CLAIMS

1. A chimeric cytokine receptor, comprising:
   (a) an extracellular domain comprising a human interleukin-13 receptor alpha type 2 (IL13Ra2) ligand-binding domain (LBD);
   (b) a transmembrane domain, wherein the transmembrane domain is a human interleukin-9 receptor alpha (IL9Ra) transmembrane domain; and
   (c) an intracellular domain comprising a human IL9Ra intracellular signaling domain.

2. The chimeric cytokine receptor of claim 1, wherein the chimeric cytokine receptor comprises an amino acid sequence having at least 80% sequence identity to the sequence set forth in SEQ ID NO: 17.

3. The chimeric cytokine receptor of claim 2, wherein the chimeric cytokine receptor comprises an amino acid sequence that is identical to the sequence set forth in SEQ ID NO: 17.

4. A nucleic acid comprising a nucleotide sequence encoding the chimeric cytokine receptor of any one of claims 1-3, wherein the nucleotide sequence comprises a sequence that has at least 80% sequence identity to the sequence set forth in SEQ ID NO: 18.

5. The nucleic acid of claim 4, wherein the nucleotide sequence comprises a sequence that is identical to the sequence set forth in SEQ ID NO: 18.

6. A vector comprising the nucleic acid of claim 4 or claim 5, wherein the vector is an adenoviral vector, a retroviral vector, or a lentiviral vector.

7. A nucleic acid comprising:
   a) a first nucleotide sequence encoding a chimeric cytokine receptor comprising (i) an extracellular domain comprising a human interleukin-13 receptor alpha 2 (IL13Ra2) ligand-binding domain (LBD),

(ii) a first transmembrane domain, wherein the transmembrane domain is a human interleukin-9 receptor alpha (IL9Ra) transmembrane domain, and
(iii) a first intracellular domain comprising the human IL9Ra intracellular signaling domain; and

b) a second nucleotide sequence encoding a chimeric antigen receptor (CAR) comprising an extracellular binding domain that binds a tumor antigen, a second transmembrane domain, and a second intracellular domain.

8. The nucleic acid of claim 7, wherein the chimeric cytokine receptor comprises an amino acid sequence having at least 80% sequence identity to the sequence set forth in SEQ ID NO: 17.

9. The nucleic acid of claim 8, wherein the chimeric cytokine receptor comprises an amino acid sequence that is identical to the sequence set forth in SEQ ID NO: 17.

10. The nucleic acid of claim 7, wherein:

(a) the first nucleotide sequence comprises a sequence having at least 80% sequence identity to the sequence set forth in SEQ ID NO: 18;

(b) the extracellular binding domain that binds to the tumor antigen is a single-chain variable fragment (scFv), and wherein the tumor antigen is selected from the group consisting of alpha feto-protein (AFP)/HLA-A2, AXL, B7-H3, BCMA, CA-1X, CD2, CD3, CD4, CD5, CD7, CD8, CD19, CD20, CD22, CD30, CD33, CD38, CD44v6, CD70, CD79a, CD79b, CD80, CD86, CD117, CD123, CD133, CD147, CD171, CD276, CEA, claudin 18.2, c-Met, DLL3, DR5, EGFR, EGFRvIII, EpCAM, EphA2, FAP, folate receptor alpha (FRa)/folate binding protein (FBP), GD-2, Glycolipid F77, glypican-2 (GPC2), glypican-3 (GPC3), HER2, HLA-A2, ICAM1, IL3Ra, IL13Ra2, LAGE-1, Lewis Y, LMP1 (EBV), MAGE-A1, MAGE-A3, MAGE-A4, Melan A, mesothelin, MG7 (glycosylated CEA), MMP, MUC1, Nectin4/FAP, NKG2D-Ligands (MIC-A, MIC-B, and the ULBPs 1 to 6), NY-ESO-1, P16, PD-L1, PSCA, PSMA, ROR1, ROR2, TIM-3, TM4SF1, TnMuc1, and VEGFR2;

(c) the second transmembrane domain comprises a human CD8 transmembrane domain;

(d) the second intracellular domain comprises a costimulatory domain of a protein selected from the group consisting of proteins in the TNFR superfamily, CD28, 4-1BB (CD137), OX40 (CD134), PD-1, CD7, LIGHT, CD83L, DAP10, DAP12, CD27, CD2, CD5, ICAM-1, LFA-1, Lck, TNFR-I, TNFR-II, Fas, CD30, CD40, ICOS, NKG2C, and B7-H3 (CD276), or an intracellular domain derived from a killer immunoglobulin-like receptor (KIR); and

(e) the second intracellular domain comprises an intracellular signaling domain of a protein selected from the group consisting of a CD3 zeta chain (CD3ζ), FcγRIII, FcεRI, a cytoplasmic tail of an Fc receptor, an immunoreceptor tyrosine-based activation motif (ITAM) bearing cytoplasmic receptor, TCR zeta, FcR gamma, CD3 gamma, CD3 delta, CD3 epsilon, CD5, CD22, CD79a, CD79b, and CD66d.

11. The nucleic acid of claim 10, wherein:

(i) the second intracellular domain comprises a human 4-1BB costimulatory domain and a human CD3 zeta signaling domain;

(ii) the second intracellular domain comprises a human CD28 costimulatory domain and a human CD3 zeta signaling domain; or

(iii) the second intracellular domain comprises a human 4-1BB costimulatory domain, a human CD28 costimulatory domain, and a human CD3 zeta signaling domain.

12. The nucleic acid of claim 7, wherein the extracellular antigen binding domain is selected from the group consisting of:

(a) an anti-mesothelin scFv comprising the six complementarity-determining region (CDR) sequences contained in SEQ ID NO: 79 or SEQ ID NO: 95, wherein the scFv comprises an amino acid sequence having at least 95% sequence identity to the sequence set forth in SEQ ID NO: 79 or SEQ ID NO: 95;

(b) an anti-GD2 scFv comprising the six CDR sequences contained in SEQ ID NO: 117, wherein the scFv comprises an amino acid sequence having at least 95% sequence identity to the sequence set forth in SEQ ID NO: 117;

(c) an anti-HER2 scFv comprising the six CDR sequences contained in SEQ ID NO: 119 or SEQ ID NO: 121, wherein the scFv comprises an amino acid sequence having at least 95% sequence identity to the sequence set forth in SEQ ID NO: 119 or SEQ ID NO: 121;

(d) an anti-TnMuc1 scFv comprising the six CDR sequences contained in SEQ ID NO: 123, wherein the scFv comprises an amino acid sequence having at least 95% sequence identity to the sequence set forth in SEQ ID NO: 123;

(e) an anti-CD70 scFv comprising the six CDR sequences contained in SEQ ID NO: 125, wherein the scFv comprises an amino acid sequence having at least 95% sequence identity to the sequence set forth in SEQ ID NO: 125;

(f) an anti-PSMA scFv comprising the six CDR sequences contained in SEQ ID NO: 129, wherein the scFv comprises an amino acid sequence having at least 95% sequence identity to the sequence set forth in SEQ ID NO: 129; or

(g) an anti-EGFRvIII scFv comprising the six CDR sequences contained in SEQ ID NO: 131, wherein the scFv comprises an amino acid sequence having at least 95% sequence identity to the sequence set forth in SEQ ID NO: 131.

13. A vector comprising the nucleic acid of any one of claims 7-12, wherein the vector is an adenoviral vector, a retroviral vector or a lentiviral vector.

14. A human T cell comprising
the chimeric cytokine receptor of any one of claims 1-3.

15. A human T cell comprising the nucleic acid of any one of claims 4, 5, or 7-12.

16. A human T cell comprising the vector of claim 6 or claim 13.

17. A human T cell that expresses:

a) a chimeric cytokine receptor comprising (i) an extracellular domain comprising a human interleukin-13 receptor alpha 2 (IL13Ra2) ligand-binding domain (LBD), (ii) a first transmembrane domain, wherein the first transmembrane domain is a

human interleukin-9 receptor alpha (IL9Ra) transmembrane domain, and (iii) an intracellular domain comprising a human IL9Ra intracellular signaling domain; and

b) a chimeric antigen receptor (CAR) comprising an extracellular antigen binding domain that binds a tumor antigen, a second transmembrane domain, and a second intracellular domain.

18. The human T cell of claim 17, wherein:

(i) the second transmembrane domain comprises a human CD8 transmembrane domain; and

(ii) the second intracellular domain comprises: (a) a human 4-1BB costimulatory domain and a human CD3z signaling domain; (b) a human CD28 costimulatory domain and a human CD3z signaling domain; or (c) a human 4-1BB costimulatory domain, a human CD28 costimulatory domain, and a human CD3z signaling domain.

19. The human T cell of claim 17 or claim 18, wherein the tumor antigen is selected from the group consisting of mesothelin, GD2, HER2, TnMuc1, CD70, PSMA, and EGFRvIII.

20. The human T cell of claim 17 or claim 18, wherein the extracellular antigen binding domain that binds a tumor antigen is a single-chain variable fragment (scFv) comprising an amino acid sequence having at least 80% sequence identity to the sequence set forth in any one of SEQ ID NOs: 79, 95, 117, 119, 121, 123, 125, 129, or 131.

21. The human T cell of any one of claims 17 to 20, wherein the chimeric cytokine receptor activates STAT1, STAT3, STAT5, or any combination thereof, in the human T cell.

22. The human T cell of any one of claims 17 to 21, wherein the chimeric cytokine receptor comprises an amino acid sequence having at least 80% sequence identity to the sequence set forth in SEQ ID NO: 17.

23. The human T cell of any one of claims 17 to 22, wherein the chimeric cytokine receptor is encoded by a nucleotide sequence having at least 80% sequence identity to the sequence set forth in SEQ ID NO: 18.

24. Use of the human T cell of any one of claims 17 to 23 in the manufacture of a pharmaceutical composition for treating cancer in a human subject in need thereof, wherein the cancer is selected from the group consisting of a B-cell malignancy, lung cancer, non-small cell lung cancer, small cell lung cancer, Merkel cell carcinoma, melanoma, Hodgkin's lymphoma, non-Hodgkin's lymphoma, urothelial carcinoma, gastric cancer, cervical cancer, cutaneous squamous cell carcinoma, renal cell carcinoma, breast cancer, triple-negative breast cancer, colon cancer, esophagus cancer, stomach cancer, liver cancer, kidney cancer, pancreatic cancer, prostate cancer, brain cancer, lung adenocarcinoma, glioblastoma, hepatocellular carcinoma, gallbladder cancer, cervical cancer, cervical squamous cell carcinoma, colorectal cancer, and ovarian cancer.