

WHAT IS CLAIMED IS:

1. An *ex vivo* method of recellularizing a tissue or organ matrix,
5 comprising the steps of:
 - a) providing a tissue or organ matrix perfused with a physiological buffer under pressure; and
 - b) reendothelializing the tissue or organ matrix by perfusing the tissue or organ matrix with a physiological composition comprising a
10 substantially pure population of endothelial cells or endothelial progenitor cells.
2. The method of claim 1, wherein the endothelial cells are selected from the group consisting of blood endothelial cells, bone marrow endothelial cells, circulating endothelial cells, human aorta endothelial cells, human brain
15 microvascular endothelial cells, human dermal microvascular endothelial cells, human intestinal microvascular endothelial cells, human lung microvascular endothelial cells, human microvascular endothelial cells, hepatic sinusoidal endothelial cells, human saphenous vein endothelial cells, human umbilical vein endothelial cells, lymphatic endothelial cells, microvessel endothelial cells,
20 microvascular endothelial cells, pulmonary artery endothelial cells, retinal capillary endothelial cells, retinal microvascular endothelial cells, vascular endothelial cells, umbilical cord blood endothelial cells, liver sinusoidal endothelial cells, colony forming unit-endothelial cells (CFU-ECs), circulating angiogenic cells (CACs), circulating endothelial precursors (CEPs), endothelial
25 colony-forming cells (ECFC), low proliferative potential ECFC (LPP-ECFC), high proliferative ECFC (HPP-ECFC), and combinations thereof.
3. The method of claim 1 or 2 wherein the endothelial cells or endothelial progenitor cells are embryonic stem cells (ESCs)- or induced
30 pluripotent stem cells (iPSCs)-derived endothelial cells or endothelial progenitor cells.
4. The method of any one of claims 1 to 3 wherein the tissue or organ matrix is a biological tissue or organ matrix.

5 5. The method of claim 4, wherein the biological tissue or organ matrix originates from an organ selected from the group consisting of a heart, kidney, liver, lung, pancreas, intestine, muscle, skin, breast, esophagus, trachea, or omentum.

 6. The method of claim 4, wherein the biological tissue or organ matrix is a perfusion-decellularized tissue or organ matrix.

10 7. The method of claim 4, wherein the biological tissue or organ matrix and the endothelial cells or endothelial precursor cells are xenogeneic.

 8. The method of claim 4, wherein the biological tissue or organ matrix and the endothelial cells or endothelial precursor cells are allogeneic.

15 9. The method of any one of claims 1 to 8 further comprising introducing cells other than endothelial or endothelial progenitor cells into or onto the tissue or organ matrix before step b).

20 10. The method of any one of claims 1 to 9 further comprising introducing cells other than endothelial or endothelial progenitor cells into or onto the tissue or organ matrix after step b).

25 11. A method of reducing thrombogenesis and immunogenicity in a recellularized tissue or organ following transplantation into a recipient, comprising:

- a) providing a tissue or organ matrix perfused with a physiological buffer under pressure;
- b) reendothelializing the tissue or organ matrix by perfusing the tissue or organ matrix with a physiological composition comprising a substantially pure population of endothelial cells or endothelial progenitor cells; and
- c) transplanting the reendothelialized tissue or organ matrix into the recipient.

12. The method of claim 11, wherein the endothelial cells are selected from the group consisting of blood endothelial cells, bone marrow endothelial cells, circulating endothelial cells, human aorta endothelial cells, human brain
5 microvascular endothelial cells, human dermal microvascular endothelial cells, human intestinal microvascular endothelial cells, human lung microvascular endothelial cells, human microvascular endothelial cells, hepatic sinusoidal endothelial cells, human saphenous vein endothelial cells, human umbilical vein endothelial cells, lymphatic endothelial cells, microvessel endothelial cells,
10 microvascular endothelial cells, pulmonary artery endothelial cells, retinal capillary endothelial cells, retinal microvascular endothelial cells, vascular endothelial cells, umbilical cord blood endothelial cells, liver sinusoidal endothelial cells, colony forming unit-endothelial cells (CFU-ECs), circulating angiogenic cells (CACs), circulating endothelial precursors (CEPs), endothelial
15 colony-forming cells (ECFC), low proliferative potential ECFC (LPP-ECFC), high proliferative ECFC (HPP-ECFC), and combinations thereof.

13. The method of claim 11 or 12 wherein the endothelial cells or endothelial progenitor cells are embryonic stem cells (ESCs)- or induced
20 pluripotent stem cells (iPSCs)-derived endothelial cells or endothelial progenitor cells.

14. The method of any one of claims 11 to 13 wherein the tissue or organ matrix is a biological tissue or organ matrix.
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15. The method of claim 14 wherein the biological tissue or organ matrix originates from an organ selected from the group consisting of a heart, kidney, liver, lung, pancreas, intestine, muscle, skin, breast, esophagus, trachea, or omentum.
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16. The method of claim 14, wherein the biological tissue or organ matrix is a perfusion-decellularized tissue or organ matrix.

17. The method of claim 14, wherein the biological tissue or organ matrix and the endothelial cells or endothelial precursor cells are xenogeneic.

5 18. The method of claim 14, wherein the biological tissue or organ matrix and the endothelial cells or endothelial precursor cells are allogeneic.

10 19. The method of claim 14, wherein the biological tissue or organ matrix is xenogeneic to the recipient and wherein the endothelial cells or endothelial progenitor cells are allogeneic to the recipient.

20. The method of any one of claims 11 to 19 further comprising introducing cells other than endothelial or endothelial progenitor cells into or onto the tissue or organ matrix before step b).

15 21. The method of any one of claims 11 to 20 further comprising introducing cells other than endothelial or endothelial progenitor cells into or onto the tissue or organ matrix after step b).

20 22. The method of any one of claims 11 to 21 further comprising introducing cells other than endothelial cells or endothelial progenitor cells into or onto the tissue or organ matrix after step c).

25 23. The method of claim 20, 21 or 22, wherein the physiological composition comprising cells other than endothelial cells or endothelial progenitor cells is introduced to the tissue or organ matrix via perfusion, direct injection, topical application, or combinations thereof.

30 24. The method of any one of claims 1 to 23 wherein the provided tissue or organ matrix is perfusion decellularized.

CLAIMS:

1. An *ex vivo* method of recellularizing a tissue or organ matrix, comprising the steps of:

a) providing a decellularized matrix of a mammalian organ or vascularized tissue, wherein said matrix of said organ comprises an intact organ capsule, wherein said matrix of said organ or tissue comprises a vascular system, wherein when fluid is introduced to one entry point of said vascular system of said decellularized matrix, and exits through a different route; and

b) reendothelializing the tissue or organ matrix by perfusing, in antegrade and retrograde directions, the decellularized vascular system of the tissue or organ matrix with a composition comprising a substantially pure population of endothelial cells or endothelial progenitor cells.

2. The method of claim 1, wherein the endothelial cells are selected from the group consisting of blood endothelial cells, bone marrow endothelial cells, circulating endothelial cells, human aorta endothelial cells, human brain microvascular endothelial cells, human dermal microvascular endothelial cells, human intestinal microvascular endothelial cells, human lung microvascular endothelial cells, human microvascular endothelial cells, hepatic sinusoidal endothelial cells, human saphenous vein endothelial cells, human umbilical vein endothelial cells, lymphatic endothelial cells, microvessel endothelial cells, microvascular endothelial cells, pulmonary artery endothelial cells, retinal capillary endothelial cells, retinal microvascular endothelial cells, vascular endothelial cells, umbilical cord blood endothelial cells, liver sinusoidal endothelial cells, colony forming unit-endothelial cells (CFU-ECs), circulating angiogenic cells (CACs), circulating endothelial precursors (CEPs), endothelial colony-forming cells (ECFC), low proliferative potential ECFC (LPP-ECFC), high proliferative ECFC (HPP-ECFC), and combinations thereof.

3. The method of claim 1 or 2 wherein the endothelial cells or endothelial progenitor cells are embryonic stem cells (ESCs) or induced pluripotent stem cells (iPSCs)-derived endothelial cells or endothelial progenitor cells.

4. The method of claim 1, wherein the tissue or organ matrix originates from an organ selected from the group consisting of a heart, kidney, liver, lung, pancreas, intestine, muscle, skin, breast, esophagus, trachea, or omentum.

5. The method of claim 1, wherein the tissue or organ matrix and the endothelial cells or endothelial precursor cells are xenogeneic.

6. The method of claim 1, wherein the tissue or organ matrix and the endothelial cells or endothelial precursor cells are allogeneic.

7. The method of any one of claims 1 to 6 further comprising introducing cells other than endothelial or endothelial progenitor cells into or onto the tissue or organ matrix before step b).

8. The method of any one of claims 1 to 7 further comprising introducing cells other than endothelial or endothelial progenitor cells into or onto the tissue or organ matrix after step b).

9. The method of claim 7 or 8, wherein the cells other than endothelial cells or endothelial progenitor cells are introduced to the tissue or organ matrix via perfusion, direct injection, topical application, or combinations thereof.

10. The method of any preceding claim wherein the step of providing a decellurized matrix of a mammalian organ or vascularized tissue comprises perfusion decellurization of the organ or vascularized tissue.