CLAIMS:

1. One or more vectors comprising:

(a) a first polynucleotide encoding a chimeric antigen receptor (CAR) capable of activating a dendritic cell, wherein the CAR comprises (1) an extracellular antigen-binding domain, (2) a transmembrane domain and (3) an intracellular signaling domain, and

(b) a second polynucleotide encoding one or more tumor antigens, the tumor antigen is a tumor associated antigen (TAA) or tumor specific antigen (TSA),

wherein the intracellular signaling domain comprises a cytoplasmic domain of a dendritic cell activating receptor selected from the group consisting of RIG-1, NLRP10, DEC-205, BDCA-2, CD86, 4-1BBL, OX40L, CD40, IFNAR, TLR4, TNFR (e.g., TNFR2), CD80, CD40L, CD367 (DCIR), CD207 (Langerin), CD371 (DCAL-2, CLEC12a), CD204, CD36, IFNγR, Dectin-1 and FcγR, or a combination thereof,

wherein the CAR and/or the tumor antigen when expressed in the dendritic cell is capable of activating the dendritic cell in an immune suppressive tumor microenvironment,

wherein the vector is a DNA or RNA.

2. The one or more vectors of claim 1, wherein the immune suppressive tumor microenvironment comprises a tumor and/or tumor infiltrating immune cells that are: 1) expressing an immune inhibitory molecule, and/or 2) deficient in an immune stimulating cytokine,

wherein the immune inhibitory molecule is selected from the group consisting of PD-1, TIM-3, TIGIT, LAG-3, A2AR, BTLA (CD272),

CTLA-4 (CD152), IDO1, IDO2, TDO, NOX2, VISTA, SIGLEC7 (CD328), PVR(CD155) and SIGLEC9 (CD329), PD-L1, PD-L2, B7-H3 (CD276), B7-H4 (VTCN1), PVR(CD155), HLA class I, sialoglycoprotein, CD112, CD113, Galectin9, CD24, and CD47,

wherein the immune stimulating cytokine is selected from TNF-a, IFN-β, IFN-γ, IL-1, IL-2, IL-4, IL-6, IL-8, IL-10, IL-12, IL-18, granulocyte-macrophage colony stimulating factor and a combination thereof.

3. The one or more vectors of claim 1, wherein the intracellular signaling domain comprises the cytoplasmic domain of Dectin-1 and the cytoplasmic domain of FcγR.

4. The one or more vectors of claim 3, wherein the cytoplasmic domain of Dectin-1 comprises an amino acid sequence set forth in SEQ ID NO: 1, or any functional forms thereof.

5. The one or more vectors of claim 3, wherein the cytoplasmic domain of FcγR comprises an amino acid sequence set forth in SEQ ID NO: 2 or any functional forms thereof.

6. The one or more vectors of claim 1, wherein the intracellular signaling domain comprises an amino acid sequence set forth in SEQ ID NO: 3 or any functional forms thereof.

7. The one or more vectors of claim 1, wherein the intracellular signaling domain comprises an amino acid sequence encoded by a nucleic acid sequence set forth in SEQ ID NO: 4 or any functional forms thereof.

8. The one or more vectors of claim 1, wherein the extracellular antigen-binding domain comprises a single-chain variable fragment (scFv), the scFv is specific for a tumor surface marker.

9. The one or more vectors of claim 8, wherein the tumor surface marker is selected from the group consisting of: EphA2, CD19, CD70, CD133, CD147, CD171, DLL3, EGFRvIII, Mesothelin, ganglioside GD2, FAP (fibroblast activating protein), FBP (folate binding protein), Lewis Y, Claudin 18.2, IL13Ra2, HER2, MDC1, PMSA (prostate membrane specific antigen), ROR1, B7-H3, CAIX, CD133, CD171, CEA, GPC3, MUC1, and NKG2D.

10. The one or more vectors of claim 1, wherein the CAR further comprises a signal peptide, the signal peptide comprises a signal peptide of CD8 alpha.

11. The one or more vectors of claim 10, wherein the signal peptide of CD8 alpha comprises a sequence set forth in SEQ ID NO: 5 or any functional forms thereof.

12. The one or more vectors of claim 1, wherein the transmembrane domain comprises a transmembrane domain of CD8 alpha.

13. The one or more vectors of claim 12, wherein the transmembrane domain of CD8 alpha comprises a sequence set forth in SEQ ID NO: 6, or any functional forms thereof.

14. The one or more vectors of claim 1, wherein the extracellular antigen-binding domain is linked to the transmembrane domain by a hinge region, the hinge region comprises a hinge region of CD8 alpha.

15. The one or more vectors of claim 14, wherein the hinge region of CD8 alpha comprises a sequence set forth in SEQ ID NO: 7, or any functional forms thereof.

16. The one or more vectors of claim 1, wherein the second polynucleotide is a mutated tumor gene or a fragment thereof, wherein the tumor gene is

selected from p53, ras, beta-catenin, BRCA1/2, CDK4, CML66, fibronectin, MART-2, TGF-betaRII.

17. The one or more vectors of claim 1, wherein the tumor antigen is selected from CEA, immature laminin receptor, TAG-72, HPV E6, HPV E7, BING-4, calcium-activated chloride channel 2, cyclin-B1, 9D7, Ep-Cam, EphA3, GPC3, Her2/neu, telomerase, mesothelin, SAP-2, and surviving.

18. The one or more vectors of claim 1, wherein the tumor antigen is selected from a p53 R273H mutated peptide, a p53 R175H mutated peptide, a p53 R248Q mutated peptide, a p53 R249S mutated peptide, a p53-R175H-R248Q-R249S-R273H mutated peptide, a KRAS G12V mutated peptide, a KRAS G12C mutated peptide or combination thereof.

19. The one or more vectors of claim 18, wherein the p53 R273H mutated peptide has a sequence set forth in SEQ ID NO: 29, the p53-R175H-R248Q-R249S-R273H mutated peptide has a sequence set forth in SEQ ID NO: 37, the KRAS G12V mutated peptide has a sequence set forth in SEQ ID NO: 31, or the KRAS G12C mutated peptide has a sequence set forth in SEQ ID NO: 30.

20. An engineered cell comprising the one or more vectors of any one of the preceding claims.

21. A method of producing the engineered cells, comprising introducing to a starting cell the one or more vector of any one of claims 1-19 under conditions suitable for expression of the CAR and the tumor antigen.

22. The method of claim 21, wherein the starting cell is a dendritic cell or a precursor or a progenitor cell thereof.

23. The method of claim 21, wherein the dendritic cell or a precursor or a progenitor cell thereof is derived from a peripheral blood cell, a bone marrow cell, an embryonic stem cell, or an induced pluripotent stem cell.

24. A population of cells produced ex vivo by the method of claim 21.

25. A pharmaceutical composition comprising (i) the one or more vectors of any one of claims 1-19, or the population of the engineered cells of claim 20 or the population of cells of claim 24, and (ii) a pharmaceutically acceptable medium.

26. Use of the pharmaceutical composition of claim 25 in the manufacture of a medicament for the treatment of cancer in a subject in need thereof.

27. Use of the engineered cell of claim 20 in the manufacture of a medicament for inducing proliferation of immune cells, prolonging the survival of immune cells, and/or increasing expression and/or secretion of immune stimulating cytokines from immune cells in an immune suppressive microenvironment, wherein the immune cell is autologous or allogeneic.