## CLAIMS

1. A method of manufacturing a recombinant therapeutic protein, the method comprising:

providing a system comprising a first vessel and a second vessel, where the first vessel comprises a liquid comprising a recombinant therapeutic protein and the second vessel contains a volume of a sterilizing gas; and

flowing a first volume of the liquid out of the first vessel into the second vessel through the volume of the sterilizing gas contained within a headspace of the second vessel, wherein the method results in the manufacturing of the recombinant therapeutic protein.

2. The method of claim 1, wherein the second vessel further comprises:

(i) a fluid inlet configured such that the first volume of the liquid entering the second vessel passes through the headspace;

(ii) a fluid outlet configured such that liquid exiting the second vessel is flowed from below the headspace;

(iii) at least one gas inlet; and

(iv) at least one gas outlet,

wherein the fluid inlet is in fluid communication with the first vessel.

3. The method of claim 2, wherein the first vessel comprises a fluid outlet in fluid communication with the fluid inlet of the second vessel.

4. The method of claim 1, wherein during the method the second vessel is at least partially filled with a liquid.

5. The method of claim 1, wherein the sterilizing gas is sparged into the second vessel.

6. The method of claim 1, wherein the sterilizing gas is introduced directly into the headspace of the second vessel.

7. The method of claim 1, wherein the first vessel is a sterilized vessel.

8. The method of claim 1, wherein the system is a biological manufacturing system.

9. The method of claim 1, wherein the method further comprises:

(i) flowing a second volume of fluid from the second vessel into a first multi-column chromatography system (MCCS1);

(ii) capturing the recombinant therapeutic protein in the second volume of fluid using the MCCS1, wherein the eluate from the MCCS1 comprising the recombinant therapeutic protein is continuously fed into a second multi-column chromatography system (MCCS2); and

(iii) purifying and polishing the recombinant therapeutic protein using the MCCS2, wherein the eluate from the MCCS2 comprises the recombinant therapeutic protein.

10. The method of claim 9, wherein the method is integrated and runs continuously from the first vessel to the eluate from the MCCS2.

11. The method of claim 9, wherein the MCCS1 is a first periodic countercurrent chromatography system (PCCS1).

12. The method of claim 9, wherein the MCCS2 is a second periodic countercurrent chromatography system (PCCS2).

13. The method of claim 9, wherein the MCCS1 is a first periodic countercurrent chromatography system (PCCS1) and the MCCS2 is a second periodic countercurrent chromatography system (PCCS2).

14. The method of claim 1, wherein the recombinant therapeutic protein is an antibody or antibody fragment.

15. The method of claim 1, wherein the recombinant therapeutic protein is an enzyme.

16. The method of claim 15, wherein the enzyme is α-galactosidase-A.

17. The method of claim 15, wherein the enzyme is beta-glucosidase.

18. The method of claim 15, wherein the enzyme is alglucosidase.

19. The method of claim 1, wherein the sterilizing gas comprises ozone.

20. The method of claim 1, wherein the sterilizing gas comprises ethylene oxide.

21. The method of claim 1, wherein the sterilizing gas comprises nitrogen dioxide.

22. The method of claim 1, wherein the sterilizing gas comprises vaporized hydrogen peroxide.

23. The method of any one of claims 1-22, wherein the first vessel is a bioreactor.

24. The method of claim 23, wherein the bioreactor is a perfusion bioreactor.

25. The method of claim 23, wherein the bioreactor is a fed-batch bioreactor.

26. The method of claim 23, wherein the bioreactor is a production bioreactor.

27. The method of any one of claims 1-22, wherein the first vessel is a chromatography system.

28. The method of any one of claims 1-22, wherein the first vessel is an ultrafiltration/diafiltration system.