: 37.
9. A nucleic acid encoding a protein of claim 1.
10. A vector comprising the nucleic acid of claim 9.

11. The vector of claim 10, further comprising a promoter operably linked to the nucleic acid, and optionally, an enhancer sequence operably linked to the nucleic acid.

12. The vector of claim 10, further comprising a sequence encoding a chimeric antigen receptor which binds specifically to a tumor antigen.

13. The vector of claim 12, wherein the tumor antigen is selected from the group consisting of: glypican-3, BCMA, MAGE, MUC16, CD19, WT-1, CD22, LI-CAM, ROR-1, CEA, 4-1BB, ETA, 5T4, adenocarcinoma antigen, alpha-fetoprotein (AFP), BAFF, B-lymphoma cell, C242 antigen, CA-125, carbonic anhydrase 9 (CA-IX), C-MET, CCR4, CD152, CD20, CD125 CD200, CD221, CD23 (IgE receptor), CD28, CD30 (TNFRSF8), CD33, CD4, CD40, CD44 v6, CD51, CD52, CD56, CD74, CD80, CEA, CNT0888, CTLA-4, DR5, EGFR, EpCAM, CD3, FAP, fibronectin extra domain-B, folate receptor 1, GD2, GD3 ganglioside, glycoprotein 75, GPNMB, HER2/neu, HGF, human scatter factor receptor kinase, IGF-1 receptor, IGF-I, IgG1, IL-13, IL-6, insulin-like growth factor I receptor, integrin $\alpha 5\beta 1$, integrin $\alpha v\beta 3$, MORAb-009, MS4A1, MUC1, mucin CanAg, N-glycolylneuraminic acid, NPC-1C, PDGF-R a, PDL192, phosphatidylserine, prostatic carcinoma cells, RANKL, RON, SCH 900105, SDC1, SLAMF7, TAG-72, tenascin C, TGF beta 2, TGF- β , TRAIL-R1, TRAIL-R2, tumor antigen CTAA16.88, VEGF-A, VEGFR-1, VEGFR2, and vimentin.

14. The vector of claim 10, wherein the chimeric antigen receptor comprises one or more co-stimulatory signaling domains selected from the group consisting of: 4-1BB, CD27, OX40, CD40, CD28, GITR, CD2, CD5, ICAM-1, CD11a, Lck, TNFR-I, TNFR-II, FasR, CD30, ICOS, LIGHT, NKG2C, B7-H3, DAP-10, and DAP-12.

15. The vector of claim 10, wherein the vector is a lentiviral or an adenoviral vector.

16. A mammalian cell comprising a vector of claim 10.

17. The mammalian cell of claim 16, wherein the mammalian cell is an immune cell.
18. The mammalian cell of claim 17, wherein the immune cell is selected from the group consisting of: a CD4⁺ T cell, a CD8⁺ T cell, a B cell, a monocyte, a natural killer cell, a dendritic cell, a macrophage, a regulatory T cell, and a helper T cell.
19. A pharmaceutical composition comprising a vector of claim 10 and a pharmaceutically acceptable carrier.
20. A pharmaceutical composition comprising a mammalian cell of claim 16.