Claims

1. A self-contained organ-on-a-chip device (1) comprising:
   (a) at least one medium feed reservoir (2), and
   (b) at least one organ growth section (3) comprising at least one organ cavity (4, 4a, 4b), and

   wherein the medium feed reservoir (2) is connected to the at least one organ growth section (3) by a microfluidic feed channel (6) and the at least one organ cavity (4, 4a, 4b).

2. A self-contained organ-on-a-chip device (1) comprising
   (a) at least one organ growth section (3) comprising at least one organ cavity (4, 4a, 4b), and
   (b) wherein the at least one organ cavity (4, 4a, 4b) comprises and/or is connected to at least one sensor (8, 8a, 8b).

3. The self-contained organ-on-a-chip device (1) according to claim 2, further comprising at least one medium feed reservoir (2) wherein the medium feed reservoir (2) is connected to the at least one organ growth section (3) by a microfluidic feed channel (6) and the at least one organ cavity (4, 4a, 4b).

4. The self-contained organ-on-a-chip device (1) of claims 1 to 3, wherein the organ growth section (3) comprises a stem cell cavity (9).

5. A self-contained organ-on-a-chip device (1) comprising:
   (a) at least one organ growth section (3) comprising at least one organ cavity (4, 4a, 4b), and
   (b) wherein the organ growth section (3) comprises a stem cell cavity (9).

6. The self-contained organ-on-a-chip device (1) according to claim 5, further comprising at least and one medium feed reservoir (2), wherein the medium feed reservoir (2) is connected to the at least one organ growth section (3) by a microfluidic feed channel (6).

7 The self-contained organ-on-a-chip device (1) according to claims 1 to 6, further comprising at least one medium waste reservoir (5), wherein the at least one organ cavity

(4, 4a, 4b) is connected to the at least one medium waste reservoir (5) by a microfluidic waste channel (7).

8. The self-contained organ-on-a-chip device (1) according to claims 1 to 7, wherein at least one sensor (8, 8a, 8b) is arranged between the at least one organ cavity (4, 4a, 4b) and at least one medium waste reservoir (5) and/or within the at least one organ cavity.

9. The self-contained organ-on-a-chip device (1) of claims 4 to 8, wherein the stem cell cavity (9) has a diameter of less than 100 µm.

10. The self-contained organ-on-a-chip device (1) of claims 4 to 9, wherein the stem cell cavity is cylindrical.

11. The self-contained organ-on-a-chip device (1) of claims 4 to 10, wherein the stem cell cavity is fluidly connected to the at least one organ cavity (4, 4a, 4b) by an opening of less than 80 µm.

12. The self-contained organ-on-a-chip device (1) of claims 1 to 11, wherein the organ cavity (4) comprises structures selected from the group consisting of:

(a) biodegradable micro-carriers;
(b) pressurizing means;
(c) a collagen web;
(d) calcification zones;
(e) capillaries connected to a further medium feed reservoir;
(f) at least two reservoirs each provided with a pulsative pressurizing means for providing a secondary flow through the organ cavity;
(g) one or more electrodes;
(h) fibrin gels;
(i) synthetic polypeptide gels;
(j) cross linked proteins;
(k) woven and/or non woven polymeric fibres;
(l) electromagnetic field forces;
(m) micropumps;
(n) sensor substances;
(o) sensors; and

(p) optical fibres.

13. The self-contained organ-on-a-chip device (1) of claims 1 to 12, wherein the growth section comprises two or more organ cavities (4, 4a, 4b), that are radially arranged with respect to an outlet (10) of the microfluidic feed channel (6).

14. The self-contained organ-on-a-chip device (1) of claim 13, wherein the organ cavities (4, 4a, 4b) are in the form of conical segments of a disc.

15. The self-contained organ-on-a-chip device (1) of claims 13 or 14, wherein the stem cell cavity (9) is arranged opposite the outlet (10) of the microfluidic feed channel (6).

16. The self-contained organ-on-a-chip device (1) of claims 1 to 15, wherein the one or more organ cavities (4, 4a, 4b) and/or the at least one sensor (8, 8a, 8b) are microscopable.

17. The self-contained organ-on-a-chip device (1) of claims 2 to 16, wherein the stem cell cavity (9) is microscopable.

18. The self-contained organ-on-a-chip device (1) of claims 1 to 17, wherein the sensor (8, 8a, 8b) is selected from the group consisting of:

(a) pH sensor;
(b) pO_2 sensor;
(c) analyte capture sensor;
(d) conductivity sensor;
(e) plasmon resonance sensor;
(f) temperature sensor;
(g) CO_2 sensor;
(h) NO sensor;
(i) chemotaxis sensor;
(j) cytokine sensor;
(k) ion sensor;
(l) potentiometric sensor;
(m) amperometric sensor;
(n) flow-through-sensor;
(o) fill sensor;

(p) impedance sensor;
(q) conductivity sensor;
(r) electromagnetic field sensor;
(s) surface acoustic wave (SAW) sensor; and
(t) metabolic sensor

19. The self-contained organ-on-a-chip device (1) of claims 1 to 18, wherein two or more sensors (8, 8a, 8b) are arranged in the flow path from one organ cavity (4) to the medium waste reservoir (5).

20. The self-contained organ-on-a-chip device (1) of claims 1 to 19, wherein the medium waste reservoir (5) comprises a hydrophilic material and/or a micro pump is arranged in the flow path between the medium feed reservoir (2) and the medium waste reservoir (5).

21. The self-contained organ-on-a-chip device (1) of claims 1 to 20, further comprising heating means, arranged to heat the at least one medium feed reservoir (2) and/or the at least one organ cavity (4, 4a, 4b).

22. The self-contained organ-on-a-chip device (1) of claim 21, further comprising heating means (11), arranged to heat the at least one medium feed reservoir (2) and/or the at least one organ cavity (4, 4a, 4b).

23. The self-contained organ-on-a-chip device (1) of claim 22, wherein the heating means (11) consist of indium tin oxide, platinum and gold.

24. The self-contained organ-on-a-chip device (1) of claims 1 to 23, further comprising a temperature sensor arranged to determine the temperature in the at least one medium feed reservoir (2) and/or the at least one organ cavity (4, 4a, 4b).

25. The self-contained organ-on-a-chip device (1) of claims 1 to 24, wherein the device comprises at least a medium layer (12) and an organ growth section layer (13).

26. The self-contained organ-on-a-chip device (1) of claim 25, wherein the medium feed reservoirs (2) and/or the medium waste reservoirs (5) are arranged in the medium layer (12).

27. The self-contained organ-on-a-chip device (1) of claims 25 or 26, wherein the medium layer (12) comprises one or more openings each allowing access to an organ growth section (3), preferably an organ cavity (4) and/or stem cell cavity (9).

28. The self-contained organ-on-a-chip device (1) of claims 25 to 27, wherein the organ growth section layer comprises an upper closing layer (14), an organ cavity layer (15) and a lower closing layer (16).

29. The self-contained organ-on-a-chip device (1) of claim 28, wherein the upper closing layer (14) comprises one or more openings each allowing access to an organ growth section (3), preferably an organ cavity (4) and/or stem cell cavity (9) and optionally organ specific surface structures in the area of an organ growth section (3).

30. The self-contained organ-on-a-chip device (1) of claim 29, wherein the organ cavity layer (15) comprises one or more organ cavities (4, 4a, 4b) and/or stem cell cavities (9) and optionally micro-fluidic channels.

31. The self-contained organ-on-a-chip device (1) of claim 30, wherein the lower closing layer (16) comprises one or more of the following: heating means (11), temperature sensing means (23), or electric connectors for connecting the device to corresponding electric connectors (19) of a holding means (18).

32. The self-contained organ-on-a-chip device (1) of claims 1 to 31, wherein the medium reservoir (2) comprises a cell growth medium.

33. A method of manufacturing a self-contained organ-on-a-chip device (1) of claims 1 to 32, comprising the steps of bonding a medium layer (12) fluid-tight to a growth section layer (13) or parts thereof.

34. A supply unit (17) for holding the self-contained organ-on-a-chip device (1) of claims 1 to 33 during operation comprising:

(a) holding means (18) for releasably engaging the self-contained organ-on-a-chip device (1), and

(b) electric connectors (19) for connecting to corresponding connectors on the self-contained organ-on-a-chip device (1) to the supply unit (17).

35. The supply unit (17) of claim 34, further comprising indicator means.

36. The supply unit (17) of claim 34 or 35, further comprising regulating means.

37. The supply unit (17) of claims 34 to 36, configured to hold at least two organ-on-a-chip devices (1) on top of each other.

38. A method of establishing an organ and/or organoid in a self-contained organ-on-a-chip device (1) of claims 1 to 32, comprising the steps of:

(a) loading a suspension of cells or a tissue slice into one or more organ cavities (4, 4a, 4b), and

(b) fluid-tight sealing of the one or more organ cavities (4, 4a, 4b).

39. The method of claim 38, wherein the suspension of cells comprises totipotent or pluripotent stem cells, lineage committed cells, differentiated cells, extracellular matrix components or mixtures thereof.

40. The method of claim 38 or 39, wherein fibrin glue, biocompatible polymer foil spray-on bandage, or products of coagulation is used in step (b).

41. The method of claims 38 to 40, comprising the further step of incubating the self-contained organ-on-a-chip device (1) until an organ or organoid is formed.

42. The method of claim 41, wherein the incubation is carried out without external control of the temperature, and/or without providing a defined atmosphere and/or without providing external sterility.

43. A method of testing the effect of one or more test compounds on one or more organs and/or organoids established in a self-contained organ-on-a-chip device (1) of claims 1 to 32, comprising:

(a) providing a self-contained organ-on-a-chip device (1) of claims 1 to 32 comprising one or more organs and/or organoids or

carrying out the method of establishing an organ and/or organoid in a self-contained organ-on-a-chip device (1) of claims 38 to 42,

(b) adding one or more test compounds to the organ and/or organoid

(c) assessing the organ and/or organoid microscopically; and/or

determining one or more parameter determinable by one or more sensors (8, 8a, 8b).

44. Use of the self-contained organ-on-a-chip device (1) of claims 1 to 32 comprising one or more organs and/or organoids for testing the effects of one or more test compounds on the organs or organoids or for examining organ or organoid functions.

45. Use of claim 44, wherein the efficacy, side-effects, biosafety or mode of action of the one or more test compounds is determined.

Claims

1. A self-contained organ-on-a-chip device (1) comprising:

   (a) at least one medium feed reservoir (2),

   (b) at least one organ growth section (3) comprising a stem cell cavity (9) and at least one organ cavity (4, 4a, 4b), wherein the stem cell cavity (9) is fluidically connected to the at least one organ cavity (4, 4a, 4b),

   (c) at least one medium waste reservoir (5), and

   wherein the medium feed reservoir (2) is connected to the at least one organ growth section (3) by a microfluidic feed channel (6) and the at least one organ cavity (4, 4a, 4b) which is connected to the at least one medium waste reservoir (5) by a microfluidic waste channel (7).

2. The self-contained organ-on-a-chip device (1) according to claim 1, wherein at least one sensor (8, 8a, 8b) is arranged between the at least one organ cavity (4, 4a, 4b) and at least one medium waste reservoir (5) and/or within the at least one organ cavity.

3. The self-contained organ-on-a-chip device (1) of claims 1 or 2, wherein the stem cell cavity (9) has a diameter of less than 100 mm.

4. The self-contained organ-on-a-chip device (1) of claims 1 to 3, wherein the organ cavity (4) comprises structures selected from the group consisting of:

   (a) biodegradable micro-carriers;

   (b) pressurizing means;

   (c) a collagen web;

   (d) calcification zones;

   (e) capillaries connected to a further medium feed reservoir;

   (f) at least two reservoirs each provided with a pulsative pressurizing means for providing a secondary flow through the organ cavity;

   (g) one or more electrodes;

   (h) fibrin gels;

   (i) synthetic polypeptide gels;

   (j) cross linked proteins;

   (k) woven and/or non woven polymeric fibres;

   (l) electromagnetic field forces;

   (m) micropumps;

   (n) sensor substances;

(o) sensors; and

(p) optical fibres.

5. The self-contained organ-on-a-chip device (1) of claims 1 to 4, wherein the growth section comprises two or more organ cavities (4, 4a, 4b), that are radially arranged with respect to an outlet (10) of the microfluidic feed channel (6).

6. The self-contained organ-on-a-chip device (1) of claims 1 to 5, wherein the one or more organ cavities (4, 4a, 4b) and/or the at least one sensor (8, 8a, 8b) are microscopable.

7. The self-contained organ-on-a-chip device (1) of claims 1 to 6, wherein the sensor (8, 8a, 8b) is selected from the group consisting of:

(a) pH sensor;

(b) pO_2 sensor;

(c) analyte capture sensor;

(d) conductivity sensor;

(e) plasmon resonance sensor;

(f) temperature sensor;

(g) CO_2 sensor;

(h) NO sensor;

(i) chemotaxis sensor;

(j) cytokine sensor;

(k) ion sensor;

(l) potentiometric sensor;

(m) amperometric sensor;

(n) flow-through-sensor;

(o) fill sensor;

(p) impedance sensor;

(q) conductivity sensor;

(r) electromagnetic field sensor;

(s) surface acoustic wave (SAW) sensor; and

(t) metabolic sensor

8. The self-contained organ-on-a-chip device (1) of claims 1 to 7, wherein two or more sensors (8, 8a, 8b) are arranged in the flow path from one organ cavity (4) to the medium waste reservoir (5).

9. A method of manufacturing a self-contained organ-on-a-chip device (1) of claims 1 to 8, comprising the steps of bonding a medium layer (12) fluid-tight to a growth section layer (13) or parts thereof.

10. A supply unit (17) holding the self-contained organ-on-a-chip device (1) of claims 1 to 8 further comprising:

(a) holding means (18) for releasably engaging the self-contained organ-on-a-chip device (1), and

(b) electric connectors (19) for connecting to corresponding connectors on the self-contained organ-on-a-chip device (1) to the supply unit (17).

11. The supply unit (17) of claim 10, further comprising indicator means and/or regulating means.

12. A method of establishing an organ and/or organoid in a self-contained organ-on-a-chip device (1) of claims 1 to 8, comprising the steps of:

(a) loading a suspension of cells or a tissue slice into one or more organ cavities (4, 4a, 4b), and

(b) fluid-tight sealing of the one or more organ cavities (4, 4a, 4b).

13. A method of testing the effect of one or more test compounds on one or more organs and/or organoids established in a self-contained organ-on-a-chip device (1) of claims 1 to 8, comprising:

(a) providing a self-contained organ-on-a-chip device (1) of claims 1 to 8 comprising one or more organs and/or organoids or carrying out the method of establishing an organ and/or organoid in a self-contained organ-on-a-chip device (1) of claim 12,

(b) adding one or more test compounds to the organ and/or organoid

(c) assessing the organ and/or organoid microscopically; and/or determining one or more parameter determinable by one or more sensors (8, 8a, 8b).

14. Use of the self-contained organ-on-a-chip device (1) of claims 1 to 8 comprising one or more organs and/or organoids for testing the effects of one or more test compounds on the organs or organoids or for examining organ or organoid functions.