CLAIMS

1. A microfluidic device, comprising:

a gel chamber with a gel matrix disposed therein, the gel chamber including an open top surface region;

a fluidic chamber wherein a first interface region is formed between the gel chamber and the fluidic chamber;

a membrane disposed at the first interface region, the membrane including a first side facing the gel chamber and a second side facing the fluidic chamber; and

a movable cover disposed on the gel chamber above the gel matrix, the movable cover configured to provide access to the gel chamber, wherein the movable cover defines an aperture having one end configured to align with the opened top surface region of the gel chamber when the movable cover is disposed on the gel chamber such that a fluid material entering the aperture flows through the movable cover and into the opened top surface region of the gel chamber.

2. The microfluidic device of claim 1, wherein the gel matrix includes fibroblasts and keratinocytes in or on the gel matrix.

3. The microfluidic device of Claim 1, wherein a gel matrix disposed in the gel chamber is secured by structural anchors.

4. A method for creating a patterned gel in a microfluidic device for simulating a tissue microstructure, comprising:

a) providing a gel solution in a device, the device including a first chamber, a second chamber, a removable cover and a membrane separating the first chamber from the second chamber, the first chamber comprising an opened region when the cover is removed;

b) removing the removable cover;

c) placing a plunger stamp into the first chamber through the opened region such that a textured bottom surface of the plunger stamp is in contact with the gel solution within the first chamber, wherein the textured bottom surface includes a pattern of features to be imprinted into the surface of the gel solution;

d) allowing the gel solution to solidify in the first chamber; and

e) removing the plunger stamp from the first chamber, thereby creating a patterned gel to simulate a tissue microstructure in the device.

5. The method of claim 4, wherein the patterned gel includes a biological tissue and/or an artificial tissue.

6. A method of growing fibroblasts and keratinocytes in a microfluidic device, comprising:

a) providing i) living fibroblasts, ii) living keratinocytes, and iii) a microfluidic device comprising first chamber with a extracellular matrix disposed therein and a removable cover disposed above said chamber, the first chamber in fluidic communication with a second chamber including a fluid source, the first and second chamber separated by a membrane;

b) removing said removable cover;

c) seeding the extracellular matrix with the fibroblasts;

d) at least four days after the seeding of step b), seeding the extracellular matrix with the keratinocytes at a ratio of at least 4 keratinocytes to 1 fibroblast; and

e) at least four days after the seeding of step c), initiating an air-liquid interface under conditions such that, after a number of days, keratinocytes are in multiple layers with numerous large cells indicating differentiation.

7. The method of claim 6, wherein the seeding of step b) is at day zero and the seeding of step c) is at day seven, and the initiating of step d) is at day fourteen.

8. The method of one of claims 6 or 7, wherein the keratinocytes are in multiple layers with numerous large cells by day twenty-one.

9. The method of any of claims 6 to 8, wherein at day twenty-one, the fibroblasts express more vimentin and pro-collagen I than fibroblasts cultured in transwells under similar culture conditions for the same period of time.

10. The method of Claim 6, further comprising, before step d), supplying culture fluid to the cells at a flow rate in the second chamber.

11. A method of seeding cells in a microfluidic device, comprising:

(a) providing a microfluidic device comprising a first chamber, the first chamber including a gel matrix disposed therein, and a second chamber, said second chamber separated from the first chamber by a membrane, the gel matrix positioned under a removable cover, said removable cover disposed above said first chamber;

(b) removing the removable cover thereby exposing the gel matrix; and

(c) seeding the gel with cells.

12. The method of claim 11, wherein the gel matrix has a patterned surface.

13. The method of one of claims 11 or 12, wherein the membrane includes endothelial cells.

14. The method of any one of claims 11, 12 or 13, further comprising (d) culturing the cells submerged in culture fluid.

15. The method of Claim 11, wherein the gel matrix is secured by structural anchors.

16. The method of claim 14, further comprising (e) culturing the cells in air without culture media.

17. The method of any one of claims 11, 12 or 13 to 16, wherein said cells are intestinal cells.

18. The microfluidic device of one claims 1 or 2,

wherein the aperture is a channel.

19. The microfluidic device of claim 18, wherein the channel is circular, oval, spiral, or irregularly shaped.