Claims

1. An apparatus comprising:

a membrane, the membrane comprising:

a first side;

a second, opposing side; and

a plurality of pores spanning the membrane from the first side to the second side,

wherein the membrane comprises primarily inorganic material, and

wherein the apparatus is configured for cell culturing and/or performing a cell assay.

2. An apparatus as in claim 1, further comprising:

first and second compartments constructed and arranged to contain fluid, the first and second compartments separated by the membrane; and

components constructed and arranged to facilitate containment, within each compartment, of a fluid positioned adjacent the membrane.

3. An apparatus as in claim 1, further comprising:

a cell adhesive material layer positioned on the first side of the membrane such that the cell adhesive material layer is exposed through the pores from the second, opposing side.

4. An apparatus as in claim 3, wherein the cell adhesive material layer occludes at least some of the plurality of pores.

5. An apparatus as in claim 4, wherein the cell adhesive material layer occludes at essentially all of the plurality of pores.

6. An apparatus as in claim 3, wherein the cell adhesive material layer comprises collagen.

7. An apparatus as in claim 1, wherein the inorganic material is a metal oxide and/or metal nitride.

8. An apparatus as in claim 7, wherein the inorganic material is silicon nitride.

9. An apparatus as in claim 1, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 30 microns.

10. An apparatus as in claim 9, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 20 microns.

11. An apparatus as in claim 10, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 10 microns.

12. An apparatus as in claim 11, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 5 microns.

13. An apparatus as in claim 1, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 10%.

14. An apparatus as in claim 1, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 5%.

15. An apparatus as in claim 1 wherein at least about 50% of the pores are positioned less than about 25 microns from a nearest, adjacent pore.

16. An apparatus as in claim 1, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 30% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

17. An apparatus as in claim 16, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 40% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

18. An apparatus as in claim 17, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 50% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

19. An apparatus as in claim 3, further comprising cells positioned on the second side of the membrane and attached to the cell adhesive material layer, wherein each attached cell is associated with a single pore, such that a spatial distribution of the cells on the membrane is directed by a spatial distribution of the pores.

20. An article for cell culturing and/or cell assay, comprising:

a membrane having a first side and a second, opposing side;

a plurality of pores spanning the membrane from the first side to the second side and

a cell adhesive material layer positioned on the first side of the membrane such that the cell adhesive material layer is exposed through the pores to an environment in contact with the second, opposing side and occludes at least some of the plurality of pores.

21. An article as in claim 20, wherein the cell adhesive material layer occludes at essentially all of the plurality of pores.

22. An article as in claim 20, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 30 microns.

23. An article as in claim 20,
wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 10%.

24. An article as in claim 20, wherein at least about 50% of the pores are positioned less than about 25 microns from a nearest, adjacent pore.

25. An article as in claim 20, wherein the article includes at least one portion comprising at least a portion of the membrane, having an area of at least about 1 mm^2, which exhibits at least 30% transmission of light at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

26. A method, comprising:

providing a membrane comprising a first side, a second, opposing side, and a plurality of pores spanning the membrane between the first and second sides;

placing cells on the membrane, wherein the pores are sized such that the cells substantially seal the pores to substantially prevent fluid flow between the first and second sides of the membrane across the membrane;

exposing the first side of the membrane to a first fluid and the second side of the membrane to a second fluid, wherein fluid exchange does not occur across the membrane between the first and second sides or occurs at a rate of less than 1 cm^3 fluid per hour per cm^2 membrane surface area.

27. A method as in claim 26, wherein the membrane comprises primarily inorganic material.

28. A method as in claim 26, wherein the membrane further comprises a cell adhesive material layer positioned on the first side such that the cell adhesive material layer is exposed to the cells through the pores from the second, opposing side.

29. A method as in claim 28, wherein the cell adhesive material layer occludes at least some of the plurality of pores.

30. A method as in claim 29, wherein the cell adhesive material layer occludes at essentially all of the plurality of pores.

31. A method as in claim 28, wherein the cell adhesive material layer comprises collagen.

32. A method as in claim 26, wherein the membrane comprises primarily inorganic material.

33. A method as in claim 32, wherein the inorganic material is a metal oxide and/or metal nitride.

34. A method as in claim 33, wherein the inorganic material is silicon nitride.

35. A method as in claim 26, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 30 microns.

36. A method as in claim 35, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 20 microns.

37. A method as in claim 36, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 10 microns.

38. A method as in claim 37, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 5 microns.

39. A method as in claim 26, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 10%.

40. A method as in claim 26, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 5%.

41. A method as in claim 26, wherein at least about 50% of the pores are positioned less than about 25 microns from a nearest, adjacent pore.

42. A method as in claim 26, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 30% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

43. A method as in claim 42, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 40% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

44. A method as in claim 43, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 50% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

45. A method as in claim 26, further comprising attaching the cells to the membrane, wherein each cell is attached over a single pore, such that a spatial distribution of the cells on the membrane is directed by a spatial distribution of the pores.

46. A method as in claim 26, wherein a first portion of the cell is exposed to the first fluid and a second portion of the cell is exposed to the second fluid, such that a first species can enter the cell through the first portion of the cell and a second species can exit the cell through the second portion of the cell.

47. A method, comprising:

providing a membrane having a first side and a second, opposing side and a plurality of pores spanning the membrane between the first and second sides;

presenting cells to at least the first side of the membrane; and

determining migration of at least one of these cells through the pores from the first side to the second side.

48. A method as in claim 47, wherein the membrane comprises primarily inorganic material.

49. A method as in claim 47, wherein the membrane is in contact with a cell adhesive material layer.

50. A method as in claim 49, wherein the cell adhesive material layer occludes at least some of the plurality of pores.

51. A method as in claim 50, wherein the cell adhesive material layer occludes at essentially all of the plurality of pores.

52. A method as in claim 49, wherein the cell adhesive material layer comprises collagen.

53. A method as in claim 47, wherein the membrane comprises primarily inorganic material.

54. A method as in claim 53, wherein the inorganic material is a metal oxide and/or metal nitride.

55. A method as in claim 54, wherein the inorganic material is silicon nitride.

56. A method as in claim 47, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 30 microns.

57. A method as in claim 47, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 20 microns.

58. A method as in claim 47, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 10 microns.

59. A method as in claim 47, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 5 microns.

60. A method as in claim 47, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 10%.

61. A method as in claim 47, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 5%.

62. A method as in claim 47, wherein at least about 50% of the pores are positioned less than about 25 microns from a nearest, adjacent pore.

63. A method as in claim 47, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 30% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

64. A method as in claim 47, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 40% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

65. A method as in claim 47, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 50% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

66. A method as in claim 47, further comprising attaching cells to the membrane, wherein each cell is attached over a single pore, such that a spatial distribution of the cells on the membrane is directed by a spatial distribution of the pores.

Claims

1. An apparatus comprising:

a membrane, the membrane comprising:

a first side;

a second, opposing side;

a plurality of pores spanning the membrane from the first side to the second side;

a cell adhesive material layer positioned on the first side of the membrane, with the second side of the membrane remaining essentially free of the cell adhesive material; and

cells positioned on the second side of the membrane and attached to the cell adhesive material layer through the pores,

wherein the membrane comprises primarily inorganic material, and

wherein at least about 50% of the pores are positioned less than about 25 microns from a nearest, adjacent pore and the apparatus is configured for cell culturing and/or performing a cell assay.

2. An apparatus as in claim 1, further comprising:

first and second compartments constructed and arranged to contain fluid, the first and second compartments separated by the membrane; and

components constructed and arranged to facilitate containment, within each compartment, of a fluid positioned adjacent the membrane.

3. An apparatus as in claim 1, wherein the cell adhesive material layer occludes at least some of the plurality of pores.

4. An apparatus as in claim 3, wherein the cell adhesive material layer occludes essentially all of the plurality of pores.

5. An apparatus as in claim 1, wherein the cell adhesive material layer comprises collagen.

6. An apparatus as in claim 1, wherein the inorganic material is a metal oxide and/or metal nitride.

7. An apparatus as in claim 6, wherein the inorganic material is silicon nitride.

8. An apparatus as in claim 1, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 30 microns.

9. An apparatus as in claim 8, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 20 microns.

10. An apparatus as in claim 9, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 10 microns.

11. An apparatus as in claim 10, wherein the membrane comprises at least one portion having a thickness measured between the first and second sides of less than about 5 microns.

12. An apparatus as in claim 1, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 10%.

13. An apparatus as in claim 1, wherein no more than about 5% of all pores deviate in size from an average pore size of the plurality of pores by more than about 5%.

14. An apparatus as in claim 1, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 30% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

15. An apparatus as in claim 14, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 40% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

16. An apparatus as in claim 15, wherein the membrane includes at least one portion, having an area of at least about 1 mm^2, which exhibits at least 50% transmission of light at at least one wavelength within a wavelength range of from about 400 nm to about 800 nm.

17. An apparatus as in claim 1, wherein each attached cell is associated with a single pore, such that a spatial distribution of the cells on the membrane is directed by a spatial distribution of the pores.

18. An article for cell culturing and/or cell assay, comprising:

a membrane having a first side and a second, opposing side;

a plurality of pores spanning the membrane from the first side to the second side;

a cell adhesive material layer positioned on the first side of the membrane such that the cell adhesive material layer is exposed through the pores to an environment in contact with the second, opposing side and occludes at least some of the plurality of pores; and

cells positioned on the second side of the membrane and attached to the cell adhesive material layer, wherein each attached cell is associated with a single pore, such that a spatial distribution of the cells on the membrane is directed by a spatial distribution of the pores.