

CLAIMS:

The invention is claimed as follows:

1. A biochip for growing ductal tissue, the biochip comprising:
at least one membrane structure, wherein the at least one membrane structure includes
at least one porous membrane configured to provide a mimetic cellular environment;
at least one chassis, wherein the at least one chassis includes,
a channel configured to support the at least one membrane structure and
at least one microfluidic channel in fluid communication with the channel
supporting the at least one membrane structure; and
at least one cover slip;
wherein the at least one chassis is configured such that an internal space is provided
within the at least one chassis and capable of creating at least one channel within the at least
one chassis,
wherein the internal space created between the chassis provides a compartment that is
internal relative to the body of the chassis but external relative to the membrane structure; and
wherein a plurality of openings are provided on the at least one chassis to allow fluid
or air to enter or exit the internal space created between the chassis that provides an external
compartment relative to the membrane structure created between the chassis.
2. The biochip of claim 1, wherein the at least one membrane structure is one or
more cylindrical scaffolds.
3. The biochip of claim 2, wherein at least one membrane structure is capable of
being combined within the internal space within the cylindrical scaffolds of the at least one
membrane structure, providing layers of porous membrane ductal scaffolds nested within each
other.
4. The biochip of claim 1, wherein the at least one membrane structure is selected
from the group of synthetic polymers, organic polymers or composite material.
5. The biochip of claim 1, wherein the at least one membrane structure is capable
of mimicking the in-vivo tissue conditions for different or the same biological material.

6. The biochip of claim 1, wherein the membrane structure is capable of providing an environment for a plurality of stromal tissue types.

7. The biochip of claim 1, wherein the at least one membrane structure is capable of providing an environment for the testing of a plurality of disease models.

8. The biochip of claim 1, wherein the at least one chassis contains features that hold the cylindrical ductal scaffold in position giving access to the internal and the external compartments of the ductal scaffold.

9. The biochip of claim 1, wherein biological components may be pipetted or pumped into the microfluidic channels of the biochip.

10. The biochip of claim 1, wherein biological components are the same biological components.

11. The biochip of claim 1, wherein biological components are different biological components.

12. The biochip of claim 1, wherein the at least one chassis contains features forming one or more microfluidic channels giving access to the internal and the external compartments of the ductal scaffold.

13. The biochip of claim 1, wherein the at least one chassis contains features forming the microfluidic channels leading to the internal and the external compartments of the ductal scaffold.

14. The biochip of claim 1, wherein the at least one chassis contains microfluidic channels leading to the internal and the external compartments of the ductal scaffold are interconnected at one or more areas of the porous ductal scaffold locations.

15. The biochip of claim 1, wherein the at least one chassis contains microfluidic channels leading to the inner and external compartments of the ductal scaffold are interconnected, is only separated by the walls of the porous ductal scaffold after assembly.

16. The biochip of claim 1, wherein the at least one chassis contains microfluidic channels leading to the inner and external compartments of the ductal scaffold are interconnected, are only connected through the pores on the walls of the ductal scaffold after it's assembly.

17. The biochip of claim 1, wherein the features of the at least one chassis forming the microfluidic channels leading to the external compartment of the ductal scaffold could be engraved in the inner layers of the at least one chassis.

18. The biochip of claim 1, wherein the features of the at least one chassis forming the microfluidic channels leading to the external compartment of the ductal scaffold could be engraved on the outer surfaces of the at least one chassis and enclosed by the at least one thin coverslip creating the full channel.

19. The biochip of claim 1, wherein the cylindrical duct cross-section could be circular, ellipsoidal or any other enclosed shape.

20. The biochip of claim 1, wherein the duct could be porous and the pores could be of any count, shape and size.

21. The biochip of claim 1, wherein some pores allow for the diffusion of biological components.

22. The biochip of claim 1, wherein some pores allow for the migration of cells across the duct wall.

23. The biochip of claim 1, wherein the at least one chassis include at least one inlet and at least one outlet holes.

24. The biochip of claim 1, wherein the features of the at least one chassis, forming the microfluidic channels leading to the internal compartment of the ductal scaffold, could extend between the inlet and outlet holes of the channel.

25. The biochip of claim 1, wherein the features of the at least one chassis, forming the microfluidic channels leading to the internal compartment of the ductal scaffold, could extend beyond the inlet and outlet holes of the channel and later be plugged post-assembly of the chip sub-components.

26. The biochip of claim 1, wherein the at least one chassis is configured to be used with a microscope or imaging device.

27. The biochip of claim 1, wherein the microfluidic channels allowing fluids to flow to the internal and external compartment surrounding the ductal scaffold are enclosed between the at least one chassis.

28. The biochip of claim 1, wherein the microfluidic channels allowing fluids to flow to the external compartment surrounding the ductal scaffold are enclosed between the at least one chassis and the at least one coverslip glass covering the additional side of the biochip not enclosed by the at least one chassis.

29. The biochip of claim 1, wherein the at least one membrane structure bonded to the at least one chassis could be surrounded with the stromal microfluidic channel void from all sides when the membrane is curved and bonded prior to assembly in an area on the ductal scaffold surface along its length.

30. The biochip of claim 1, wherein the at least one chassis is made of a material that is one of brittle, transparent and low autofluorescence such as glass or polymer.

31. The biochip of claim 1, wherein the at least one chassis is made of a material that is opaque.

32. The biochip claim 1, wherein the at least one chassis is configured to deform, in response to a stimulus, and encapsulated the at least one membrane structure.

33. The biochip of claim 32, wherein the stimulus is one of heat, pressure, chemical exposure or radiation exposure.

34. The biochip of claim 33, wherein the at least one cover slip and the at least one chassis are integrated to form a unitary body.

35. The biochip of claim 1, wherein the at least one cover slip is made of a material that is transparent.

36. The biochip of claim 1, wherein the biochip is capable of being connected to and interacting with a plurality of additional biochips.

37. A method of manufacturing a biochip, the method comprising:
providing at least one chassis, wherein the at least one chassis includes,
a channel configured to support the at least one membrane structure and
at least one microfluidic channel in fluid communication with the channel;
providing at least one porous membrane;
curving at least one porous membrane into a closed loop of cylindrical cross-section.
wherein a round, cylindrical porous duct is formed by curving a first part of a
porous membrane and a one or more additional porous membranes form a second part
of the duct, and
inserting the at least one porous membrane between the at least one chassis.

38. The method of claim 37, wherein the at least one porous membrane is curved between 0° to 180° from a plane parallel to the top surface between at least one chassis to form a full duct shape and the other membranes are curved to form the rest of the full duct.

39. The method of claim 37, wherein the at least one chassis is configured to contain features forming the microfluidic channels leading to the internal and the external compartments of the ductal scaffold.

40. The method of claim 37, wherein at least one membrane structure is combined within the internal space within the cylindrical scaffolds of the at least one membrane structure, providing layers of porous membrane ductal scaffolds nested within each other.

41. The method of claim 37, wherein the at least one chassis is configured so that microfluidic channels leading to the internal and the external compartments of the ductal scaffold are interconnected at one or more areas of the porous ductal scaffold locations.

42. The method of claim 37, wherein the at least one chassis is configured so that the microfluidic channels leading to the inner and external compartments of the ductal scaffold are interconnected, is only separated by the walls of the porous ductal scaffold after assembly.

43. The method of claim 37, wherein the at least one chassis is configured so that the microfluidic channels leading to the inner and external compartments of the ductal scaffold are interconnected, are only connected through the pores on the walls of the ductal scaffold after assembly.

44. The method of claim 37, wherein the features of the at least one chassis forming the microfluidic channels leading to the external compartment of the ductal scaffold could be engraved in the inner layers of the at least one chassis.

45. The method of claim 37, wherein the features of the at least one chassis forming the microfluidic channels leading to the external compartment of the ductal scaffold could be engraved on the outer surfaces of the at least one chassis, and covered with another chassis part or at least one coverslip creating the full channel.

46. The method of claim 37, wherein the features the at least one chassis is configured to provide at least one inlet and at least one outlet hole providing access to the channel.

47. The method of claim 37, wherein the features of the at least one chassis forming the microfluidic channels leading to the internal compartment of the ductal scaffold could extend between the inlet and outlet holes of the channel.

48. The method of claim 37, wherein the features of the at least one chassis forming the microfluidic channels leading to the internal compartment of the ductal scaffold could extend beyond the inlet and outlet holes of the channel and later be plugged post-assembly of the chip sub-components.

49. The method of claim 37, wherein the cylindrical duct is formed by bonding the membranes and the at least one chassis by one of or a combination of chemical bonding, pressure bonding, or heat bonding.

50. The method of claim 49, wherein the curved membranes forming the cylindrical ductal scaffold can be bonded prior or post to assembly in the at least one chassis.

51. The method of claim 49, wherein the bonding method is used to melt a controlled thickness of the materials surfaces, welding the different parts together.

52. The method of claim 49, wherein the chemical bonding contains a mixture of ethanol and chloroform.

53. The method of claim 49, wherein the heat bonding can include surface irradiation.

54. The method of claim 49, wherein the at least one coverslip glass forming the top and bottom layers of the biochip is bonded to the at least one chassis using the same method as the other parts or using a glass-polymeric glue.

55. The method of claim 37, wherein the plugs closing the extremities of the microfluidic channels leading to the ductal scaffold inner compartment, are bonded or using a polymeric glue.

56. The method of claim 37, wherein the extension of the ductal scaffold membrane are held at its extremities and tensioned to prevent any wrinkling in the membranes.

57. The method of claim 37, wherein a round porous duct is formed by curving a flat membrane over a rod in a closed loop of cylindrical cross-section and bonding it in an area on the ductal scaffold surface along its length

58. The method of claim 37, wherein a round porous duct is formed by curving a flat membrane over a rod in a closed loop of cylindrical cross-section and bonding it in a flat area along the surface of the ductal scaffold that is an extension of the duct surface.

59. The method of claim 37, wherein a round porous duct is formed by curving more than one flat membrane over a rod in a closed loop of cylindrical cross-section and bonding it in a flat area along the surface of the ductal scaffold that is extension of the duct surface.

60. The method of claim 37, wherein forming the membranes includes a rod holding the membrane into its desired shapes is located in between the at least one chassis, with the extremities of the ductal scaffold is bonded to the chassis and surrounded by the at least one chassis.