

Claims

1. A circulation system (1), which is self-contained and comprises:
 - a. at least one capillary growth section (2), comprising at least two micro inlets (3) and two micro outlets (4),
 - b. a directional pumping device (5), and
 - c. an arteriolar transport channel (6) connecting the directional pumping device (5) and the at least two inlets (3) and a venular transport channel (7) connecting the directional pumping device (5) and the at least two outlets (4).
2. The circulation system (1) of claim 1, wherein the circulation system (1) comprises at least two capillary growth sections (2).
3. The circulation system (1) of any of claim 1 or 2, wherein one capillary growth section (2) is at least in part gas permeable.
4. The circulation system (1) of any of claims 1 to 3, wherein the capillary growth section (2) comprises or consists of a semi-solid, biocompatible matrix (8) and/or semi-solid, biocompatible hollow fibres (9).
5. The circulation system (1) of claim 4, wherein the biocompatible matrix (8) comprises micro channels, structures and/or networks, which allow formation of capillaries (14) by endothelial cells.
6. The circulation system (1) of any claim 1 to 5, wherein a section of the capillary growth section (2) is devoid of micro inlets (3) and outlets (4).
7. The circulation system (1) of any of claims 1 to 6, wherein the capillary growth section (2) further comprises an extra-capillary fluid and/or waste collector (10).
8. The circulation system (1) of any of claims 1 to 7, wherein the extra-capillary fluid and/or waste collector (10) is separated from the biocompatible matrix (8) and/or biocompatible hollow fibre (9) by a cell retention membrane or by cell exclusion channels (11).

9. The circulation system (1) of claim 8, wherein at least one sensor (12) is arranged in the extra capillary fluid and/or waste collector (10).

5 10. The circulation system (1) according to any of claims 1 to 9, further comprising capillaries (14) and/or organoids (15) formed in the capillary growth section (2).

11. The circulation system (1) according to any of claims 1 to 10, wherein two or more different tissues and/or organoids (15) are maintained within one self-contained system,
10 which are perfused by the same circulating fluid.

12. The circulation system (1) according to any of claims 1 to 11, wherein a sub-section (16) within the capillary growth section (2) is provided which is devoid of micro inlets (3) and outlets (4).

15 13. The circulation system (1) according to claim 12, wherein the sub-section (16) is sufficiently far removed from corresponding micro inlets (3) and micro outlets (4) such that the formation of capillaries (14) is impaired in this sub-section.

20 14. The circulation system (1) according to claim 12 or 13, wherein the sub-section (16) has a distance from at least 100 μm and up to 500 μm , preferably 100 μm to 300 μm , from the micro inlets (3) and/or micro outlets (4).

15. The circulation system (1) according to any of claims 1 to 14, wherein the arteriolar transport channel (6) branches of at least once to connect with the at least two inlets (3), and the venular transport channel (7) branches of at least once to connect with the at least two outlets (4), respectively.

25 16. The circulation system (1) of claim 15, wherein the combined cross-sectional area of the arteriolar channels after the branching point (13) is essentially identical to the cross-sectional area of the arteriolar channel in front of the branching point (13) and/or the combined cross-sectional area of the venular transport channels (7) after the branching point (13) is essentially identical to the cross-sectional area of the venular channel in front of the branching point (13).
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17. The circulation system (1) of claim 15 or 16, wherein the combined cross-sectional area of all inlets (3) is essentially identical to the cross-sectional area of said arteriolar channel and/or arteriolar channels and the combined cross-sectional area of all outlets (4) is essentially identical to the cross-sectional area of said venular channel and/or venular channels, preferably are the cross-sectional areas of arteriolar and venular channels identical.

18. A method of establishing a circulation system (1) according to any of claims 1 to 17, comprising the steps of

- a. seeding endothelial cells into the circulation system (1), and
- b. incubating at least until capillaries (14) have formed in the capillary growth section (2) and/or until an endothelial cell layer has formed in the transport channels and/or until an endothelial cell layer has covered all inner surfaces of the pumping device (5).

19. The method of establishing a circulation system (1) according to claim 18, wherein the method further comprises the step of injecting whole blood into said circulation system.

20. The method of establishing a circulation system (1) according to any of claim 18 or 19, wherein step b) is carried out under shear force.

21. The circulation system (1) producible by the method of any of claims 18 to 20.

22. Use of the circulation system (1) according to claims 1 to 17 or claim 21 for monitoring the effect of one or more test compounds and/or for determination the efficacy, side-effects, biosafety, metabolites, mode of action or organ regeneration.

Claims

1. A circulation system (1), which is self-contained and comprises:
 - a. at least one capillary growth section (2), comprising at least two micro inlets (3) and two micro outlets (4),
 - b. a directional pumping device (5), and
 - c. an arteriolar transport channel (6) connecting the directional pumping device (5) and the at least two inlets (3) and a venular transport channel (7) connecting the directional pumping device (5) and the at least two outlets (4),wherein a sub-section (16) within the capillary growth section (2) is provided which is devoid of micro inlets (3) and outlets (4) and wherein the sub-section (16) is sufficiently far removed from corresponding micro inlets (3) and micro outlets (4) such that the formation of capillaries (14) is impaired in this sub-section, wherein the sub-section (16) has a distance from at least 100 μm and up to 500 μm from the micro inlets (3) and/or micro outlets (4).
2. The circulation system (1) of claim 1, wherein the circulation system (1) comprises at least two capillary growth sections (2).
3. The circulation system (1) of any of claim 1 or 2, wherein one capillary growth section (2) is at least in part gas permeable.
4. The circulation system (1) of any of claims 1 to 3, wherein the capillary growth section (2) comprises or consists of a semi-solid, biocompatible matrix (8) and/or semi-solid, biocompatible hollow fibres (9), wherein the biocompatible matrix (8) optionally comprises micro channels, structures and/or networks, which allow formation of capillaries (14) by endothelial cells.
5. The circulation system (1) of any of claims 1 to 4, wherein the capillary growth section (2) further comprises an extra-capillary fluid and/or waste collector (10).
6. The circulation system (1) of any of claims 4 to 5, wherein the extra-capillary fluid and/or waste collector (10) is separated from the biocompatible matrix (8) and/or biocompatible hollow fibre (9) by a cell retention membrane or by cell exclusion channels (11) and wherein optionally at least one sensor (12) is arranged in the extra capillary fluid and/or waste collector (10).
7. The circulation system (1) according to any of claims 1 to 6, further comprising capillaries (14) and/or organoids (15) formed in the capillary growth section (2).
8. The circulation system (1) according to any of claims 1 to 7 wherein two or more different tissues and/or organoids (15) are maintained within one self-contained system, which are perfused by the same circulating fluid.

9. The circulation system (1) according to claim 1 to 8, wherein the sub-section (16) has a distance from 100 μ m to 300 μ m from the micro inlets (3) and/or micro outlets (4).
10. The circulation system (1) according to any of claims 1 to 9, wherein the arteriolar transport channel (6) branches of at least once to connect with the at least two inlets (3), and the venular transport channel (7) branches of at least once to connect with the at least two outlets (4), respectively.
11. The circulation system (1) of claim 10, wherein
- a. the combined cross-sectional area of the arteriolar channels after the branching point (13) is essentially identical to the cross-sectional area of the arteriolar channel in front of the branching point (13) and/or the combined cross-sectional area of the venular transport channels (7) after the branching point (13) is essentially identical to the cross-sectional area of the venular channel in front of the branching point (13) and/or
 - b. the combined cross-sectional area of all inlets (3) is essentially identical to the cross-sectional area of said arteriolar channel and/or arteriolar channels and the combined cross-sectional area of all outlets (4) is essentially identical to the cross-sectional area of said venular channel and/or venular channels, preferably are the cross-sectional areas of arteriolar and venular channels identical.
12. A method of establishing a circulation system (1) according to any of claims 1 to 11, comprising the steps of
- a. seeding endothelial cells into the circulation system (1), and
 - b. incubating at least until capillaries (14) have formed in the capillary growth section (2) and/or until an endothelial cell layer has formed in the transport channels and/or until an endothelial cell layer has covered all inner surfaces of the pumping device (5).
13. The method of establishing a circulation system (1) according to claim 12, wherein
- (a) the method further comprises the step of injecting whole blood into said circulation system or
 - (b) step b) is carried out under shear force.
14. Use of the circulation system (1) according to claims 1 to 11 for monitoring the effect of one or more test compounds and/or for determination the efficacy, side-effects, biosafety, metabolites, mode of action or organ regeneration.