

CLAIMS

1. A microfluidic device comprising:
an insert comprising a first central channel;
a base comprising a second central channel, a third side channel, a fourth side channel, a fifth passage channel connecting the second central channel and the third side channel, and a sixth passage channel connecting the second central channel and the fourth side channel; and
a porous membrane positioned between the insert and the base.
2. The microfluidic device according to claim 1, wherein the insert is detachable from the base.
3. The microfluidic device according to claim 1 or 2, wherein the base comprises a groove into which the insert is capable of being inserted.
4. The microfluidic device according to any one of claims 1-3, wherein the insert comprises a first fastening head,
the base comprises a second fastening head, and
the first fastening head and the second fastening head are hooked to each other so that the insert and the base are attached and detached by a snap fit.
5. The microfluidic device according to any one of claims 1-4, wherein the third side channel and the fourth side channel do not contact the porous membrane.
6. The microfluidic device according to any one of claims 1-5, wherein the first central channel, the second central channel, the third side channel, and the fourth side channel comprise an inlet and an outlet capable of inducing and controlling the perfusion of the liquid agent.
7. The microfluidic device according to any one of claims 1-6, wherein the fifth passage channel and the sixth passage channel have a lower channel height than the second central channel, the third side channel, and the fourth side channel.
8. The microfluidic device according to any one of claims 1-7, wherein the base further comprises a first fluid reservoir and a second fluid reservoir.

9. The microfluidic device according to claim 8, wherein the base comprises a seventh passage channel connecting the third side channel and the first fluid reservoir, and an eighth passage channel connecting the fourth side channel and the second fluid reservoir.
10. The microfluidic device according to claim 9, wherein the seventh passage channel and the eighth passage channel have a lower channel height than the second central channel, the third side channel, and the fourth side channel.
11. The microfluidic device according to claim 9 or 10, wherein the seventh passage channel and the eighth passage channel are formed perpendicular to the direction of the second central channel.
12. The microfluidic device according to any one of claims 1-11, wherein the microfluidic device is made of plastic, glass, metal, or silicon.
13. The microfluidic device according to any one of claims 1-12, wherein the first central channel comprises tissue barrier cells.
14. The microfluidic device according to claim 13, wherein the tissue barrier cells are one or more selected from the group consisting of vascular endothelial cells; skin cells; cancer cells; secretory gland cells; muscle cells; and epithelial cells of bronchi, large intestine, small intestine, pancreas, or kidney.
15. The microfluidic device according to any one of claims 1-14, wherein the second central channel comprises internal tissue cells and hydrogel.
16. The microfluidic device according to claim 15, wherein the internal tissue cells are one or more selected from the group consisting of astrocytes, pericytes, nerve cells, neural stem cells, glial cells, cardiac myocytes, smooth muscle cells, intestinal epithelial cells, keratinocytes, skin fibroblasts, podocytes, and glomerular endothelial cells.
17. The microfluidic device according to claim 15 or 16, wherein the hydrogel is one or more selected from the group consisting of collagen, laminin, hyaluronic acid, mineral, fibrin,

fibronectin, elastin, peptide, polyethylene glycol, and alginate.

18. The microfluidic device according to wherein 1-17, wherein each of one or more cells selected from the group consisting of cells included in the first central channel, cells included in the second central channel, and cells attached to the porous membrane is capable of being separated by separating the insert from the base.

19. A method of culturing cells in a microfluidic device, the method comprising:
a step of assembling a microfluidic device, wherein the microfluidic device comprises an insert comprising a first central channel; a base comprising a second central channel, a third side channel, and a fourth side channel; and a porous membrane positioned between the insert and the base, wherein the insert is detachable from the base;
a step of injecting second cells into the second central channel and then inverting the microfluidic device and culturing them;
a step of injecting hydrogel comprising third cells into the second central channel and then culturing them; and
a step of inverting the microfluidic device and then injecting first cells into the first central channel and culturing them.

20. The method of culturing cells in a microfluidic device according to claim 19, wherein the first central channel, the second central channel, the third side channel, and the fourth side channel comprise an inlet and an outlet capable of inducing and controlling the perfusion of the liquid agent,

the second cells and the hydrogel comprising the third cells are injected through the inlet of the second central channel, and

the first cells are injected through the inlet of the first central channel.

21. The method of culturing cells in a microfluidic device according to claim 19 or 20, wherein the first cells are selected from the group consisting of vascular endothelial cells; skin cells; cancer cells; secretory gland cells; muscle cells; and epithelial cells of bronchi, large intestine, small intestine, pancreas, or kidney;

the second cells are selected from the group consisting of pericytes, glial cells, cardiac myocytes, smooth muscle cells, intestinal epithelial cells, keratinocytes, skin fibroblasts, podocytes, and glomerular endothelial cells; and

the third cells are selected from the group consisting of astrocytes, nerve cells, and neural stem cells.

22. A method of simulating an organ or a body part in a microfluidic device, wherein the microfluidic device is comprising an insert comprising a first central channel; a base comprising a second central channel, a third side channel, a fourth side channel, a first fluid reservoir, and a second fluid reservoir; and a porous membrane positioned between the insert and the base, wherein the insert is detachable from the base, wherein the method comprises

a step of perfusing a first fluid through the first central channel; and

a step of injecting a second fluid into the first fluid reservoir to sequentially reach the third side channel, the second central channel, the fourth side channel, and the second fluid reservoir.

23. The method of simulating an organ or a body part according to claim 22, wherein the base further comprises a fifth passage channel connecting the second central channel and the third side channel, a sixth passage channel connecting the second central channel and the fourth side channel, a seventh passage channel connecting the third side channel and the first fluid reservoir, and an eighth passage channel connecting the fourth side channel and the second fluid reservoir.

24. The method of simulating an organ or a body part according to claim 22 or 23, wherein the first fluid is perfused with a shear stress of 1 to 10 dyne/cm².

25. The method of simulating an organ or a body part according to any one of claims 22-24, wherein the flow rate of the second fluid is maintained at 1 to 100 µl/h for at least 12 hours by using the hydrostatic pressure difference between the first fluid reservoir and the second fluid reservoir.

26. A method of analyzing physiological, pharmacological or toxicological effects of an agent, said method comprising:

- a) providing a microfluidic device according to Claim 1;
- b) introducing the agent into the microfluidic device; and
- c) evaluating physiological, pharmacological or toxicological effects of the agent.

27. The method of analyzing physiological, pharmacological or toxicological effects of an

agent according to claim 26, wherein the agent is a drug, toxin or pathogen.