SUMMARY

One or more examples of the disclosure may address one or more of the aforementioned problems. Certain examples according to the disclosure provide a biological cartridge including a housing chamber defining an interior region, wherein the housing chamber includes an inlet orifice and an outlet orifice. The biological cartridge also comprises at least one porous hydrogel block (PHB), such as a plurality of PHBs vertically stacked upon each other, located within the interior region of the housing chamber.

In another aspect, certain examples of the disclosure provide a system comprising a plurality of biological cartridges, such as those described and disclosed herein, connected to each other in series to define a biological cartridge network (BCN). The BCN may include at least (i) a first biological cartridge having a first inlet and a first outlet, and (ii) a second biological cartridge having a second inlet in operative communication with the first outlet, and a second outlet. In accordance with certain examples of the disclosure, each of the plurality of biological cartridges include a respective plurality of PHBs seeded with a first cell type of interest housed therein.

In another aspect, certain examples of the disclosure provide a system comprising a biological cartridge network (BCN) comprising (i) a first set of biological cartridges comprising a first plurality of biological cartridges, such as those described and disclosed herein, connected to each other in series, and (ii) a second set of biological cartridges comprising a second plurality of biological cartridges, such as those described and disclosed herein, connected to each other in series. The first set of biological cartridges and the second set of biological cartridges may be aligned in a parallel relationship with respect to each other and a common feed source.

In another aspect, certain examples of the disclosure provide a system comprising a biological cartridge network (BCN) comprising a plurality of biological cartridges, such as those described and disclosed herein, wherein the plurality of biological cartridges include (i) a first plurality of biological cartridges that are operatively connected in series, and (ii) a second plurality of biological cartridges are operatively connected in parallel. In this regard, the BCN may comprise a nearly unlimited number of individual biological cartridges in a nearly unlimited number of different overall configurations (e.g., a variety of series and/or parallel interconnections between biological cartridges with a variety of different cell types of interest being seeded in any number of biological cartridges).

In another aspect, certain examples of the disclosure provide a method of cultivating one or more cell types of interest, comprising: (i) providing a first biological

cartridge, such as those described and disclosed herein, wherein the first biological cartridge includes a first plurality of PHBs housed therein; (ii) seeding the first plurality of PHBs with at least a first cell type of interest; (iii) feeding the at least a first cell type of interest with a first culture media, and allowing the at least a first cell type of interest to propagate throughout the first network of microporous channels and/or chambers of the first plurality of PHBs; and (iv) harvesting at least a portion of the first cell type of interest located throughout the first network of microporous channels and/or chambers of the plurality of PHBs.

In another aspect, certain examples of the disclosure provide a method of cultivating one or more cell types of interest, comprising: (a) providing or forming a biological cartridge network (BCN) comprising (i) a first set of biological cartridges comprising a first plurality of biological cartridges, such as those described and disclosed herein, connected to each other in series, and (ii) a second set of biological cartridges comprising a second plurality of biological cartridges, such as those described and disclosed herein, connected to each other in series; wherein the first set of biological cartridges and the second set of biological cartridges are aligned in a parallel relationship with respect to each other and a common feed source; (b-1) seeding the respective PHBs within the respective initial biological cartridges of the first and second sets of biological cartridges with a first cell type of interest, and seeding respective immediately subsequent biological cartridges with a second cell type of interest, wherein the first and second cell types are different; or (b-2) seeding the respective PHBs within the respective initial biological cartridges of the first and second sets of biological cartridges with a first cell type of interest, and seeding an immediately subsequent biological cartridge of the first set of biological cartridges with a second cell type of interest, and seeding an immediately subsequent biological cartridge of the second set of biological cartridges with a third cell type of interest, wherein the first cell type, the second cell type, and the third cell type are all different from each other; and (c) harvesting at least a portion of the first cell type of interest and/or at least a portion of the second cell type of interest and/or at least a portion of the third cell type of interest.

BRIEF DESCRIPTION OF THE DRAWING(S)

The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that

THAT WHICH IS CLAIMED:

1. A biological cartridge, comprising:

a housing chamber defining an interior region, wherein the housing chamber includes an inlet orifice and an outlet orifice;

at least one porous hydrogel block (PHB) located within the interior region of the housing chamber.

2. The biological cartridge of claim 1, wherein the at least one PHB comprises a plurality of PHBs vertically stacked upon each other in a z-direction that is perpendicular to the x-y plane.

3. The biological cartridge according to any one of claims 1-2, further comprising at least one mounting element extending through the interior region.

4. The biological cartridge of claim 3, wherein the at least one mounting element comprises a single mounting element aligned along a central axis of the housing chamber and extending along an entire operating length of the housing chamber.

5. The biological cartridge of claim 3, further comprising a top plate and/or a bottom plate releasably engaged directly or indirectly to the housing chamber, and the single mounting element may optionally be directly or indirectly attached to the top plate and/or bottom plate.

6. The biological cartridge according to any one of claims 4-5, wherein the plurality of PHBs vertically stacked upon each other include a respective female mounting component

comprising a respective PHB orifice extending completely through a respective thickness in the z-direction of the respective PHBs, the respective female mounting components are configured to allow the at least one mounting element to extend through the respective PHB orifices.

7. The biological cartridge of claim 6, wherein the at least one mounting element may have a non-round cross-section and the respective PHB orifices have a corresponding non-round cross-section, wherein the vertically stacked respective PHBs are restrained from rotating in respective x-y planes relative to each other.

8. The biological cartridge of claim 3, wherein the at least one mounting element comprises at least one fin component attached to the housing chamber and projecting inwardly into the interior region of the housing chamber, and wherein at least one fin component extends along a at least a majority of the entire operating length of the housing chamber, such as at least about 55, 60, 65 and 75% of the entire operating length of the housing chamber, and/or at most about any of the following: 100, 98, 95, 90, 85, 80, and 75% of the entire operating length of the housing chamber, and wherein the plurality of PHBs vertically stacked upon each other include a respective female mounting component comprising a respective PHB cutout portion extending completely through a respective thickness in the z-direction of the respective PHBs, the respective female mounting components configured to allow the at least one mounting element to extend through the respective PHB orifices.

9. The biological cartridge according to any one of claims 1-8, further comprising (i) an inlet distribution filter located directly or indirectly above all of the at least one PHBs, wherein an incoming fluid passes through the inlet distribution filter prior to passing into any of the at least one PHBs, (ii) a drain filter located directly or indirectly below all of the at least one PHBs, wherein an exiting fluid passes through the drain filter prior exiting the biological cartridge, or (iii) both (i) and (ii).

10. The biological cartridge according to any one of claims 1-9, wherein the at least one PHB has a three-dimensional (3D) macrostructure defined by a continuous polymeric matrix material and the network of microporous channels and/or chambers extending throughout the continuous polymeric matrix material, wherein the continuous polymeric matrix material comprises a swellable hydrogel.

11. The biological cartridge of claim 10, wherein the swellable hydrogel comprises one or more natural polymers, such as plant-derived polymers and animal-derived polymers.

12. The biological cartridge according to any one of claims 10-11, wherein the continuous polymeric matrix material mimics a natural tissue of interest by including one or more physical properties within about 20%, such as within about 15%, 10%, 8%, 5%, 3%, or 1%, of the natural tissue of interest, wherein the one or more physical property of interest includes softness and tension.

13. A system, comprising:

a plurality of biological cartridges according to any one of claims 1-12 connected to each other in series to define a biological cartridge network (BCN), wherein the BCN includes at least (i) a first biological cartridge having a first inlet and a first outlet, and (ii) a second biological cartridge having a second inlet in operative communication with the first outlet, and a second outlet;

wherein each of the plurality of biological cartridges include a respective plurality of PHBs seeded with a first cell type of interest housed therein.

14. The system of claim 13, wherein the BCN comprises a fresh feed inlet and a product outlet, and wherein the BCN includes from 2 to about 50 biological cartridges, such as at

least about any of the following: 2, 5, 8, 10, 12, 15, 18, 20, 22, and 25 biological cartridges, and/or at most about any of the following: 50, 45, 40, 35, 30, and 25 biological cartridges.

15. The system according to any one of claims 13-14, wherein fresh feed inlet comprises a fresh feed-manifold having one or more ports in operative communication with the first biological cartridge, wherein the first biological cartridge is the initial biological cartridge of the BCN to receive fluid from the fresh-feed manifold.

16. The system according to any one of claims 13-14, wherein one or more of the plurality of biological cartridges includes a respective inlet manifold operatively connected to an immediately preceding biological cartridge via a respective conduit, and wherein the respective inlet manifold includes one or more supplemental ports in operative configuration with the respective plurality of PHBs for the supply of supplemental fluids.

17. A system, comprising:

a biological cartridge network (BCN) comprising (i) a first set of biological cartridges comprising a first plurality of biological cartridges according to any one of claims 1-12 connected to each other in series, and (ii) a second set of biological cartridges comprising a second plurality of biological cartridges according to any one of claims 1-12 connected to each other in series; wherein the first set of biological cartridges and the second set of biological cartridges are aligned in a parallel relationship with respect to each other and a common feed source.

18. The system of claim 17, wherein respective initial biological cartridges of the first and second sets of biological cartridges are each seeded with a first cell type of interest, and respective immediately subsequent biological cartridges are each seeded with a second cell type of interest, wherein the first and second cell types are different.

19. The system of claim 17, wherein respective initial biological cartridges of the first and second sets of biological cartridges are each seeded with a first cell type of interest, and an immediately subsequent biological cartridge of the first set of biological cartridges is seeded with a second cell type of interest, and an immediately subsequent biological cartridge of the second set of biological cartridges is seeded with a third cell type of interest, wherein the first cell type, the second cell type, and the third cell type are all different from each other.

20. The system according to any one of claims 17-19, wherein one or more of the first plurality and/or second plurality of biological cartridges includes a respective inlet manifold operatively connected to an immediately preceding biological cartridge via a respective conduit, and wherein the respective inlet manifold includes one or more supplemental ports in operative configuration with the respective plurality of PHBs for the supply of supplemental fluids.

21. A system, comprising: a biological cartridge network (BCN) comprising a plurality of biological cartridges according to any one of claims 1-12, wherein the plurality of biological cartridges include (i) a first plurality of biological cartridges that are operatively connected in series, and (ii) a second plurality of biological cartridges are operatively connected in parallel.

22. The system of claim 21, wherein the BCN includes at least one fresh feed-inlet, such as from 1 to about 10 fresh feed-inlets, and at least one product outlet, such as from 1 to about 10 product outlets.

23. A method of cultivating one or more cell types of interest, comprising:

(i) providing a first biological cartridge according to any one of claims 1-12, wherein the first biological cartridge includes a first plurality of PHBs seeded with a first cell type of interest housed therein;

(ii) seeding the first plurality of PHBs with at least a first cell type of interest;

(iii) feeding the at least a first cell type of interest with a first culture media, and allowing the at least a first cell type of interest to propagate throughout the first network of microporous channels and/or chambers of the first plurality of PHBs; and

(iv) harvesting at least a portion of the first cell type of interest located throughout the first network of microporous channels and/or chambers of the plurality of PHBs, wherein optionally (i) the step of harvesting at least a portion of the first cell type of interest located throughout the first network of microporous channels and/or chambers of the first plurality of PHBs comprises flushing them out of the first plurality of PHBs with a fluid medium and/or (ii) the step of harvesting at least a portion of the first cell type of interest located throughout the first network of microporous channels and/or chambers of the first plurality of PHBs comprises degrading the respective 3D macrostructure of the respective first plurality of PHBs.

24. The method of claim 23, further comprising providing a second biological cartridge according to any one of claims 1-12, wherein the second biological cartridge includes a second plurality of PHBs seeded with the first cell type of interest housed therein; and operatively connecting the first biological cartridge and the second biological cartridge in series.

25. The method of claim 23, further comprising providing a second biological cartridge according to any one of claims 1-12, wherein the second biological cartridge includes a second plurality of PHBs seeded with a second cell type of interest housed therein; and operatively connecting the first biological cartridge and the second biological cartridge in series, and optionally feeding the second cell type of interest with a second culture media, and allowing the second cell type of interest to propagate throughout the second network of microporous channels and/or chambers of the second plurality of PHBs.

26. The method of claim 25, further comprising harvesting at least a portion of the second cell type of interest located throughout the second network of microporous channels and/or chambers of the second plurality of PHBs, wherein optionally (i) the step of harvesting at least a portion of the second cell type of interest located throughout the second network of microporous channels and/or chambers of the second plurality of PHBs comprises flushing them out of the second plurality of PHBs with a fluid medium and/or (ii) the step of harvesting at least a portion of the second cell type of interest located throughout the second network of microporous channels and/or chambers of the second plurality of PHBs comprises degrading the respective 3D macrostructure of the respective second plurality of PHBs.

27. A method of cultivating one or more cell types of interest, comprising:

(a) providing or forming a biological cartridge network (BCN) comprising (i) a first set of biological cartridges comprising a first plurality of biological cartridges according to any one of claims 1-12 connected to each other in series, and (ii) a second set of biological cartridges comprising a second plurality of biological cartridges according to any one of claims 1-12 connected to each other in series; wherein the first set of biological cartridges and the second set of biological cartridges are aligned in a parallel relationship with respect to each other and a common feed source;

(b-1) seeding the respective PHBs within the respective initial biological cartridges of the first and second sets of biological cartridges with a first cell type of interest, and seeding respective immediately subsequent biological cartridges with a second cell type of interest, wherein the first and second cell types are different; or

(b-2) seeding the respective PHBs within the respective initial biological cartridges of the first and second sets of biological cartridges with a first cell type of interest, and seeding an immediately subsequent biological cartridge of the first set of biological cartridges with a second cell type of interest, and seeding an immediately subsequent biological cartridge of the second set of biological cartridges with a third cell type of interest, wherein the first cell type, the second cell type, and the third cell type are all different from each other; and

(c) harvesting at least a portion of the first cell type of interest and/or at least a portion of the second cell type of interest and/or at least a portion of the third cell type of interest.

28. The method of claim 27, further comprising (i) feeding the second cell type of interest with a second culture media, (ii) feeding the third cell type of interest with a third culture media, or (iii) both (i) and (ii).