CLAIMS

1. A method of culturing cells, comprising: (a) providing a microfluidic device comprising a top chamber, a bottom chamber, and a membrane disposed in at least one interface region between the top and bottom chambers; (b) seeding stem-cell derived neurons within at least a portion of the top chamber and brain microvascular endothelial cells within at least a portion of the bottom chamber so as to create seeded cells; (c) exposing at least a portion of the seeded cells to a flow of a first fluid for a period of time; and (d) culturing the seeded cells under conditions such that a percentage of the neurons exhibit development indicative of the spinal cord.

2. A method according to Claim 1, in which the exhibited development indicative of the spinal cord comprises spontaneous bursts of calcium transient activity.

3. A method according to Claim 2, in which the spontaneous bursts activity is periodic.

4. A method according to Claim 1, in which the exhibited development indicative of the spinal cord comprises at least one marker selected from the list comprising SMI32, nuclear marker islet1 (ISL1), Beta 3 tubulin (TUBB3), NKX6.1, neurofilament marker microtubule-associated protein 2 (MAP2), and synaptic marker synaptophysin (SYNP).

5. A method according to Claim 1, in which the top chamber comprises an open region.

6. A method according to Claim 1, in which the microfluidic device further comprises a top channel, the top channel fluidically coupled to the top chamber.

7. A method according to Claim 1, in which the microfluidic device further comprises a bottom channel, the bottom channel fluidically coupled to the bottom chamber.

8. A method according to Claim 1, in which the stem-cell derived neurons seeded within at least a portion of the top chamber are disposed within a gel or gel-precursor.

9. A method according to Claim 1, in which the stem-cell derived neurons are seeded on top of a gel present within a portion of the top chamber.

10. A method according to Claim 1, in which the stem-cell derived neurons are derived from induced pluripotent stem-cells.

11. A method according to Claim 1, in which the stem-cell derived neurons are derived from embryonic stem-cells.

12. A method according to Claim 1, in which the neurons comprise one or more cell types selected from the list comprising of motor neurons, upper motor neurons, lower motor neurons, sensory neurons, and interneurons.

13. A method according to Claim 1, further comprising seeding glial cells on the top surface.

14. A method according to Claim 14, in which glial cells comprise one or more cell types selected from the list comprising astrocytes, oligodendrocytes, ependymal cells, Schwann cells, microglia, and satellite cells.

15. A method according to Claim 1, in which the first fluid comprises culture media

16. A method according to Claim 1, in which the first fluid comprises blood or at least one blood component.

17. A method of culturing cells, comprising: (a) providing a microfluidic device comprising a top chamber, a bottom chamber, and a membrane disposed in at least one interface region between the top and bottom chambers; (b) seeding neuron progenitors within at least a portion of the top chamber and brain microvascular endothelial cells within at least a portion of the bottom chamber so as to create seeded cells; (c) exposing at least a portion of the seeded cells to a flow of a first fluid for a period of time; and (d) culturing the seeded cells under conditions such that a portion of the progenitor cells differentiate to neurons and a percentage of the neurons exhibit development indicative of the spinal cord.

18. A method according to Claim 17, in which the exhibited development indicative of the spinal cord comprises spontaneous bursts of calcium transient activity.

19. A method according to Claim 18, in which the spontaneous bursts activity is periodic.

20. A method according to Claim 18, in which the exhibited development indicative of the spinal cord comprises at least one marker selected from the list comprising SMI32, nuclear marker islet1 (ISL1), Beta 3 tubulin (TUBB3), NKX6.1, neurofilament marker microtubule-associated protein 2 (MAP2), and synaptic marker synaptophysin (SYNP).

21. A method according to Claim 17, in which the top chamber comprises an open region.

22. A method according to Claim 17, in which the microfluidic device further comprises a top channel, the top channel fluidically coupled to the top chamber.

23. A method according to Claim 17, in which the microfluidic device further comprises a bottom channel, the bottom channel fluidically coupled to the bottom chamber.

24. A method according to Claim 17, in which the neuron progenitors seeded within at least a portion of the top chamber are disposed within a gel or gel-precursor.

25. A method according to Claim 17, in which the neuron progenitors are seeded on top of a gel present within a portion of the top chamber.

26. A method according to Claim 17, in which the neuron progenitors are derived from induced pluripotent stem-cells.

27. A method according to Claim 17, in which the neuron progenitors are derived from embryonic stem-cells.

28. A method according to Claim 17, in which the neurons comprise one or more cell types selected from the list comprising of motor neurons, upper motor neurons, lower motor neurons, sensory neurons, and interneurons.

29. A method according to Claim 17, further comprising seeding glial cells on the top surface.

30. A method according to Claim 29, in which glial cells comprise one or more cell types selected from the list comprising astrocytes, oligodendrocytes, ependymal cells, Schwann cells, microglia, and satellite cells.

31. A method according to Claim 17, in which the first fluid comprises culture media.

32. A method according to Claim 17, in which the first fluid comprises blood or at least one blood component.