SUMMARY OF THE INVENTION

In accordance with the instant invention, an incubation apparatus ~~for maintaining~~configured to maintain a fetus in an extrauterine ~~setting to allow for growth and maturation~~environment is provided. In a particular embodiment, the incubation apparatus comprises an incubation chamber ~~for holding~~configured to hold a volume of a sterile liquid and the fetus, the volume of the sterile liquid sufficient ~~such~~so that the fetus can be submerged in the sterile liquid in the incubation chamber, the incubation chamber including an inlet port and an outlet port, the inlet port configured to provide a path for the sterile fluid into the incubation chamber, the outlet port configured to provide a path for the sterile liquid out of the incubation chamber. ~~The incubation chamber comprises an inlet port for pumping in sterile liquid and an exit port for the removal of used liquid.~~ The apparatus further ~~comprises~~ includes a pumpless oxygenation circuit comprising an ~~low resistance~~ oxygenator having an inflow port and an outflow port. The pumpless oxygenation circuit configured to be coupled to the fetus such that the pumpless oxygenation circuit defines a path that includes: 1) a first portion that provides arterial outflow from the fetus ~~under pulsatile systemic pressure connected~~ to the oxygenator inflow port, and 2) a second portion that provides return flow from~~connected to~~ the outflow port to the fetus. The apparatus further comprises a pump configured to pump~~means for pumping liquid to provide a flow of~~ the sterile liquid through the inlet port, into the incubation chamber, and~~. The flow enters through the inlet port and drains~~ through the outlet port.

In accordance with another aspect of the instant invention, an incubation apparatus for maintaining a fetus in an extrauterine setting to allow for growth and maturation is provided. In a particular embodiment, the apparatus comprises an incubation chamber ~~for holding~~configured to hold a volume of liquid so that the fetus can be submerged in the liquid in the incubation chamber. The apparatus further comprises a pump in fluid communication with the incubation chamber, the pump configured to pump liquid into the incubation chamber. The apparatus further comprises a pumpless oxygenation circuit comprising a low resistance oxygenator having an inflow port and an outflow port. The circuit provides arterial outflow from the fetus under pulsatile systemic pressure connected to the

What is claimed is:

1. An incubation apparatus configured to maintain a fetus in an extrauterine environment, the incubation apparatus comprising:

an incubation chamber configured to hold a volume of a sterile liquid and the fetus, the volume of the sterile liquid sufficient such that the fetus can be submerged in the sterile liquid in the incubation chamber, the incubation chamber including an inlet port and an outlet port, the inlet port configured to provide a path for the sterile fluid into the incubation chamber, the outlet port configured to provide a path for the sterile liquid out of the incubation chamber;

a pumpless oxygenation circuit including an oxygenator having an inflow port and an outflow port, the pumpless oxygenation circuit configured to be coupled to the fetus such that the pumpless oxygenation circuit defines a path that includes: 1) a first portion that provides arterial outflow from the fetus to the oxygenator inflow port, and 2) a second portion that provides return flow from the outflow port to the fetus; and

a pump configured to pump the sterile liquid through the inlet port, into the incubation chamber, and through the outlet port.

2. The incubation apparatus of claim 1 wherein the pump pumps sterile liquid through the inlet port to exchange the used liquid in the chamber with sterile liquid.

3. The incubation apparatus of claim 1, wherein the oxygenator has a pressure drop of less than 40 mmHg at 1.5 l/min of blood flow, as measured between the inflow port and the outflow port.

4. The incubation apparatus of claim 1, wherein when the incubation chamber holds the volume of the sterile liquid the oxygenator is positioned outside the volume of the sterile liquid.

5. The incubation apparatus of claim 1, wherein the pumpless oxygenation circuit permits innate hemodynamics to be maintained by autoregulation.

6. The incubation apparatus of claim 1, wherein the pumpless oxygenation circuit is configured to provide a flow of blood at a rate of about 2.0 l/min or greater.

7. The incubation apparatus of claim 1, wherein when the incubation chamber holds the volume of the sterile liquid, the incubation chamber is sealed to prevent contamination of the volume of the sterile liquid in the incubation chamber.

8. The incubation apparatus of claim 1, wherein the incubation chamber comprises a bag or sac.

9. The incubation apparatus of claim 8 wherein the bag or sac comprises inert medical grade plastic or silicone.

10. The incubation apparatus of claim 1, comprising a suction mechanism configured to provide access to the volume of the sterile fluid to permit removal of waste products and debris from the volume of the liquid in the incubation chamber.

11. The incubation apparatus of claim 1, wherein the incubation chamber comprises at least one glove port to allow sterile access to the fetus while the fetus is in the volume of the sterile liquid.

12. The incubation apparatus of claim 1, wherein the sterile liquid in the incubation chamber comprises synthetic amniotic liquid.

13. The incubation apparatus of claim 1, further comprising a gas mixer configured to blend a mixture of air and oxygen to form a sweep gas, wherein the sweep gas is connected with the oxygenator.

14. The incubation apparatus of claim 1, wherein the oxygenation circuit is configured to provide a gas transfer rate of about 150 ml/min or greater.

15. The incubation apparatus of claim 1, further comprising a filter configured to filter the sterile liquid, wherein the sterile liquid is pumped through the filter and the filtered sterile liquid is then pumped into the incubation chamber.

16. The incubation apparatus of claim 1 comprising:

a supply tank configured to store a supply of sterile liquid greater than the volume of the sterile liquid in the incubation chamber; and

a drain configured to receive used liquid from the incubation chamber;

wherein the pump is configured to pump the sterile liquid from the supply tank into the incubation chamber.

17. The incubation apparatus of claim 1 wherein the chamber is a closed sterile system with continuous liquid exchange.

18. An incubation apparatus for maintaining a fetus in an extrauterine setting to allow for growth and maturation, comprising:

an incubation chamber configured to hold a volume of liquid so that the fetus can be submerged in the liquid in the incubation chamber;

a pump in fluid communication with the incubation chamber, the pump configured to pump liquid into the incubation chamber;

a pumpless oxygenation circuit comprising;

an low resistance oxygenator having an inflow port and an outflow port;

wherein the circuit provides arterial outflow from the fetus under pulsatile systemic pressure connected to the oxygenator inflow port and return flow connected to the outflow port; and

wherein the oxygenator is positioned outside the liquid in the incubation chamber.

19. The incubation apparatus of claim 18 wherein the incubation chamber comprises a bag or sac.

20. The incubation apparatus of claim 19 wherein the bag or sac comprises inert medical grade plastic or silicone.

21. The incubation apparatus of claim 18 comprising a suction mechanism to permit removal of waste products and debris from the liquid in the chamber.

22. The incubation apparatus of claim 18 wherein the chamber comprises glove ports to allow sterile access to the fetus while the fetus is in the liquid.

What is claimed is:

1. An incubation apparatus for maintaining a fetus in an extrauterine setting to allow for growth and maturation, comprising:

an incubation chamber for holding a volume of liquid so that the fetus can be submerged in the liquid in the incubation chamber;

wherein the incubation chamber comprises an inlet port for pumping in sterile liquid and an exit port for the removal of used liquid;

a pumpless oxygenation circuit comprising:

an low resistance oxygenator having an inflow port and an outflow port;

wherein the circuit provides arterial outflow from the fetus under pulsatile systemic pressure connected to the oxygenator inflow port and return flow connected to the outflow port;

means for pumping liquid to provide a flow of sterile liquid through the incubation chamber, wherein the flow enters through the inlet port and drains through the outlet port.

2. The incubation apparatus of claim 1 wherein the means for pumping pumps sterile liquid through the inlet port and discharges fluid from the outlet port to exchange the used liquid in the chamber with sterile liquid.

3. The incubation apparatus of claim 1 wherein the oxygenator has a pressure drop of less than 40 mmHg at 1.5 l/min of blood flow.

4. The incubation apparatus of claim 1 wherein the oxygenator is outside the liquid in the incubation chamber.

5. The incubation apparatus of claim 1 wherein the pumpless oxygenation circuit permits innate hemodynamics to be maintained by autoregulation.

6. The incubation apparatus of claim 1 wherein the pumpless oxygenation circuit provides blood flow of about 2.0 l/min or greater.

7. The incubation apparatus of claim 1 wherein the incubation chamber is sealed to prevent contamination of the liquid in the chamber.

8. The incubation apparatus of claim 1 wherein the incubation chamber comprises a bag or sac.

9. The incubation apparatus of claim 8 wherein the bag or sac comprises inert medical grade plastic or silicone.

10. The incubation apparatus of claim 1 comprising suction means to permit removal of waste products and debris from the liquid in the chamber.

11. The incubation apparatus of claim 1 wherein the chamber comprises glove ports to allow sterile access to the fetus while the fetus is in the liquid.

12. The incubation apparatus of claim 1 wherein the liquid in the chamber comprises synthetic amniotic liquid.

13. The incubation apparatus of claim 1 comprising a gas mixer for blending a mixture of air and oxygen to form a sweep gas, wherein the sweep gas is connected with the oxygenator.

14. The incubation apparatus of claim 1 wherein the oxygenation circuit provides gas transfer rate of about 150 ml/min or greater.

15. The incubation apparatus of claim 1 comprising means for filtering the liquid, wherein the liquid is pumped through the means for filtering and the filtered liquid is then pumped into the chamber.

16. The incubation apparatus of claim 1 comprising:

a supply tank for storing a supply of liquid greater than the volume of liquid in the incubation chamber; and

a drain for receiving used liquid from the incubation chamber;

wherein the means for pumping pumps liquid from the supply tank into the chamber and the means for pumping pumps fluid from the chamber to the drain.

17. The incubation apparatus of claim 1 wherein the chamber is a closed sterile system with continuous liquid exchange.

18. An incubation apparatus for maintaining a fetus in an extrauterine setting to allow for growth and maturation, comprising:

an incubation chamber for holding a volume of liquid so that the fetus can be submerged in the liquid in the incubation chamber;

a pumpless oxygenation circuit comprising;

an low resistance oxygenator having an inflow port and an outflow port;

wherein the circuit provides arterial outflow from the fetus under pulsatile systemic pressure connected to the oxygenator inflow port and return flow connected to the outflow port; and

wherein the oxygenator is positioned outside the liquid in the incubation chamber.

19. The incubation apparatus of claim 18 wherein the incubation chamber comprises a bag or sac.

20. The incubation apparatus of claim 19 wherein the bag or sac comprises inert medical grade plastic or silicone.

21. The incubation apparatus of claim 18 comprising suction means to permit removal of waste products and debris from the liquid in the chamber.

22. The incubation apparatus of claim 18 wherein the chamber comprises glove ports to allow sterile access to the fetus while the fetus is in the liquid.