device capable of growing complex cells in three dimensions.

[0009] The information disclosed in this Background of the Invention is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

BRIEF SUMMARY

[0010] Advantageously, the cell scaffold devices detailed in the present disclosure address the shortcomings in the prior art detailed above.

[0010A] According to an aspect of the present disclosure, there is provided a cell-scaffold device comprising:

a plurality of branching channel networks comprising

a first branching channel network,

a second branching channel network, and

a third branching channel network,

wherein the first branching channel network comprises a plurality of first channels formed by at least three generations of branching, the plurality of first channels comprising a first-generation first channel and a plurality of final-generation first channels;

the second branching channel network comprises a plurality of second channels formed by branching and recursive recombination, the plurality of second channels comprising an inlet second channel, an outlet second channel and a plurality of intermediate second channels branched from the inlet second channel and recursively recombined to the outlet second channel, wherein one or more second channels in the plurality of second channels are located in a first layer and one or more other second channels in the plurality of second channels are located in a second layer that is different than the first layer;

the third branching channel network comprises a plurality of third channels formed by at least three generations of branching, the plurality of third channels comprising a first-generation third channel and a plurality of final-generation third channels; and

the plurality of final-generation first channels of the first branching channel network is disposed adjacent to the first layer of the second branching channel network, the plurality of final-generation third channels of the third branching channel network is disposed adjacent to the second layer of the second branching channel network, the plurality of final-generation first channels of the first branching channel network and the plurality of final-generation third channels of the third branching channel network are connected with each other by a plurality of bypass channels, and each of the plurality of bypass channels bypasses the second branching channel network , thereby producing a compact three-dimensional structure with interwoven channels.

[0011] Various aspects of the present disclosure are directed to providing a cell-scaffold device having a fractal structure utilized for growing tissue. The device includes at least one channel network. The channel network includes an inlet and a plurality of channels. The plurality of channels includes a parent channel having a first end portion in communication with the inlet and a second end portion in communication with a first bifurcation. The fist bifurcation forming two child channels. Each child channel has a first end portion in communication with an end portion of the first bifurcation and a second end portion in communication with a second bifurcation. The second bifurcation forming two grand-child channels from each child channel. Each grand-child channel has a first end portion in communication with an end portion of the second bifurcation and a second end portion. The second end portion of the grand-child channel forms either an outlet or a third child channel in communication with the grand-child channel. Each forming of grand-child channels defines a generation of the fractal structure.

[0012] In some embodiments, the device is formed by an additive manufacturing method. The manufacturing method is selected from the group consisting of binder jetting, material extrusion, material jetting, polyjet, powder bed, sheet lamination, VAT photopolymerization, or a combination thereof. In some embodiments, the device is formed by injection molding. Further, in some embodiments the device is formed by layered fabrication. In specific embodiments, the layered fabrication method is selective laser sintering or stereolithography.

[0013] In some embodiments, the device is formed as a positive mold such that the channels of the device are formed by a printing material of a particular manufacturing device. In another

WHAT IS CLAIMED IS:

1. A cell-scaffold device having a fractal structure utilized for growing tissue, wherein the device comprises at least one channel network comprising:

an inlet;

a plurality of channels comprising:

a parent channel having a first end portion in communication with the inlet and a second end portion in communication with a first bifurcation, thereby forming two child channels,

each child channel having a first end portion in communication with a respective end portion of the first bifurcation and a second end portion in communication with a second bifurcation, thereby forming two grand-child channels from each child channel, and

each grand-child channel having a first end portion in communication with a respective end portion of the second bifurcation and a second end portion, wherein the second end portion of the grand-child channel either forms an outlet or a third child channel in communication with the grand-child channel,

wherein each forming of grand-child channels defines a generation of the fractal structure.

2. The scaffold device of claim 1, wherein the device is formed by an additive manufacturing method.

3. The scaffold device of claim 2, wherein the device is formed as a positive mold such that walls of the channels are being formed.

4. The scaffold device of claim 2, wherein the device is formed as a negative mold such that voids between the channels are being formed.

~~5. The scaffold device according to any one of claims 1-4, wherein cells populate an exterior of the device in a naturally occurring manner.~~

~~6. The scaffold device according to any one of claims 1-4, wherein cells populate an exterior of the device in a preassembled manner.~~

~~7. The scaffold device according to any one of claims 2-6, wherein cells are bio-printed concurrently, sequentially, or a combination thereof with the manufacturing of the device.~~

~~8. The scaffold device according to any one of claims 2-7, wherein the additive manufacturing method is selected from the group consisting of: binder jetting, material extrusion, material jetting, polyjet, powder bed, sheet lamination, and VAT photopolymerization.~~

~~9. The scaffold device according to any one of claims 1-8, wherein the channel network is formed from a resorbable or biodegradable material.~~

~~10. The scaffold device according to any one of claims 1-8, wherein the channel network is formed from a non-resorbable material.~~

~~11. The scaffold according to any one of claims 1-8, wherein the channel network is formed from a non-resorbable material, a biodegradable material, a non-resorbable material, or a combination thereof.~~

~~12. The scaffold device according to any one of claims 1-11, wherein the channel network is formed from an optically transparent or translucent material.~~

~~13. The scaffold device according to any one of claims 1-12, wherein the channel network is formed from a synthetic polymer, a natural polymer, or a combination thereof.~~

~~14. The scaffold device of claim 1, wherein the channel network is formed from a material selected from the group consisting of: poly-dimethyl-siloxane (PDMS), poly-glycerol-sebacate (PGS),~~

~~polylactic acid (PLA), poly-L-lactic acid (PLLA), poly-D-lactic acid (PDLA), polyglycolide, polyglycolic acid (PGA), polylactide-co-glycolide (PLGA), polydioxanone, polygluconate, polylactic acid-polyethylene oxide copolymers, modified cellulose, collagen, polyhydroxybutyrate, polyhydroxpriopionic acid, polyphosphoester, poly(alpha-hydroxy acid), polycaprolactone, polycarbonates, polyamides, polyanhydrides, polyamino acids, polyorthoesters, polyacetals, polycyanoacrylates, degradable urethanes, aliphatic polyesterspolyacrylates, polymethacrylate, acyl substituted cellulose acetates, non-degradable polyurethanes, polystyrenes, polyvinyl chloride, polyvinyl flouride, polyvinyl imidazole, chlorosulphonated polyolifins, polyethylene oxide, polyvinyl alcohol, Teflon©, nylon silicon, and shape memory materials, such as poly(styrene-block-butadiene), polynorbornene, hydrogels, metallic alloys, and oligo(ε-caprolactone)diol as switching segment/oligo(p-dioxyanone)diol as physical crosslink.~~

~~15. The scaffold device of claim 1, wherein the device is formed by injection molding.~~

~~16. The scaffold device of claim 1, wherein the device is formed by layered fabrication.~~

~~17. The scaffold device of claim 16, wherein the layered fabrication method is selective laser sintering or stereolithography.~~

~~18. The scaffold device according to any one of claims 1-17, wherein:~~

~~a diameter of a smallest channel is predetermined; and~~

~~each preceding channel after the smallest channel has a diameter increased by a first predetermined factor relative to a diameter of an immediately subsequent channel.~~

~~19. The scaffold device according to any one of claims 1-18, wherein:~~

~~a diameter of the inlet is predetermined; and~~

~~each subsequent channel after the inlet has a diameter reduced by a first predetermined factor relative to a diameter of an immediately preceding channel.~~

20. The scaffold device of claim 19, wherein a diameter of a smallest channel is between 5 microns µm and 650 µm.

21. The scaffold device of claim 19, wherein the first predetermined factor is defined by Murray's Law, $D_o^3 = \sum_{i=1}^{n} D_i^3$, wherein:

D_o is a diameter of the parent channel;

n is a number of child channels; and

22. D_i is a diameter of an i^{th} child channel.

23. The scaffold device of claim 19, wherein the first predetermined factor is a constant less than or equal to 1.

The scaffold device of claim 22, wherein the first predetermined factor is $2^{-1/3}$ or 0.5.

24. The scaffold device according to any one of claims 1-23, wherein:

25. a length of the parent channel is predetermined; and

26. a length of each subsequent channel is reduced by a second predetermined factor relative to a length of an immediately preceding channel.

27. The scaffold device of claim 24, wherein the second predetermined factor is a constant less than or equal to 1.

28. The scaffold device of claim 25, wherein the second predetermined factor is 0.5.

29. The scaffold device according to any one of claims 1-26, wherein a ratio of a diameter to a length of a channel is fixed along the length of the channel.

30. The scaffold device of claim 27, wherein the ratio is in between 1:4 and 1:25.

31. The scaffold device of claim 27, wherein a characteristic length of the device is between 0.1 centimeters (cm) and 30 cm.

~~32. The scaffold device of claim 27, wherein a cross-section of the device is square or rectangular.~~

~~33. The scaffold device of claim according to any one of claims 1-30, wherein each channel and bifurcation exhibit laminar flow therein.~~

~~34. The scaffold device of claim according to any one of claims 1-31, wherein a cross-section of each channel has a uniform aspect ratio of 1:1.~~

~~35. The scaffold device of claim according to any one of claims 1-32, wherein a gross morphology of the device has an implantable shape, wherein the implantable shape externally resembles a member to be replaced by the device.~~

~~36. The scaffold device of claim 32, wherein the cross-section of each channel is circular or square.~~

~~37. The scaffold device of claim 32, wherein the cross-section of each channel is a cross-section of a platonic solid.~~

~~38. The scaffold device according to any one of claims 1-35, wherein a wall thickness of each surface of a channel is the same.~~

~~39. The scaffold device according to any one of claims 1-36, wherein a wall thickness of a channel is in between 5 μm and 10000 μm.~~

~~40. The scaffold device according to any one of claims 1-37, wherein a distance between a channel and a nearest adjacent channel surface is in between 10 μm and 4 cm.~~

~~41. The scaffold device according to any one of claims 1-38, wherein a connection between each channel and its corresponding bifurcation is a linear ramp, a smooth concave ramp, a smooth convex ramp, a step, a plurality of steps, or a reducer.~~

~~42. The scaffold device of claim 39, wherein the step intersects a diameter of an immediately subsequent channel at a front end portion, a rear end portion, or an intermediate portion of the connection.~~

~~43. The scaffold device of claim 39, wherein the connection is configured to have a surface of a channel in a channel network flush with a coplanar surface of each channel of the channel network.~~

~~44. The scaffold device according to any one of claims 1-41, wherein each bifurcation is a circular jog, a semi-circle, a C-shape, a T-shape, a U-shape, or a V-shape.~~

~~45. The scaffold device according to any one of claims 1-42, wherein each bifurcation has at least one chamfered or filleted edge portion.~~

~~46. The scaffold device of claim 42, wherein each bifurcation comprises a protrusion protruding towards an immediately preceding channel.~~

~~47. The scaffold device of claim 44, wherein the protrusion is a semi-circle, a V-shape, a wedge, a concave wedge, or a convex wedge.~~

~~48. The scaffold device of claim 42, wherein each bifurcation comprises an indentation towards an immediately preceding channel.~~

~~49. The scaffold device of claim 44, wherein the indentation is a semi-circle, a V-shape, a wedge, a concave wedge, or a convex wedge.~~

~~50. The scaffold device according to any one of claims 1-47, wherein each bifurcation branches orthogonal to an immediately preceding channel.~~

~~51. The scaffold device according to any one of claims 1-47, wherein each bifurcation branches at an angle in between 75° and 105° relative to an immediately preceding channel.~~

~~52. The scaffold device according to any one of claims 1-49, wherein the inlet is a portion of a master inlet.~~

~~53. The scaffold device according to any one of claims 1-50, wherein the second end portion grand-child channel is in communication with a third bifurcation, thereby forming two outlets.~~

~~54. The scaffold device according to any one of claims 1-51, wherein the inlet comprises a bifurcation subsequent the parent channel.~~

~~55. The scaffold device according to any one of claims 1-52, wherein the first channel network is recursively formed such that outlets of a first layer and outlets of a second layer combined to form a paired layer.~~

~~56. The scaffold device of claim 1, wherein the at least one channel network comprises a first channel network and a second channel network which are linked through communicating outlets therebetween, thereby forming a first paired layer.~~

~~57. The scaffold device of claim 54, wherein the first channel network is formed of a material different than a material of the second channel network.~~

~~58. The scaffold device of claim 54, wherein the first channel network is formed of a same material as the second channel network.~~

~~59. The scaffold device of claim 54, wherein the first channel network is configured as a hepatobiliary network and the second channel network is configured as a portal venous network.~~

~~60. The scaffold device of claim 54, wherein the first channel network is stacked onto the second channel network such that the outlets of the first channel network and the outlets of the second channel network are in communication, thereby allowing material to flow therebetween.~~

~~61. The scaffold device of claim 54, wherein the first channel network is stacked onto the second channel network such that the outlets of the first channel network and the outlets of the second channel network are not in communication, thereby preventing material from flowing therebetween.~~

~~62. The scaffold device of claim 54, wherein the first channel network is embedded internally in the second channel network.~~

~~63. The scaffold device of claim 60, wherein the first channel network is either centered or offset inside the second channel network.~~

~~64. The scaffold device of claim 54, wherein the second channel network is embedded internally in the first channel network.~~

~~65. The scaffold device of claim 60, wherein the second channel network is either centered or offset inside the first channel network.~~

~~66. The scaffold device of claim 54, wherein the first channel is oriented 0°, 90°, or 180° to the second channel wherein:~~

~~the 0° orientation is defined as the inlet of the first channel network and the inlet of the second channel network exist on a same side of the device;~~

~~the 90° orientation is defined as the inlet of the first channel network exists on an adjacent side of the device to the inlet of the second channel network; and~~

~~the 180° orientation is defined as the inlet of the first channel network and the inlet of the second channel network exist on opposing sides of the device.~~

~~67. The scaffold device of claim 54, wherein the communication is defined as either:~~

~~a direct flow of material from the first channel network to the second channel network;~~

~~or~~

an indirect flow of material from the first channel network to the second channel network by an exchange mechanism.

68. The scaffold device of claim 54, wherein the communication is defined as either:

a direct flow of material from the second channel network to the first channel network;

or

an indirect flow of material from the second channel network to the first channel network by an exchange mechanism.

69. The scaffold device of claim 66, wherein the exchange mechanism is mediated by a membrane or a plurality of pores.

70. The scaffold device of either claims 66 or 67, wherein the exchange mechanism has a thickness from about 10 μm to about 5000 μm.

71. The scaffold device according to any one of claims 66-68, wherein the exchange mechanism is formed on at least a portion of at least a first surface of at least one channel of a member selected from the first channel network, the second channel network, and a combination thereof.

72. The scaffold device according to any one of claims 66-69, wherein a side channel extending from at least a first surface of the first channel network to at least a first surface of the second channel network is formed and the exchange mechanism is disposed interposing between the side channel and the channel networks.

73. The scaffold device according to any one of claims 66-70, wherein the exchange mechanism is on all sides of either the first channel network or the second channel network, but never both channel networks.

74. The scaffold device according to any one of claims 66-71, wherein the membrane is selected from the group consisting of: Track-etch membranes and fibrous membranes.

~~75. The scaffold device according to any one of claims 66-72, wherein a parameter of the exchange mechanism is configured to selectively allow predetermined compounds, particles, and/or cells to pass therethrough while retaining other material.~~

~~76. The scaffold device of claim 73, wherein the parameter is a member selected from a pore diameter, a pore density, a pore depth, a porosity, a pore proximity, a membrane thickness, or a combination thereof.~~

~~77. The scaffold device of claim 74, wherein the pore density of the exchange mechanism is from about 1 pore per μm^2 to about 10 pores per μm^2.~~

~~78. The scaffold device of either claims 74 or 75, wherein the porosity of the exchange mechanism is from about 5 % to about 95 %.~~

~~79. The scaffold device according to any one of claims 74-76, wherein a distance from a center of a first pore to a center of an adjacent pore is from about 5 μm to about 100 μm.~~

~~80. The scaffold device according to any one of claims 74-77, wherein a diameter of each pore is from about 5 μm to about 100 μm.~~

~~81. The scaffold device according to any one of claims 74-78, wherein the depth of each pore is from about 10 μm to about 5000 μm.~~

~~82. The scaffold device according to any one of claims 66-79, wherein a wall thickness of a channel and a thickness of the exchange mechanism are a same value.~~

~~83. The scaffold device of claim 54, further comprising a third channel network and a fourth channel network which are linked through communicating outlets therebetween, thereby forming a second paired layer.~~

~~84. The scaffold device of claim 81, wherein the first paired layer and the second paired layer communicate with each other through an exchange mechanism therebetween, thereby combining to form a stackable unit, or stack.~~

~~85. The scaffold device of claim 81, wherein the first paired layer is a hepatobiliary layer and the second paired layer is a portal venous layer.~~

~~86. The scaffold device of claim 81, wherein the first paired layer is a distribution layer and the second paired layer is a collection layer.~~

~~87. The scaffold device of claim 82, wherein the first paired layers of each stack are in communication with each other by an exchange mechanism and the second paired layers of each stack are in communication with each other by the exchange mechanism, thereby forming a stacked first layer and a stacked second layer.~~

~~88. The scaffold device of claim 82, wherein said stack is a member of a plurality of stacks.~~

~~89. The scaffold device of claim 86, wherein the inlets and the outlets of the first paired layers combine to form a first master inlet and a first master outlet, respectively, and the inlets and the outlets of the second paired layers combine to form a second master inlet and a second master outlet, respectively.~~

~~90. The scaffold device of claim 87, wherein the device is disposed in a closed compartment such that only the master inlets and the master outlets are externally accessible.~~

~~91. The scaffold device 1, wherein the device is encapsulated, or suspended, in a hydrogel to promote cell development therein.~~

~~92. The scaffold device 89, wherein the hydrogel comprises induced stem cells including one or more member selected from totipotent cells (iTC), pluripotent cells (iPSC), progenitor cells (iMSC), or combinations thereof.~~

~~93. The scaffold device of claim 90, wherein a first type of induced stem cell is initially included in the hydrogel and at least one of the other induced stem cells is post-populated in the hydrogel.~~

~~94. The scaffold device according to any one of claims 1-90, wherein a thin film of collagen is disposed on the device.~~

~~95. The scaffold device of claim 92, wherein the thin film of collagen is disposed inside the device.~~

~~96. The scaffold device of claim 92, wherein the thin film of collagen is disposed inside or on the exchange mechanism.~~

~~97. The scaffold device according to any one of claims 92-94, wherein the thin film of collagen has a thickness from about 0.1 μm to about 100 μm.~~

~~98. The scaffold device of claim 1, wherein cells are disposed on the device simultaneous to fabrication of the device.~~

~~99. The scaffold device of either claims 1 or 96, wherein cells are disposed surrounding the device after fabrication of the device.~~

~~100. The scaffold device of claim 1, wherein cells develop around the device after fabrication of the device.~~

~~101. A scaffold device of any of claim 92 to 98, wherein the cells are nourished by an exchange mechanisms of the device.~~

~~102. The scaffold device of claim 98, wherein the cells are derived from, or develop into, complex tissue.~~

~~103. The scaffold device of claim 98, wherein the cells encapsulate the device in three dimensions.~~

104. The scaffold device of claim 101, wherein the device is consumed, deteriorates, dissolves, or a combination thereof after a predetermined time period.

105. The scaffold device of claim 101, wherein the device is consumed, deteriorates, dissolves, or a combination thereof after the cells have reach a predetermined maturity or cell density.

106. The scaffold device of claim 101, wherein the device is consumed, deteriorates, dissolves, or a combination thereof due to a photochemical reaction.

107. The scaffold device of claim 102, wherein the predetermined time is related to a chemical equation or equilibrium.

108. The scaffold device of claim 101, wherein after the device is consumed, deteriorates, or dissolves cells are seeded into a resulting structure.

109. A cell-scaffold device having a fractal structure utilized for growing tissue, wherein the device comprises:

a plurality of stackable units, or stacks, each stack comprising:

a first channel network; and

a second channel network disposed below the first channel network,

wherein each channel network comprises:

an inlet;

a plurality of channels comprising:

a parent channel having a first end portion in communication with the inlet and a second end portion in communication with a first bifurcation, thereby forming two child channels,

each child channel having a first end portion in communication with a respective end portion of the first bifurcation and a second end portion in communication with a second bifurcation, thereby forming two grand-child channels from each child channel, and

each grand-child channel having a first end portion in communication with a respective end portion of the second bifurcation and a second end portion, wherein the second end portion of the grand-child channel either forms an outlet or a third child channel in communication with the grand-child channel,

wherein each bifurcation comprises a ramp or step at a front end portion thereof, such that each layer has a flush surface,

wherein each stack communicates with an adjacent stack by an exchange mechanism therebetween.

110. The scaffold device of claim 109, wherein:

the first channel network is a hepatobiliary network; and

the second channel network is a portal venous network.

111. A cell-scaffold device having a fractal structure utilized for growing tissue, wherein the device comprises:

a plurality of stackable units, each unit comprising:

a first channel network configured as inflow;

a second channel network and disposed below the first channel network;

a third channel network configured as an outflow and disposed below the second channel network; and

a fourth channel network disposed below the third network,

wherein each layer comprises:

an inlet;

a plurality of channels comprising:

a parent channel having a first end portion in communication with the inlet and a second end portion in communication with a first bifurcation, thereby forming two child channels,

each child channel having a first end portion in communication with a respective end portion of the first bifurcation and a second end

~~portion in communication with a second bifurcation, thereby forming two grand-child channels from each child channel, and each grand-child channel having a first end portion in communication with a respective end portion of the second bifurcation and a second end portion, wherein the second end portion of the grand-child channel either forms an outlet or a third child channel in communication with the grand-child channel,~~

~~wherein,~~

~~the outlets of the first layer communicate with the outlets of the third layer,~~

~~the outlets of the fourth layer and the second layer and are self-contained, and~~

~~each bifurcation comprises a ramp or step at a front end portion thereof, such that each layer has a flush surface,~~

~~wherein each stack communicates with an adjacent stack by an exchange mechanism therebetween.~~

~~112. The scaffold device of claim 109, wherein:~~

~~the first channel network is a hepatobiliary inflow network;~~

~~the second channel network is a portal venous inflow and outflow network;~~

~~the third channel network is a hepatobiliary outflow network; and~~

~~the fourth channel network is a portal venous inflow and outflow network.~~

1. A cell-scaffold device comprising:

a plurality of branching channel networks comprising

a first branching channel network,

a second branching channel network, and

a third branching channel network,

wherein the first branching channel network comprises a plurality of first channels formed by at least three generations of branching, the plurality of first channels comprising a first-generation first channel and a plurality of final-generation first channels;

the second branching channel network comprises a plurality of second channels formed by branching and recursive recombination, the plurality of second channels comprising an inlet second channel, an outlet second channel and a plurality of intermediate second channels branched from the inlet second channel and recursively recombined to the outlet second channel, wherein one or more second channels in the plurality of second channels are located in a first layer and one or more other second channels in the plurality of second channels are located in a second layer that is different than the first layer;

the third branching channel network comprises a plurality of third channels formed by at least three generations of branching, the plurality of third channels comprising a first-generation third channel and a plurality of final-generation third channels; and

the plurality of final-generation first channels of the first branching channel network is disposed adjacent to the first layer of the second branching channel network, the plurality of final-generation third channels of the third branching channel network is disposed adjacent to the second layer of the second branching channel network, the plurality of final-generation first channels of the first branching channel network and the plurality of final-generation third channels of the third branching channel network are connected with each other by a plurality of bypass channels, and each of the plurality of bypass channels bypasses the second branching channel network , thereby producing a compact three-dimensional structure with interwoven channels.

2. The cell-scaffold device of claim 1, wherein each respective branching channel network is formed from a non-resorbable material, a biodegradable material, a resorbable material, or a combination thereof.

3. The cell-scaffold device of claim 1, wherein diameters of channels in the plurality of first, second, or third channels formed by branching obey Murray’s Law.

4. The cell-scaffold device according to any one of claims 1-3, wherein for a respective channel in the plurality of first, second, or third channels, a ratio of a diameter to a length of the respective channel is fixed along the respective channel.

5. The cell-scaffold device of claim according to any one of claims 1-3, wherein each respective branching channel network is configured to exhibit laminar flow of a medium located therein.

6. The cell-scaffold device of claim 1, further comprising an exchange mechanism interposing between a respective branching channel network and an adjacent corresponding branching channel network in the plurality of branching channel networks.

7. The cell scaffold device of claim 1, wherein a film of collagen is disposed on the cell scaffold device.

8. The cell scaffold device of claim 1, wherein the plurality of branching channel networks comprises an even number of branching channel networks greater than or equal to four.

9. The cell scaffold device of claim 1, wherein each channel of a respective branching channel network in the plurality of branching channel networks comprises a cross-sectional aspect ratio of one.

10. The cell scaffold device of claim 1, wherein a diameter of the inlet second channel is predetermined.

11. The cell scaffold device of claim 1, further comprising a polyhedron exterior surface configured to encompass the plurality of branching channel networks.

12. The cell scaffold device of claim 1, wherein one or more first channels of the first branching channel network are disposed adjacent to the one or more second channels located in the first layer of the second branching channel network to facilitate fluid communication between the first and second branching channel networks.

13. The cell scaffold device of claim 1, further comprising:

a first master inlet, wherein one of the first-generation first channel and the first-generation third channel is connected to the first master inlet;

a first master outlet, wherein the other of the first-generation first channel and the first-generation third channel is connected to the first master outlet;

a second master inlet, wherein the inlet second channel is connected to the second master inlet; and

a second master outlet, wherein the outlet second channel is connected to the second master outlet.

14. The cell scaffold device of claim 1, wherein each of the first, second and third channels is a pipe-like channel with a wall surrounding a hollow interior.

15. The cell scaffold device of claim 1, wherein a diameter of a smallest channel in the plurality of first, second, or third channels is predetermined.