In another aspect, the invention provides the use of an effective amount of an immunoresponsive cell allogeneic to a subject comprising an inhibitory chimeric antigen receptor that binds an antigen, wherein the binding inhibits the allogeneic immunoresponsive cell in the manufacture of a medicament for modulating a graft versus leukemia response or graft versus tumor response in the subject, wherein the medicament is to be administered to the subject, thereby modulating a graft versus leukemia response or graft versus tumor response in the subject.

In another aspect, the invention provides a T cell comprising:

1) an antigen recognizing receptor that binds a first antigen, wherein the binding of the antigen recognizing receptor to the first antigen is capable of activating the T cell, and

2) an inhibitory chimeric antigen receptor that binds a second antigen, wherein the binding of the inhibitory chimeric antigen receptor to the second antigen is capable of inhibiting the T cell,

wherein said inhibitory chimeric antigen receptor comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide.

In another aspect, the invention provides use of an effective amount of T cells comprising an antigen recognizing receptor that binds a first antigen, wherein the binding of the antigen recognizing receptor to the first antigen is capable of activating the T cells, and an inhibitory chimeric antigen receptor (iCAR) that binds a second antigen, wherein the binding of the inhibitory chimeric antigen receptor to the second antigen is capable of inhibiting the T cells that comprise the iCAR, and wherein said iCAR comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide, in the manufacture of a medicament for reducing tumor burden in a subject.

In another aspect, the invention provides use of an effective amount of T cells comprising an antigen recognizing receptor that binds a first antigen, wherein the binding of the antigen recognizing receptor to the first antigen is capable of activating the T cells, and an inhibitory chimeric antigen receptor (iCAR) that binds a second antigen, wherein the binding of the inhibitory chimeric antigen receptor to the second antigen is capable of inhibiting the T cells that comprise the iCAR, and wherein said iCAR comprises an

intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide, in the manufacture of a medicament for increasing survival of a subject having neoplasia.

In another aspect, the invention provides a method for producing a T cell, the method comprising:

introducing into a T cell a nucleic acid comprising a sequence that encodes an antigen recognizing receptor that binds a first antigen, wherein the binding is capable of activating the cell; and

introducing into the T cell a nucleic acid comprising a sequence that encodes an inhibitory chimeric antigen receptor that binds a second antigen, wherein the binding is capable of inhibiting the T cell,

wherein said inhibitory chimeric antigen receptor comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide.

In another aspect, the invention provides a pharmaceutical composition for the treatment of a neoplasia comprising an effective amount of T cells as disclosed herein in a pharmaceutically acceptable excipient.

In another aspect, the invention provides a kit for treatment of a neoplasia, pathogen infection, an autoimmune disorder, or an allogeneic transplant, the kit comprising a T cell comprising an antigen recognizing receptor that binds a first antigen and activates the immunoreponsive cell, and an inhibitory chimeric antigen receptor that binds a second antigen and inhibits the T cell.

In another aspect, the invention provides use of an effective amount of T cells allogeneic to the subject comprising an inhibitory chimeric antigen receptor (iCAR) that binds an antigen, wherein the binding of the inhibitory chimeric antigen receptor to the antigen is capable of inhibiting the allogeneic T cells that comprise the iCAR, and wherein said iCAR comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide, in the manufacture of a medicament for modulating a graft versus leukemia response or graft versus tumor response in a subject.

Definitions

Unless defined otherwise, all technical and scientific terms used herein have the meaning commonly understood by a person skilled in the art to which this invent ion belongs. The following references provide one of skill with a general definition of many of the terms used in this invention: Singleton et al., Dictionary of Microbiology and Molecular Biology (2nd ed. 1994); The Cam bridge Dictionary of Science and Technology (Walker ed., 1988); The Glossary of Genetics, 5th Ed., R. Rieger et al. (eds.), Springer Verlag (1991); and Hale & Marham, The Harper Collins Dictionary of Biology (1991). As used herein, the following terms have the meanings ascribed to them below, unless specified otherwise.

By "activates an immunoresponsive cell" is meant induction of signal transduction or changes in protein expression in the cell resulting in initiation of an immune response. For example, when CD3 Chains cluster in response to ligand binding and immunoreceptor tyrosine-based inhibition motifs (ITAMs) a signal transduction cascade is produced. In certain embodiments, when an endogenous TCR

Claims

1. A T cell comprising:

1) an antigen recognizing receptor that binds a first antigen, wherein the binding of the antigen recognizing receptor to the first antigen is capable of activating the T cell, and

2) an inhibitory chimeric antigen receptor that binds a second antigen, wherein the binding of the inhibitory chimeric antigen receptor to the second antigen is capable of inhibiting the T cell,

wherein said inhibitory chimeric antigen receptor comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide.

2. The T cell of claim 1, wherein the first antigen comprises a tumor antigen or pathogen antigen.

3. The T cell of claim 1, wherein the second antigen is CD33, CD38, a human leukocyte antigen (HLA), an Epithelial-mesenchymal transition (FMT) antigen, E-cadherin, cytokeratin, Opioid-binding protein/cell adhesion molecule (OPCML), HYLA2, Deleted in Colorectal Carcinoma (DCC), Scaffold/Matrix attachment region-binding protein 1 (SMAR1), or mucin type O-glycan.

4. The T cell of any one of claims 1-3, wherein said inhibitory chimeric antigen receptor is recombinantly expressed.

5. The T cell of any one of claims 1-4, wherein the inhibitory chimeric antigen receptor is expressed from a vector.

6. The T cell of any one of claims 1-5, wherein said antigen recognizing receptor is a T cell receptor (TCR) or a chimeric antigen receptor (CAR).

7. The T cell of any one of claims 1-6, wherein said antigen recognizing receptor is exogenous or endogenous.

8. The T cell of any one of claims 1-7, wherein said antigen recognizing receptor is recombinantly expressed.

9. The T cell of any one of claims 1-8, wherein the antigen recognizing receptor is expressed from a vector.

10. The T cell of any one of claims 1-9, wherein said T cell is autologous.

11. The T cell of any one of claims 1-9, wherein said T cell is non-autologous.

12. The T cell of any one of claims 1-11, wherein said first antigen is a tumor antigen selected from the group consisting of CD19, CAIX, CEA, CD5, CD7, CD10, CD20, CD22, CD30, CD33, CD34, CD38, CD41, CD44, CD49f, CD56, CD74, CD 123, CD133, CD138, a cytomegalovirus (CMV) infected cell antigen, EGP-2, EGP-40, EpCAM, erb-B2,3,4, FBP, Fetal acetylcholine receptor, folate receptor-α , GD2, GD3, HER-2, hTERT, IL-13R-α2, κ-light chain, KDR, LeY, L1 cell adhesion molecule, MAGE-A1, Mesothelin, Muc-1, Muc-16, NKG2D ligands, NY-ESO-1, oncofetal antigen (h5T4), PSCA, PSMA, ROR1, TAG-72, VEGF-R2, and WT-1.

13. The T cell of any one of claims 1-12, wherein said inhibitory chimeric antigen receptor (iCAR) further comprises a transmembrane domain of a polypeptide selected from the group consisting of a CD4 polypeptide, a CD8 polypeptide, a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide.

14. The T cell of any one of claims 1-13, wherein said inhibitory chimeric antigen receptor (iCAR) further comprises a Fab, a scFv, or a ligand.

15. The T cell of any one of claims 1-14, wherein the antigen recognizing receptor comprises a chimeric antigen receptor.

16. The T cell of claim 15, wherein the chimeric antigen receptor is selected from the group consisting of 19-28z, P28z, M28z, and 56-28z.

17. Use of an effective amount of T cells comprising an antigen recognizing receptor that binds a first antigen, wherein the binding of the antigen recognizing receptor to the first antigen is capable of activating the T cells, and an inhibitory chimeric antigen receptor (iCAR) that binds a second antigen, wherein the binding of the inhibitory chimeric antigen receptor to the second antigen is capable of inhibiting the T cells that comprise the iCAR, and wherein said iCAR comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4

polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide, in the manufacture of a medicament for reducing tumor burden in a subject.

18. The use of claim 17, wherein the method selectively targets tumor cells compared to non-tumor cells.

19. The use of claim 17, wherein the method reduces the number of tumor cells.

20. The use of claim 17, wherein the method reduces tumor size.

21. The use of claim 17, wherein the method eradicates the tumor in the subject.

22. Use of an effective amount of T cells comprising an antigen recognizing receptor that binds a first antigen, wherein the binding of the antigen recognizing receptor to the first antigen is capable of activating the T cells, and an inhibitory chimeric antigen receptor (iCAR) that binds a second antigen, wherein the binding of the inhibitory chimeric antigen receptor to the second antigen is capable of inhibiting the T cells that comprise the iCAR, and wherein said iCAR comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide, in the manufacture of a medicament for increasing survival of a subject having neoplasia.

23. The use of claim 22, wherein the neoplasia is selected from the group consisting of blood cancer, B cell leukemia, multiple myeloma, acute lymphoblastic leukemia (ALL), chronic lymphocytic leukemia, non-Hodgkin's lymphoma, ovarian cancer, prostate cancer, pancreatic cancer, lung cancer, breast cancer, and sarcoma, and acute myeloid leukemia (AML).

24. The use of any one of claims 17-23, where in the first antigen is a tumor or pathogen antigen.

25. The use of any one of claims 17-24, wherein the second antigen is CD33, CD38, a human leukocyte antigen (HLA), an Epithelial-mesenchymal transition (EMT) antigen, E-cadherin, cytokeratin, Opioid-binding protein/cell adhesion molecule (OPCML), HYLA2, Deleted in Colorectal Carcinoma (DCC), Scaffold/Matrix attachment region-binding protein 1 (SMAR1), or mucin type O-glycan.

26. The use of any one of claims 17-24, wherein said inhibitory chimeric antigen receptor is recombinantly expressed.

27. The use of any one of claims 17-26, wherein the inhibitory chimeric antigen receptor is expressed from a vector.

28. The use of any one of claims 17-27, wherein said antigen recognizing receptor is a T cell receptor (TCR) or chimeric antigen receptor (CAR).

29. The use of any one of claims 17-28, wherein said antigen recognizing receptor is exogenous or endogenous.

30. The use of any one of claims 17-29, wherein said antigen recognizing receptor is recombinantly expressed.

31. The use of any one of claims 17-30, wherein the antigen recognizing receptor is expressed from a vector.

32. The use of any one of claims 17-31, wherein said T cell is autologous.

33. The use of any one of claims 17-31, wherein said T cell is non-autologous.

34. The use of any one of claims 17-33, wherein said first antigen is a tumor antigen selected from the group consisting of CD19, CAIX, CEA, CD5, CD7, CD10, CD20, CD22, CD30, CD33, CD34, CD38, CD41, CD44, CD49f, CD56, CD74, CD123, CD133, CD138, a cytomegalovirus (CMV) infected cell antigen, EGP-2, EGP-40, EpCAM, erb-B2,3,4, FBP, Fetal acetylcholine receptor, folate receptor-α, GD2, GD3, HER-2, hTERT, IL-13R-α2, κ-light chain, KDR, LeY, L1 cell adhesion molecule, MAGE-A1, Mesothelin, Muc-1, Muc-16, NKG2D ligands, NY-ESO-1, oncofetal antigen (h5T4), PSCA, PSMA, ROR1, TAG-72, VEGF-R2, and WT-1.

35. The use of any one of claims 17-34, wherein said inhibitory chimeric antigen receptor (iCAR) further comprises a transmembrane domain selected from the group consisting of a CD4 polypeptide, a CD8 polypeptide, a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide.

36. The use of any one of claims 17-35, wherein said inhibitory chimeric antigen receptor (iCAR) further comprises a Fab, a scFv, or a ligand.

37. The use of any one of claims 17-36, wherein the method reduces or eradicates the tumor burden in the subject.

38. The use of any one of claims 17-37, wherein the method reduces graft versus host disease (GVHD) in the subject.

39. A method for producing a T cell, the method comprising:

introducing into a T cell a nucleic acid comprising a sequence that encodes an antigen recognizing receptor that binds a first antigen, wherein the binding is capable of activating the cell; and

introducing into the T cell a nucleic acid comprising a sequence that encodes an inhibitory chimeric antigen receptor that binds a second antigen, wherein the binding is capable of inhibiting the T cell,

wherein said inhibitory chimeric antigen receptor comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide.

40. The method of claim 39, wherein the first antigen comprises a tumor or pathogen antigen.

41. The method of claim 39 or 40, wherein the second antigen is CD33, CD38, a human leukocyte antigen (HLA), an Epithelial-mesenchymal transition (EMT) antigen, E-cadherin, cytokeratin, Opioid -binding protein/cell adhesion molecule (OPCML), HYLA2, Deleted in Colorectal Carcinoma (DCC), Scaffold/Matrix attachment region-binding protein 1 (SMAR1), or mucin type O-glycan.

42. The method of any one of claims 39-41, wherein said inhibitory chimeric antigen receptor is recombinantly expressed.

43. The method of any one of claims 39-42, wherein the inhibitory chimeric antigen receptor is expressed from a vector.

44. The method of any one of claims 39-43, wherein said antigen recognizing receptor is a T cell receptor (TCR) or chimeric antigen receptor (CAR).

45. The method of any one of claims 39-44, wherein said antigen recognizing receptor is exogenous or endogenous.

46. The method of any one of claims 39-45, wherein said antigen recognizing receptor is recombinantly expressed.

47. The method of any one of claims 39-46, wherein the antigen recognizing receptor is expressed from a vector.

48. The method of any one of claims 39-47, wherein said T cell is autologous.

49. The method of any one of claims 39-48, wherein said T cell is non-autologous.

50. The method of any one of claims 39-49, wherein said first antigen is a tumor antigen selected from the group consisting of CD19, CAIX, CEA, CD4, CD7, CD10, CD20, CD22, CD30, CD33, CD34, CD38, CD41, CD44, CD49f, CD56, CD74, CD123, CD133, CD138, a cytomegalovirus (CMV) infected cell antigen, EGP-2, EGP-40, EpCAM, erb-B2,3,4, FBP, Fetal acetylcholine receptor, folate receptor-α, GD2, GD3, HER-2, hTERT, IL-13R-α2, κ-light chain, KDR, LeY, L1 cell adhesion molecule, MAGE-Al, Mesothelin, Muc-1, Muc-16, NKG2D ligands, NY-ESO-1, oncofetal antigen (h5T4), PSCA, PSMA, ROR1, TAG-72, VEGF-R2, and WT-1.

51. The method of any one of claims 39-50, wherein said inhibitory chimeric antigen receptor (iCAR) further comprises a transmembrane domain selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide.

52. The method of any one of claims 39-51, wherein said inhibitory chimeric antigen receptor (iCAR) further comprises a Fab, a scFv, or a ligand.

53. A pharmaceutical composition comprising an effective amount of a T cell of any one of claims 1-16 in a pharmaceutically acceptable excipient.

54. A pharmaceutical composition for the treatment of a neoplasia comprising an effective amount of T cells of any one of claims 1-16 in a pharmaceutically acceptable excipient.

55. A kit for treatment of a neoplasia, pathogen infection, an autoimmune disorder, or an allogeneic transplant, the kit comprising a T cell comprising an antigen recognizing receptor that binds a first antigen and activates the T cell, and an inhibitory chimeric antigen receptor that binds a second antigen and inhibits the T cell.

56. The kit of claim 55, wherein the kit further comprises written instructions for using said cell for the treatment of a subject having a neoplasia, a pathogen infection, an autoimmune disorder, or an allogeneic transplant.

57. Use of an effective amount of T cells allogeneic to the subject comprising an inhibitory chimeric antigen receptor (iCAR) that binds an antigen, wherein the binding of the inhibitory chimeric antigen receptor to the antigen is capable of inhibiting the allogeneic T cells that comprise the iCAR, and wherein said iCAR comprises an intracellular signaling domain of a polypeptide selected from the group consisting of a CTLA-4 polypeptide, a PD-1 polypeptide, a LAG-3 polypeptide, a 2B4 polypeptide, and a BTLA polypeptide, in the manufacture of a medicament for modulating a graft versus leukemia response or graft versus tumor response in a subject.

58. The use of claim 57, wherein the allogeneic cell comprises an endogenous T cell receptor.

59. The use of claim 57 or 58, wherein the antigen is CD33, CD38, a human leukocyte antigen (HLA), an Epithelial-mesenchymal transition (EMT) antigen, E-cadherin, cytokeratin, Opioid-binding protein/cell adhesion molecule (OPCML), HYLA2, Deleted in Colorectal Carcinoma (DCC), Scaffold/Matrix attachment region-binding protein 1 (SMAR1), or mucin type O-glycan.

60. The use of claim 59, wherein the subject has metastatic breast cancer, hematological malignancy, or a solid tumor, and the human leukocyte antigen (HLA) is HLA-I.

61. The use of claim 59, wherein the subject has a tumor that has undergone epithelium to mesenchymal transition (EMT), and the antigen is one or more of an Epithelial-mesenchymal transition (EMT) antigen, E-cadherin, and cytokeratin.

62. The use of any one of claims 57-61, wherein binding of the inhibitory chimeric antigen receptor to the antigen decreases cell death in a cell comprising the antigen.

63. The use of any one of claims 57-62, wherein the method reduces graft versus host disease (GVHD) in the subject.