explantation). However, there remains many challenges with the effectiveness of current encapsulation systems through various stages of its life cycle. One challenge includes maintaining survival of the biological moiety during the implantation and healing phase where the biological moiety is exposed to a hypoxic environment with a limited source of oxygen and nutrients. There are also challenges of scalability of designing the encapsulation device for various therapies and dose ranges. One example is the need to scale various device geometries through pre-clinical animal models to a therapeutic dose in humans without changing critical design dimensions that would result in a different environment for the biological moiety. Additionally as the biological moiety reaches the end of life, there is a desire to extend the useful life of the encapsulation device or preserve the surface area in the region of the implant such that the area can be re-used for future therapies.

[0005] Therefore, there remains a need for devices that encapsulate cells and other biological moieties that are scalable to different sizes, are able to incorporate various types of biological moieties and/or sizes of biological moieties, and can be easily accessed to remove and/or replace a therapeutic device to allow for leveraging different therapies at different stages of the device life or for extending the useful life of the device through replacement.

SUMMARY

[0005a] In one aspect, the present disclosure refers to an implantable encapsulation device comprising: a plurality of interconnected containment tubes, each said containment tube having a first access port at a first end thereof and a second access port at a second end thereof, wherein said containment tubes are substantially parallel to each other along a length of said device, and a flush port fluidly connected to one or more of said containment tubes via a tube.

[0006] One example relates to an implantable encapsulation device that includes a single containment tube, a first access port located at the first end of the containment tube, a second access port located at the second end of the containment tube, a flush port fluidly connected to the second access port via a tube, and a cap releasably attached to the first end of the containment tube and covering the first access port. The flush port may also include a resealable cap. The containment tube may contain therein a biological moiety (*e.g.*, cells) or a therapeutic device (*e.g.* a cell encapsulation member).

[0007] A second example relates to an implantable encapsulation device that includes a containment tube that has a first end and a second end and a single access port at one end (e.g., the first end). The other end (e.g., the second end) may simply be the

end of the containment tube or a permanent seal affixed to the second end. The permanent seal may be a cap non-releasably attached to the second end. The containment tube may contain therein a biological moiety (*e.g.*, cells) or a therapeutic device (*e.g.* a cell encapsulation member).

[0008] A third example relates to an implantable encapsulation device that includes a plurality of containment tubes, each containment tube having a first access port located at the first end of the containment tube and a second access port located at the second end of the containment tube. The first access ports may have thereon resealable caps to seal the first end of the containment tubes. The containment tubes may be interconnected at or near the second ends by connection members. The containment tubes are independently movable from each other and are substantially parallel to each other along a length of the device. The containment tubes may contain therein a biological moiety (*e.g.*, cells) or a therapeutic device (*e.g.* a cell encapsulation member). The encapsulation device may further include a removable manifold having at least one access port that is in fluid communication with one or more of the containment tubes. A flush port may be fluidly connected to the manifold by a tube.

[0009] A fourth example relates to an implantable encapsulation device that includes a manifold and a plurality of containment tubes, each containment tube having a first access port at a first end and a second access port at a second end. The containment tubes are affixed to the manifold at their second ends and are fluidly connected to the manifold through the second access ports. The manifold may be located at the first end or the second end of the containment tubes. A resealable (or permanent) port may be located at the opposing end of the containment tubes. The containment tubes may be connected to each other at spaced intervals along their lengths by one or more connection member and/or may be substantially parallel to one another along a length of the containment tubes. The periodically spaced intervals may be regular (e.g., spacing is the same between connection members) or irregular (e.g., the spacing between connection members are different). In some examples, the containment tubes are stacked upon each other in a three dimensional configuration. In yet other examples, the containment tubes have a substantially planar configuration with off-

axis interconnection members. The containment tubes may contain therein a biological moiety (*e.g.*, cells) or a therapeutic device (*e.g.* a cell encapsulation member).

[0010] A fifth example relates to an implantable encapsulation device that includes at least one containment tube having a first end and a second end and a manifold centrally located between the first end and the second end. The manifold has at least one access port and is fluidly connected to the at least one containment tube. In some examples, the manifold includes a divider element positioned below the at least one access port.

[0011] A sixth example relates to an implantable encapsulation device that includes a laminate sheet and a plurality of containment channels formed by adhered layers of the laminate sheet with seams interposed between each containment channel. The plurality of containment channels may be periodically connected to each other via the seams along a length of the containment channels. It is to be appreciated that access ports, manifolds, and/or flush ports may also be included this example.

[0012] A seventh example relates to an implantable encapsulation device that includes a manifold located at the first end or the second end of the encapsulation device and a plurality of containment tubes individually affixed to the manifold and in fluid communication with the manifold. The plurality of containment tubes may be interconnected in a non-planar arrangement. In at least one example, the containment tubes include a shape memory material such that the containment tubes are configured to take on the non-planar arrangement.

[0013] An eighth example relates to an implantable encapsulation device that includes a single containment tube having a first end, a second end, a point located between the first end and the second end, a divider element, and a manifold having a single access port positioned at the point which is centrally located between the first and second ends of the containment tube. The divider element enables the flow of a fluid containing cells to be divided such that a portion of the cells flow in a first direction (e.g., towards the first end) and a portion of the cells flow in a second direction (e.g., towards the second end). Alternatively, a cell containment member (or other therapeutic device) may be placed inside the containment tube though the access port.

[0014] A ninth example relates to an implantable encapsulation device that includes a first containment tube including a first distal end and a first proximal end having a first access port and a second containment tube including a second distal end and a second proximal end having a second access port, and a manifold fluidly connected to the first access port of the first proximal end and to the second access port of the second proximal end. The manifold fluidly connects the first and second containment tubes.

[0015] A tenth example relates to an implantable encapsulation device that includes a plurality of containment tubes having a first end and a second end, a point centrally located between the first end and the second end of the containment tubes, and a manifold having multiple access ports. The manifold is in fluid connection with the containment tubes. In some examples, the manifold includes divider elements that enable the flow of a fluid containing cells to be divided such that a portion of the cells flow in a first direction (e.g., towards the first end) and a portion of the cells flow in a second direction (e.g., towards the second end). It is to be noted that cell containment members may be placed inside the containment tubes though the access ports. In addition, the encapsulation device could be formed of a plurality of first containment tubes and second containment tubes connected by the manifold.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this specification, illustrate embodiments, and together with the description serve to explain the principles of the disclosure.

[0017] FIGS. 1A and 1B are schematic illustrations of cross-sections of a cell containment member in accordance with some embodiments;

[0018] FIG. 2 is a schematic illustration of a containment tube in accordance with some embodiments;

[0019] FIGS. 3-10 are schematic illustrations of cross-sections of a porous polymeric material used to construct a containment tube in accordance with some embodiments;

[0020] FIG. 11A is a schematic illustration of a containment tube having two access ports and a flush port in accordance with some embodiments;

WHAT IS CLAIMED IS:

1. An implantable encapsulation device comprising:

a plurality of interconnected containment tubes, each said containment tube having a first access port at a first end thereof and a second access port at a second end thereof,

wherein said containment tubes are substantially parallel to each other along a length of said device, and

a flush port fluidly connected to one or more of said containment tubes via a tube.

2. The device of claim 1 wherein the plurality of interconnected containment tubes are interconnected by connection members.

3. The device of claim 2, wherein said connection members are periodically spaced along a length of said containment tubes a distance from each other.

4. The device of claim 1, further comprising a removable manifold fluidly connected to said containment tubes at said first end.

5. The device of claim 4, wherein the flush port and the tube are fluidly connected to said removable manifold.

6. The device of claim 1, wherein said plurality of containment tubes are periodically connected by interconnection members.

7 The device of claim 1, wherein said plurality of containment tubes are connected by off-axis interconnection members.

8. The device of claim 1, further comprising a woven textile, a non-woven textile, or a knit.

9. The device of claim 1, further comprising resealable caps affixed to said second access ports to seal said second end of said containment tubes.

10. The device of claim 1, wherein said containment tubes comprise a permeable membrane including an inner cell retentive layer and an outer vascularizing layer or said containment tubes comprise a shape memory material.

11. The device of claim 1, wherein said containment tube comprises a lumen for the reception and containment of a biological moiety or therapeutic device therein.

12. The device of claim 11, wherein the therapeutic device comprises a drug delivery device, a gene therapy device, a cell encapsulation device and combinations thereof.

13. The device of claim 12, wherein the one or more therapeutic devices are removably sealed to a manifold fluidly connected to said containment tubes at said first end.

14. The device of claim 13, wherein each of the one or more therapeutic devices includes a grasping structure.

15. The device of claim 12, wherein said biological moiety is a plurality of cells.

16. The device of claim 1, wherein said containment tubes have thereon a bio-absorbable material.

17. The device of claim 1, wherein said containment tubes are stacked upon one another in a z-direction.

18. The device of claim 1, wherein each of the plurality of containment tubes maintains a consistent cylindrical cross-section.

19. The device of claim 1, further comprising a bio-absorbable material in at least one of a solid form and a self-cohered web.

20. The device of claim 19, wherein the bio-absorbable material is formed at the first end or the second end as the solid form with a tapered leading edge.