Claims:

1. An antigen-presenting synthetic surface for activating a T lymphocyte (T cell), comprising:

    a plurality of primary activating molecular ligands, wherein each primary activating molecular ligand comprises a major histocompatibility complex (MHC) Class I molecule configured to bind to a T cell receptor (TCR) of the T cell; and,

    a plurality of co-activating molecular ligands each comprising a TCR co-activating molecule or an adjunct TCR activating molecule,

    wherein each of the plurality of primary activating molecular ligands and the plurality of co-activating molecular ligands is specifically bound to the antigen presenting surface;

    wherein a ratio of the TCR co-activating molecules to the adjunct TCR activating molecules is 10:1 to 1:10;

    wherein the TCR co-activating molecule comprises a CD28 binding protein or a fragment thereof which retains binding ability with CD28, and the adjunct TCR activating molecule comprises a CD2 binding protein or a fragment thereof which retains binding ability with CD2, a CD27 binding protein or a fragment thereof which retains binding ability with CD27, or a CD137 binding protein or a fragment thereof which retains binding ability with CD137.

2. The antigen-presenting synthetic surface of claim 1, wherein the plurality of primary activating molecular ligands is disposed upon at least a portion of the antigen-presenting synthetic surface at a density from $4x10^2$ to $3x\ 10^4$ molecules per square micron.

3. The antigen-presenting synthetic surface of claim 1 or claim 2, further comprising a plurality of surface-blocking molecular ligands.

4. The antigen-presenting synthetic surface of any one of claims 1-3, wherein the plurality of co-activating molecular ligands is disposed upon at least a portion of the antigen-presenting synthetic surface at a density from $5x\ 10^3$ to $2x\ 10^4$ molecules per square micron.

5. The antigen-presenting synthetic surface of any one of claims 1-4, wherein a ratio of the primary activating molecular ligands to the co-activating molecular ligands present on the antigen-presenting synthetic surface is 1:10 to 2:1.

6. The antigen-presenting synthetic surface of any one of claims 1-5, wherein:
(i) the antigen-presenting synthetic surface comprises glass, metal, ceramic, and/or a metal oxide; and/or
(ii) the antigen-presenting synthetic surface comprises a polymeric surface.

7. The antigen-presenting synthetic surface of any one of claims 1-6, wherein each of the plurality of primary activating molecular ligands is noncovalently bound to a binding moiety, and further wherein the binding moiety is (i) covalently bound to the antigen-presenting synthetic surface or (ii) noncovalently bound to a second binding moiety that is covalently bound to the surface.

8. The antigen-presenting synthetic surface of any one of claims 1-7, wherein the MHC Class I molecule comprises an MHC protein sequence and a beta microglobulin.

9. The antigen-presenting synthetic surface of any one of claims 1-8, wherein the MHC Class I molecule further comprises a tumor associated antigen associated thereto.

10. The antigen-presenting synthetic surface of claim 9, wherein the tumor associated antigen is SLC45A2, TCL1, VCX3A, MART1 or NYESO1.

11. The antigen-presenting synthetic surface of any one of claims 1-10, wherein:
the TCR co-activating molecule comprises an anti-CD28 antibody or a fragment thereof, wherein the fragment retains binding activity with CD28.

12. The antigen-presenting synthetic surface of any one of claims 1-11, wherein:
(i) the adjunct TCR activating molecule comprises a CD2 binding protein or a fragment thereof, wherein the fragment retains binding activity with CD2; or
(ii) the adjunct TCR activating molecule comprises an anti-CD2 antibody or a fragment thereof, wherein the fragment retains binding activity with CD2.

13. The antigen-presenting synthetic surface of claim 3, wherein each of the plurality of surface-blocking molecular ligands comprises a polyethylene glycol (PEG) moiety, a carboxylic acid moiety, or a combination thereof.

14. The antigen-presenting synthetic surface of any one of claims 1-13, wherein the ratio of the TCR co-activating molecules to the adjunct TCR activating molecules of the plurality of co-activating molecular ligands is from 3:1 to 1:3.

15. The antigen-presenting synthetic surface of any one of claims 1-14, wherein the antigen presenting surface is the surface of a bead.

16. A method of activating T lymphocytes (T cells) comprising:

contacting a plurality of T cells with an antigen-presenting synthetic surface comprising:

a plurality of primary activating molecular ligands, each comprising a major histocompatibility (MHC) Class I molecule configured to bind to a T cell receptor of the T cells; and

a plurality of co-activating molecular ligands presented on the antigen-presenting synthetic surface, each comprising a T cell receptor (TCR) co-activating molecule or an adjunct TCR activating molecule;

a plurality of surface-blocking molecular ligands; and

culturing the plurality of T cells in contact with the antigen-presenting synthetic surface, thereby converting at least a portion of the plurality of T cells to activated T cells;

wherein a ratio of the TCR co-activating molecules to the adjunct TCR activating molecules is 10:1 to 1:10;

wherein the TCR co-activating molecule comprises a CD28 binding protein or a fragment thereof which retains binding ability with CD28, and the adjunct TCR activating molecule comprises a CD2 binding protein or a fragment thereof which retains binding ability with CD2, a CD27 binding protein or a fragment thereof which retains binding ability with CD27, or a CD137 binding protein or a fragment thereof which retains binding ability with CD137.

17. A method of activating T lymphocytes (T cells) comprising:

contacting a plurality of T cells with the antigen-presenting synthetic surface of any one of claims 1-15; and

culturing the plurality of T cells in contact with the antigen-presenting synthetic surface, thereby converting at least a portion of the plurality of T cells to activated T cells.

18. The method of claim 16 or claim 17, wherein the T cells comprise CD8+ T cells.

19. The method of any one of claims 16-18, further comprising contacting the plurality of T cells with a plurality of growth stimulatory molecular ligands.

20. The method of claim 19, wherein each of the growth stimulatory molecular ligands comprises a growth factor receptor ligand.

21. The method of claim 20, wherein the growth factor receptor ligand comprises IL-21 or a IL-21 receptor ligand fragment thereof.

22. The method of any one of claims 16-21, wherein the culturing in contact with the antigen-presenting synthetic surface is performed for a period from four days to seven days.

23. The method of any one of claims 16-22, further comprising:

completing a first period of activation in contact with the antigen-presenting synthetic surface, wherein the antigen-presenting synthetic surface is a first antigen-presenting synthetic surface;

contacting the plurality of activated T cells with a second antigen-presenting synthetic surface comprising a plurality of primary activating molecular ligands, each comprising a MHC molecule, and a plurality of co-activating molecular ligands each comprising a T cell receptor (TCR) co-activating molecule or an adjunct TCR activating molecule; and,

culturing the plurality of activated T cells in contact with the second antigen-presenting synthetic surface for a second period of culturing, thereby providing an expanded plurality of activated T cells.

24. The method of claim 23, wherein the second antigen-presenting synthetic surface is the surfaces of a plurality of antigen-presenting beads, wherein said plurality of antigen-presenting beads is added in a 1:1 ratio to the plurality of activated T cells.

25. The method of any one of claims 16-24, wherein the activated T cells are CD45RO+.

26. The method of any one of claims 16-25, wherein the activated T cells are CD28 positive.

27. The method of claim 17, wherein the antigen presenting synthetic surface is the surface of a bead, and the plurality of T cells is contacted with antigen-presenting beads in a ratio of antigen-presenting beads to cells of about 1:1.