

CLAIMS

1. A microfluidic device comprising:
 - a substrate comprised of an optically transparent material and further comprising
 - i) one or more fluid channels;
 - ii) one or more fluid channel inlets;
 - iii) one or more fluid channel outlets;
 - iv) one or more gel cage regions; and
 - v) a plurality of posts;wherein
 - all or a portion of each gel cage region is flanked by all or a portion of one or more fluid channels, thereby creating one or more gel cage region-fluid channel interface regions; and
 - each gel cage region comprises at least one row of posts which forms the gel cage region, each post of the at least one row of posts forming a triangular shape, a trapezoidal shape or a combination thereof, the sum of a contact angle of a gel on a surface of the substrate and an internal angle of a corner of each post of the at least one row of posts being about 180°, and a distance between each neighboring pair of posts in the at least one row of posts being from about 50 micrometers to about 300 micrometers.
2. The device of Claim 1 wherein each gel cage region forms a gel channel and each gel channel comprises two parallel rows of posts, in which each row of posts is along the length of each gel channel and one row is along one side of the gel channel, and the other row is along the opposite side of the gel channel thereby forming a gel cage region along each length of each gel channel.
3. The microfluidic device of Claim 1 comprising a first fluid channel and a second fluid channel of the one or more fluid channels, wherein a first gel cage region of the one or more gel cage regions forms a gel channel, and
 - wherein

all or a portion of one side of the gel channel is flanked by, and parallel to, all or a portion of the first fluid channel thereby creating a first gel channel-fluid channel interface region;

all or a portion of the other side of the gel channel is flanked by, and parallel to, all or a portion of the second fluid channel thereby creating a second gel channel-fluid channel interface region; and

the gel channel comprises two parallel rows of posts of the at least one row of posts, in which each row of posts is along the length of the gel channel and one row is along one side of the gel channel at the first gel channel-fluid channel interface, and the other row is along the other side of the gel channel at the second gel channel-fluid channel interface, thereby forming the first gel cage region along the length of the gel channel.

4. A high throughput device comprising at least two of the devices of Claim 1 linked together in series, in parallel or in a combination thereof.

5. The microfluidic device of Claim 3 further comprising:

(vii) a second gel cage region of the one or more gel cage regions which forms a second gel channel; and

(viii) a third gel cage region of the one or more gel cage regions which forms a third gel channel
wherein

all or a portion of one side of the second gel channel is flanked by, and parallel to, all or a portion of the first fluid channel thereby creating a third gel channel-fluid channel interface region;

all or a portion of the other side of the second gel channel, is flanked by, and parallel to, all or a portion of the second fluid channel thereby creating a fourth gel channel-fluid channel interface region;

all or a portion of one side of the third gel channel is flanked by, and parallel to, all or a portion of the first fluid channel thereby creating a fifth gel channel-fluid channel interface region;

all or a portion of the other side of the third gel channel, is flanked by, and parallel to, all or a portion of the second fluid channel thereby creating a sixth gel channel-fluid channel interface region;

the second gel channel comprises two parallel rows of posts of the at least one row of posts, in which each row of posts is along the length of the second gel channel and one row is along one side of the second gel channel at the third gel channel-fluid channel interface, and the other row is along the other side of the second gel channel at the fourth gel channel-fluid channel interface, thereby forming the second gel cage region along the length of the second gel channel; and

the third gel channel comprises two parallel rows of posts of the at least one row of posts, in which each row of posts is along the length of the third gel channel and one row is along one side of the third gel channel at the fifth gel channel-fluid channel interface, and the other row is along the other side of the third gel channel at the sixth gel channel-fluid channel interface, thereby forming the third gel cage region along the length of the third gel channel.

6. The device of Claim 5 comprising
at least three fluid channels,
wherein the first gel cage region, the second gel cage region and the third gel cage region are arranged in parallel to one another in the device.
7. The device of Claim 1 further comprising one or more gas channels wherein all or a portion of the one or more gas channels flanks at least one side of the one or more fluid channels, the one or more gel cage regions or a combination thereof.
8. The device of Claim 1 further comprising a membrane that is impermeable to cells and permeable to molecules secreted by cells, wherein one side of the membrane is in contact with the one or more fluid channels, the one or more gel channels or a combination thereof.

9. The device of Claim 8 further comprising a capture agent that specifically binds one or more molecules secreted by a cell, wherein the capture agent is on the opposite side of the membrane and cannot pass through the membrane.

10. The microfluidic device of Claim 1, wherein

a portion of each fluid channel is in contact with a region of the one or more gel cage regions and the remaining portion of each fluid channel extends away from the one or more gel cage region.

11. The device of Claim 10 which comprises three or more fluid channels and one gel cage region.

12. The device of Claim 11 wherein the one or more the fluid channels are in the shape of a "C", a "V", a "U" or combinations thereof, wherein a middle region of each fluid channel contacts the gel cage region and each end of each fluid channel extends away from the gel cage region.

13. The microfluidic device of Claim 1 comprising a first fluid channel and a second fluid channel of the one or more fluid channels, and

an elliptical gel cage region;

wherein

one side of the elliptical gel cage region is flanked by the first fluid channel thereby creating a first gel cage region-fluid channel interface, and the other side of the elliptical gel cage region is flanked by the second fluid channel thereby creating a second gel cage region-fluid channel interface; and

the elliptical gel cage region comprises two parallel rows of posts centrally located in the elliptical gel cage region, thereby creating a central gel chamber; a row of posts arranged in a semicircle along the first gel cage region-fluid channel interface, thereby creating a first gel chamber that flanks one side of the central gel chamber on one side; and a row of posts arranged in a semicircle at the second gel cage region-fluid channel interface, thereby creating a second gel chamber that flanks the other side of the central gel chamber.

14. The device of Claim 13 wherein the central gel cage region, the first gel chamber, the second gel chamber or a combination thereof further comprises tissue.

15. The device of claim 5 comprising at least three fluid channels, wherein the first gel cage region, the second gel case region and the third gel cage region are arranged in series to one another in the device.

16. A method of making the device of Claim 1 comprising:

- a) etching one or more fluid channels and one or more gel cage regions into a first portion of the optically transparent material and creating one or more inlets to allow flow through the one or more fluid channels and the one or more gel cage regions, thereby creating a roof and walls of the device; and
- b) bonding the first portion of the optically transparent material to a second portion of the optically transparent material that forms a floor of the device.

17. A method of identifying whether an agent is angiogenic or anti-angiogenic comprising:

- a) introducing an agent to be assessed into the one or more fluid channels of the device of Claim 1, wherein one or more fluid channels of the device comprises endothelial cells and one or more gel cage regions of the device comprises a gel that forms a gel region within the gel cage region of the device; and
- b) maintaining the device under conditions in which the endothelial cells are encouraged to adhere to the gel region at the one or more gel cage region-fluid channel interface regions; and
- c) determining whether creation of cone-like protrusions that are lined with endothelial cells into the gel region are enhanced or inhibited in the presence of the agent compared to a control;
wherein if creation of cone-like protrusions that are lined with endothelial cells into the gel region is enhanced in the presence of the agent compared to the control, then the agent is angiogenic, and if creation of cone-like protrusions that are lined with endothelial cells into the gel is inhibited in the

presence of the agent compared to the control, then the agent is anti-angiogenic.

18. A method of identifying whether an agent can be used to metastasis comprising:

- a) introducing an agent to be assessed into the one or more fluid channels of the device of Claim 1, wherein one or more fluid channels of the device comprises endothelial cells, one or more fluid or gel cage regions of the device comprise cancer cells, and one or more cage regions of the device comprises a gel that forms a gel region in the gel cage region of the device; and
- b) maintaining the device under conditions in which the endothelial cells are encouraged to adhere to the gel region at the one or more gel cage region-fluid channel interface regions, thereby forming an endothelial layer of cells; and
- c) determining whether the cancer cells disperse in the gel, migrate toward and across the endothelial layers of cells or a combination thereof in the presence of the agent;

wherein if the cancer cells have not dispersed in the gel, migrated toward the and across the endothelial layer of cells or a combination thereof, then this indicates that the agent can be used to inhibit metastasis.

19. The method of Claim 18 wherein the cancer cells are dissociated cells from a cancer patient's cancer biopsy.

20. A method of growing blood vessels *in vitro* comprising:

- a) introducing endothelial cells into one or more fluid channels of the device, wherein one or more gel cage regions of the device further comprises a gel that forms a gel cage therein; and
 - b) maintaining the device under conditions in which the endothelial cells are encouraged to adhere to the gel cage at the gel cage region-fluid channel interface region and create cone-like protrusions that are lined with endothelial cells into the gel cage,
- thereby growing blood vessels *in vitro*.

21. A method of identifying whether an agent is chemoattractive agent or a chemorepulsive agent of neuronal cells comprising:

- a) introducing an agent to be assessed and neuronal cells into the one or more fluid channels of the device of Claim 1, the one or more gel cage regions of the device of Claim 1, or a combination thereof; wherein the one or more cage regions of the device comprises a gel that forms a gel region within the gel cage region of the device; and
- b) maintaining the device under conditions in which the neuronal cells proliferate in the gel cage region; and
- c) determining whether the neuronal cells proliferate toward the agent or away from the agent;

wherein if the neuronal cells proliferate toward the agent, then the agent is a chemoattractive agent of neuronal cells, and if the neuronal cells proliferate away from the agent, then the agent is a chemorepulsive agent of neuronal cells.

22. A method of identifying whether an agent can be used to treat cancer comprising:

- a) introducing an agent to be assessed into the one or more fluid channels of the device of Claim 1, wherein one or more gel cage regions of the device comprises a gel that forms one or more gel cages, and the gel cage further comprises a biopsy of a cancerous tissue; and
- b) determining whether motility of the cancerous tissue is inhibited in the presence of the agent;

wherein if motility of the cancerous tissue is inhibited, then the agent can be used to treat cancer.