CLAIMS

1. A perforated structure for use with a simulated respiratory tract, the structure comprising a perforated envelope comprising one or more perforations and housing one or more branched channels, wherein each perforation is an open terminal of the one or more branched channels, and wherein the one more branched channels comprise one or more coatings on part or all of an internal surface of the branched channels, and wherein the one or more branched channels further comprise one or more openings capable of receiving one or more modules for containing (i) a cell culture medium containing matrix, (ii) a microsensor for monitoring conditions in the structure, or (iii) a probe for gas sampling or gas characterisation.

2. The perforated structure according to claim 1, wherein branching of each channel is dichotomous.

3. The perforated structure according to claim 1 or claim 2, wherein the diameter of each channel present after n+1 consecutive branching points is smaller than or equal to the diameter of the channel present after n branching points.

4. The perforated structure according to any of the preceding claims, wherein the total cross-sectional area of all channels present after n+1 consecutive branching points is larger than or equal to the total cross-sectional area of all channels after n branching points; preferably,

wherein the structure is asymmetric or wherein the structure has a radial symmetry.

5. The perforated structure according to any of the preceding claims, wherein the structure is modular; and/or

wherein all or part of the structure is formed from one or more materials selected from the group consisting of: non-porous materials, including metals and non-porous synthetic materials; porous materials, including porous silicone; gelatinous materials, including thermogels; hydrophobic materials; hydrophilic materials; amphiphilic materials or a combination of two or more thereof; and/or

wherein the one or more of the coatings provide water and nutrients to cells grown in all or part of one or more of the branched channels; and/or

wherein part or all of one or more of the branched channels is coated with a matrix comprising a cell culture medium and/or at least one microsensor for monitoring conditions in the structure or for gas sampling or for gas characterisation; and/or

wherein one or more of the branched channels further comprises modules for containing a cell culture medium containing matrix or a microsensor for monitoring conditions in the structure or a probe for gas sampling or for gas characterisation.

6. A pump for displacing a volume of gas comprising (i) a port for receiving and outputting the gas, and (ii) one or more of the branched channels of the perforated structure according to any one of claims 1 to 5 inside the pump, wherein the one or more branched channels of the perforated structure are connected to the.

7. The pump according to claim 6,

wherein the pump comprises a chamber configured for containing the volume of gas and comprising a base and one or more openings capable of receiving one or more modules for containing a matrix comprising a cell culture medium and/or at least one microsensor for monitoring conditions in the chamber or for gas sampling or for gas characterisation; and/or

wherein the pump further comprises a motor for controlling operation of the pump.

8. A system for determining the interaction between a test atmosphere and a simulated respiratory tract, said system comprising:

(a) a first pump comprising:

(i) a chamber configured for containing a first volume of gas comprising a test atmosphere;

(ii) a first port adapted for receiving and outputting gas and comprising a valve for regulating the flow of gas through the first port, said valve being moveable between open and closed positions, wherein in the open position said valve is openable towards a test atmosphere or surrounding air;

(iii) a second port adapted for outputting and receiving gas and comprising a valve for regulating the flow of gas through the second port, said valve being moveable between open and closed positions;

(iv) a piston plate in the chamber, said piston plate comprising one or more apertures for the uptake or inflow of gas into the chamber wherein one or more, or each, of the apertures include a valve that is movable between open and closed positions and is capable of regulating the uptake or inflow of gas; and

(v) a motor for controlling the operation of the first pump;

(b) a second pump, wherein the second pump is as defined in claims 6 or 7;

(c) a connecting structure operable to transmit the gas from the first pump into the second pump; and

(d) one or more openings in the first pump or the second pump or the walls of the connecting structure or a combination of two or more thereof, said openings being capable of receiving a module for containing a matrix comprising a cell culture medium and/or at least one microsensor for monitoring conditions in the chamber or for gas sampling or for gas characterisation.

9. A method for simulating the interaction between a test atmosphere and a simulated respiratory tract comprising the use of the pump according to claims 6 or 7 or the system according to claim 8.

10. Use of a pump according to claim 6 or 7 or the system according to claim 8 for simulating the interaction between a test atmosphere and a simulated respiratory tract.

11. A method for determining the effect of a test atmosphere on a culture of cells contained in a simulated respiratory tract comprising the use of a pump according to claim 6 or 7 or the system according to claim 8.

12. Use of a pump according to claim 6 or 7 or the system according to claim 8 for determining the effect of a test atmosphere on a culture of cells contained in a simulated respiratory tract.

13. A method for determining the effect of a test atmosphere on a culture of cells contained in a simulated respiratory tract comprising:

(a) providing the pump according to claim 6 or 7 or the system according to claim 8, wherein the pump or system contains a culture of cells and/or at least one microsensor in one or more of the modules; and

(b) comparing the culture of cells and/or the at least one microsensor before and/or after exposure to the test atmosphere, wherein a difference between the culture of cells and/or the at least one microsensor before and/or after exposure of the cells and/or the at least one microsensor to the test atmosphere is indicative that the test atmosphere effects the culture of cells and/or the at least one microsensor.

14. An apparatus configured to or adapted to perform the method of claim 11 or claim 13.

15. The perforated structure according to claim 1, wherein the one or more coatings is a cell culture medium.