CLAIMS

1. An isolated modified B cell, capable of expressing a chimeric receptor (CAR-B), wherein said chimeric receptor comprises

a) an extracellular domain, wherein the extracellular domain comprises an extracellular binding domain and a hinge domain;

b) a transmembrane domain; and

c) a cytoplasmic domain that comprises at least one signaling domain.

2. An isolated modified B cell, wherein said B cell is capable of expressing and secreting a payload, wherein the payload is not naturally expressed in a B cell or is expressed at higher levels than is naturally expressed in a B cell.

3. The isolated modified B cell of claim 2, wherein the payload is an antibody or fragment thereof.

4. An isolated modified B cell, capable of expressing a chimeric receptor, wherein said chimeric receptor comprises

a) an extracellular domain, wherein the extracellular domain comprises an extracellular binding domain and a hinge domain;

b) a transmembrane domain; and

c) a cytoplasmic domain that comprises at least one signaling domain

wherein said modified B cell is further capable of expressing a payload, wherein the payload is not naturally expressed in a B cell.

5. The isolated modified B cell of any one of claims 2-4, wherein said payload is selected from a group of cytokines, chemokines, T cell costimulatory molecules, and checkpoint molecules, the group consisting of: IL-1, IL-7, IL-8, IL-10, IL-12, IL-13, IL-17, IL-18, IL-21,

interferon a, interferon b, interferon g, TSLP, CCL21, FLT3L, XCL1, LIGHT(TNFSF14), OX40L, CD137L, CD40L, ICOSL, anti-CD3 antibody, CD47, TIM4-FC, CXCL13, CCL21, CD80, CD40L, IFNa A2, LIGHT , 4-1BBL, MDGF (C19orfl0), FGF10, PDGF, agrin, TNF-a, GM-CSF, an anti-FAP antibody, an anti-TGF-b antibody; a TGF-b trap, decoy or other inhibitory molecule; an anti-BMP antibody; a BMP trap, decoy or other inhibitory molecule.

6. The isolated modified B cell of claim 5, wherein said B cell is capable of expressing more than 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 payloads.

7. An isolated modified B cell, capable of expressing a chimeric receptor, wherein said chimeric receptor comprises an extracellular domain, wherein said extracellular domain comprises a hinge domain and an extracellular binding domain, wherein said extracellular binding domain is not naturally expressed on a B cell; and wherein said extracellular binding domain is capable of recognizing a target of interest.

8. An isolated modified B cell, capable of expressing an integrin, a homing antibody, protein, a receptor, or combinations thereof, wherein said integrin, homing antibody, protein, or receptor is not naturally expressed in a B cell or is expressed at higher levels than is naturally expressed in a B cell; and wherein said integrin, homing antibody, protein, receptor, or combinations thereof is attracted to a site or target of interest, and wherein the integrin, homing antibody, protein, and receptor is selected from CLA (PSGL-1 gly coform), CLA (PSGL-1 gly coform), CCR10, CCR3, CCR4, CCR5, CCR6, CCR9, CD43E, CD44, c-Met, CXCR3, CXCR4, LFA-1, LFA-1 (aEb2), selectin ligands, VLA-4, VLA-4 (a4b1), and a4b7, or combinations thereof.

9. The isolated modified B cell of claim 8, wherein the site of interest is a homing or target tissue, an inflammatory site in a specific location or tissue, or a tumor or tumor microenvironment, where delivery of payloads is desirable.

10. The isolated modified B cell of claim 9, wherein the homing or target tissue is selected from skin, gut (intestine, colon, mesenteric lymph nodes (mLN), Peyer's Patch (PP), small intestine), liver, lung, bone marrow, heart, peripheral lymph node (LN), CNS, thymus, and bone marrow.

11. The isolated modified B cell of claim 10, wherein the target of interest is selected from CXCL16, CCL17, CCL17(22), CCL20 (MIP-3a), CCL21, CCL25, CCL27, CCL28, CCL4, CCL5, CD62E, CD62P, CXCL10, CXCL12, CXCL13, CXCL16, CXCL9/CXCL10, CXCR3, E/P- selectin, E-selectin, GPR15L, HGF, Hyaluronate, ICAM-1, ligands for CCR1, 2, 5, MAdCAM, MAdCAM-1, PNAd, VAP-1, VC AM, and VCAM-1, or combinations thereof.

12. An isolated modified B cell, capable of expressing an immune inhibitory molecule, wherein said immune inhibitory molecule is not naturally expressed in a B cell or is expressed at higher levels than is naturally expressed in a B cell.

13. The isolated modified B cell of claim 12, wherein said immune inhibitory molecule is selected from IL-10, TGF-b, PD-L1, PD-L2, LAG-3, and TIM-3, or combinations thereof.

14. The isolated modified B cell of claim 13, wherein said immune inhibitory molecule is capable of decreasing inflammation and autoimmune activity of B cells at a site or target of interest in a patient.

15. An isolated modified B cell, wherein the isolated modified B cell is treated with a compound or a derivative thereof, wherein said compound or derivative thereof is capable of increasing the expression of an integrin, a homing antibody, a protein, a receptor, or combinations thereof in B cells.

16. The isolated modified B cell of claim 15, wherein said compound or derivative thereof is capable of altering trafficking of B cells to a site or target of interest in the patient.

17. The isolated modified B cell of claim 16, wherein said compound is all-trans-retinoic acid (ATRA) or a derivative thereof.

18. An isolated modified B cell, capable of expressing at least one or more of a constitutively active Toll-like receptor (TLR), wherein said TLR is not naturally expressed in a B cell or is expressed at higher levels than is naturally expressed in a B cell.

19. The isolated modified B cell of claim 18, wherein said TLR is selected from TLR1, TLR2, TLR3, TLR4, TLR5, TLR6, TLR7, TLR8, TLR9, TLR10, TLR11, TLR12, and TLR13, or combinations thereof.

20. The isolated modified B cell of claim 19, wherein said TLR is capable of potentiating B cells for increasing immune responses in a patient.

21. The isolated modified B cell of claim 19 or claim 20, wherein said TLR is capable of producing potent effector B cells for increasing immune responses in a patient.

22. An isolated modified B cell, wherein the isolated modified B cell is treated with at least one or more of a TLR agonist.

23. The isolated modified B cell of claim 22, wherein said TLR agonist is selected from CpG-rich oligonucleotides, double-stranded RNA mimic, polyinosinic acid:polycytidylic acid (poly-I:C).

24. An isolated modified B cell, wherein said B cell is electroporated with an mRNA encoding at least one or more of an antigen fused to a targeting signal.

25. The isolated modified B cell of claim 24, wherein said antigen is (i) not naturally presented by a B cell, (ii) not presented by a B cell simultaneously in both HLA class I and class II molecules naturally, or (iii) not presented by a B cell with high efficiencies in both HLA class I and class II molecules naturally.

26. The isolated modified B cell of claim 24 or claim 25, wherein said targeting signal is targeting signal of a lysosomal protein.

27. The isolated modified B cell of claim 26, wherein said targeting signal is a targeting signal of lysosome-associated membrane protein- 1 (LAMP1).

28. The isolated modified B cell of any one of claims 24-27, wherein said antigen is capable of being targeted to the lysosomes and presented simultaneously and efficiently in both HLA class I and class II molecules.

29. The isolated modified B cell of any one of claims 24-28, wherein said B cells is capable of increasing antigen-specific immune responses in a patient.

30. The isolated modified B cell of any one of claims 24-29, wherein the extracellular domain comprises an immunoglobulin domain.

31. The isolated modified B cell of any one of claims 24-30, wherein the chimeric receptor is capable of forming a homologous dimer.

32. An isolated modified B cell, capable of expressing a chimeric receptor (CAR-B), wherein said chimeric receptor comprises

a) an extracellular domain, wherein the extracellular domain comprises an extracellular binding domain and a hinge domain;

b) a transmembrane domain; and

c) a cytoplasmic domain.

33. An isolated modified B cell, capable of expressing a chimeric receptor (CAR-B), wherein said chimeric receptor comprises the amino acid sequence of one or more of SEQ ID NO: 142, SEQ ID NO: 144, or SEQ ID NO: 146.

34. The isolated modified B cell of any one of claims 1-33, wherein said extracellular binding domain, recognizes an antigen or protein that is secreted.

35. The isolated modified B cell of any one of claims 1-34, wherein said extracellular binding domain, recognizes an antigen or protein expressed on the surface of a target cell.

36. The isolated modified B cell of claim 35, wherein said target cell is selected from the group consisting of a tumor cell, a cardiac muscle cell, a skeletal muscle cell, a bone cell, a blood cell, a nerve cell, a fat cell, a skin cell, an endothelial cell, a hepatocyte, a pulmonary epithelial cell and a fibroblast.

37. The isolated modified B cell of any one of claims 1-36, wherein said B cell expresses more than one CAR-B receptor construct.

38. The isolated modified B cell of any one of claims 1-37, wherein said CAR-B receptor comprises more than one extracellular binding domain.

39. The isolated modified B cell of any one of claims 1-38, wherein said extracellular binding domain is a single chain variable fragment (scFv), a full-length antibody, an antibody fragment or an extracellular domain of a receptor or ligand.

40. The isolated modified B cell of any one of claims 1-39, wherein said extracellular binding domain is capable of binding to an antigen or protein selected from the group consisting of: PSMA, GP3, ASGR1, ASGR2, Sarcoglycan, Corin, and Her2, FAP, MUC1, CEA153, JAM-1, and LFA-1.

41. The isolated modified B cell of any one of claims 1-40, wherein said hinge domain is derived from the group consisting of an immunoglobulin (for example, IgG or IgM), CD28 and CD8.

42. The isolated modified B cell of any one of claims 1-41, wherein said cytoplasmic domain comprises at least one signaling domain native to B cells.

43. The isolated modified B cell of any one of claims 1-42, wherein said cytoplasmic domain comprises at least one signaling domain that is an immunoglobulin.

44. The isolated modified B cell of any one of claims 1-43, wherein said cytoplasmic domain comprises a domain selected from the group consisting of: CD79a (Immunoglobulin a), CD79b (Immunoglobulin b), CD40, CD 19, CD 137, Fcyr2a, MyD88, CD21, Syk, FYN, LYN, PI3K, BTK, PLCy2, CD3 and BLNK.

45. The isolated modified B cell of any one of claims 1-44, wherein said cytoplasmic domain further comprises a costimulatory domain.

46. The isolated modified B cell of any one of claims 1-45, wherein the modified B cell further encodes at least one protein selected from the group consisting of: the cytoplasmic domains of CD79a (Immunoglobulin a), CD79b (Immunoglobulin b), CD40, CD19, CD137, Fcyr2a, €O3z and MyD88.

47. The isolated modified B cell of any one of claims 1-46, wherein herein said B cell is capable of expressing more than one chimeric receptor.

48. The isolated modified B cell of any one of claims 1-47, wherein said B cell is further capable of expressing a payload.

49. The isolated modified B cell of claim 48, wherein said payload is selected from a group of cytokines, chemokines, T cell costimulatory molecules, and checkpoint molecules, the group consisting of: IL-1, IL-7, IL-8, IL-10, IL-12, IL-13, IL-17, IL-18, IL-21, interferon a, interferon b, interferon g, TSLP, CCL21, FLT3L, XCL1, LIGHT(TNFSF14), OX40L, CD137L, CD40L, ICOSL, anti-CD3 antibody, CD47, TIM4-FC, CXCL13, CCL21, CD80, CD40L, IFNa A2, LIGHT , 4-1BBL, MDGF (C19orfl0), FGF10, PDGF, agrin, TNF-a, GM-CSF, an anti-FAP

antibody, an anti-TGF-b antibody; a TGF-b trap, decoy or other inhibitory molecule; an anti-BMP antibody; a BMP trap, decoy or other inhibitory molecule.

50. The isolated modified B cell of claim 48 or 49, wherein said B cell is capable of expressing more than 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 payloads.

51. A nucleic acid capable of expressing a chimeric B cell receptor, wherein said chimeric receptor comprises:

a) an extracellular domain, wherein said extracellular domain comprises an extracellular binding domain and a hinge domain;

b) a transmembrane domain; and

c) a cytoplasmic domain that comprises at least one signaling domain.

52. A vector comprising a nucleic acid capable of expressing a chimeric B cell receptor, wherein said chimeric receptor comprises:

a) an extracellular domain, wherein said extracellular domain comprises an extracellular binding domain and a hinge domain;

b) a transmembrane domain; and

c) a cytoplasmic domain that comprises at least one signaling domain.

53. The nucleic acid of claim 51 or the vector of claim 52, wherein the secreted protein accumulates in the extracellular matrix.

54. The nucleic acid of claim 51 or the vector of claim 52, wherein said extracellular binding domain recognizes an antigen or protein expressed on the surface of a target cell.

55. The nucleic acid of claim 51 or the vector of claim 52, wherein said extracellular binding domain, recognizes an antigen or protein that is a secreted protein.

56. The nucleic acid of claim 51 or the vector of claim 52, wherein the secreted protein accumulates in the extracellular matrix.

57. The nucleic acid of claim 51 or the vector of claim 52, wherein said target cell is selected from the group consisting of a tumor cell, a cardiac muscle cell, a skeletal muscle cell, a bone cell, a blood cell, a nerve cell, a fat cell, a skin cell, an endothelial cell, a hepatocyte, a pulmonary epithelial cell or a fibroblast.

58. The nucleic acid of claim 51 or the vector of claim 52, wherein said vector expresses more than one CAR-B receptor.

59. The nucleic acid of claim 51 or the vector of claim 52, wherein said CAR-B expresses more than one extracellular binding domain.

60. The nucleic acid of claim 51 or the vector of claim 52, wherein said extracellular binding domain is a single chain variable fragment (scFv), a full-length antibody, an antibody fragment, an extracellular domain of a receptor or ligand.

61. The nucleic acid of claim 51 or the vector of claim 52, wherein said extracellular binding domain is capable of binding to an antigen or protein selected from the group consisting of: PSMA, GPC3, ASGR1, AGSR2, Sarcoglycan, Corin, Her2, PAF1, MUC1, CEA153, JAM-1, and LFA-1.

62. The nucleic acid of claim 51 or the vector of claim 52, wherein said hinge domain is derived from the group consisting of an immunoglobulin domain (for example, IgG or IgM), CD28 and CD8.

63. The nucleic acid of claim 51 or the vector of claim 52, wherein said cytoplasmic domain comprises at least one signaling domain native to B cells.

64. The nucleic acid of claim 51 or the vector of claim 52, wherein said cytoplasmic domain comprises a signaling domain selected from the group consisting of: CD79a (Immunoglobulin a), CD79b (Immunoglobulin b), CD40, CD19, CD137, Fcyr2a, MyD88, CD21, Syk, FYN, LYN, PI3K, BTK, PLCy2, CD3t and BLNK.

65. The nucleic acid of claim 51 or the vector of claim 52, wherein said cytoplasmic domain further comprises a costimulatory domain.

66. A method of treating a patient comprising administering the isolated modified B cell of any one of claims 1-50.

67. The method of claim 66, further comprising administering a checkpoint inhibitor capable of inhibiting a checkpoint molecule selected from the group consisting of: PD-1, PD-L1, CTLA-4, LAG3, TIM-3 and NKG2A.

68. The method of claim 66 or claim 67, further comprising administering a compound or a derivative thereof, wherein the compound or derivative thereof is capable of modulating the expression of the integrin, homing antibody, protein, and receptor, or combinations thereof.

69. The method of claim 68, wherein the compound or a derivative thereof is capable of altering trafficking of B cells to a site or target of interest in the patient.

70. The method of claim 69, wherein the compound is all-trans-retinoic acid (ATRA) or a derivative thereof.

71. A method of treating a patient comprising administering the isolated modified B cell of claims 24-31, wherein said antigen is (i) not naturally presented by a B cell, (ii) not presented by a B cell simultaneously by both HLA class I and class II molecules naturally, or (iii) not

presented by a B cell with high efficiencies by both HLA class I and class II molecules naturally.

72. The method of claim 71, wherein said targeting signal is targeting signal of a lysosomal protein.

73. The method of claim 72, wherein said targeting signal is a targeting signal of lysosome-associated membrane protein-1 (LAMP1).

74. The method of claim 73, wherein said antigen is capable of being targeted to the lysosomes and presented simultaneously and efficiently in both HLA class I and class II molecules.

75. The method of claim 74, wherein said B cells is capable of increasing antigen-specific immune responses in the patient.

76. The method of any one of claims 66-75, wherein the patient is treated with more than one differently modified B cells.

77. The method of any one of claims 65-76, further comprising administering at least one or more of a TLR agonist to the patient, wherein said at least one or more TLR agonists is capable of (i) potentiating B cells, and (ii) producing potent effector B cells, for increasing immune responses in a patient.