We claim:

~~1. An adherent cell culture bioreactor comprising a substrate for adherent cell culture, a feed-in pump and a feed-out pump, wherein the feed-in pump and the feed-out pump are configured to provide a constant-rate output of cell culture media from the bioreactor at an output volume of less than 50 mL of media per 1,800 cells per day, the substrate providing at least 400 m^2 of surface area for adherent cell culture, the bioreactor configured to contain at least 20 liters of cell culture media.~~

~~2. The adherent cell culture bioreactor of claim 1, the feed-in pump and the feed-out pump configured to provide a minimum constant-rate output of not more than 16.7 mL of media per 1,800 cells per day.~~

~~3. A method for culturing adherent cells on a substrate comprising:~~

~~a. obtaining the bioreactor of claim 1, and then~~

~~b. adding to the bioreactor cell culture media and cells, and then~~

~~c. culturing the cells in adherent mode on the substrate, while circulating the cell culture media about the cells at a rate of less than 50 mL of media per 1,800 cells per day.~~

~~4. The method of claim 3, wherein the cells in adherent mode produce a recombinant polypeptide.~~

~~5. The method of claim 4, wherein the cells in adherent mode produce a virus.~~

~~6. The method of claim 5, wherein the virus comprises a viral capsid containing a non-viral transgene.~~

~~7~~1. An adherent cell culture bioreactor comprising a substrate for adherent cell growth , a feed-in pump and a feed-out pump, wherein the feed-in pump and the feed-out pump are configured to provide a constant-rate output of cell culture media from the bioreactor at an output volume of less than 50 mL media per m^2 substrate area per day, the bioreactor configured to contain at least 20 liters of cell culture media.

~~8~~2. The adherent cell culture bioreactor of claim ~~7~~1, the substrate comprising at least 60 m^2 of surface area.

~~9~~3. The adherent cell culture bioreactor of claim ~~8~~2, the substrate comprising at least 400 m^2 of surface area.

~~10~~4. The adherent cell culture bioreactor of claim ~~7~~1, wherein the feed-out pump is connected to the bioreactor via a tube having an interior diameter sized to accommodate the pump output volume of cell culture media without the formation of air bubbles inside the tube.

~~11~~5. A method for culturing adherent cells on a substrate comprising:

a. obtaining the bioreactor of claim ~~7~~1, and then

b. adding to the bioreactor cell culture media and cells, and then

c. culturing the cells in adherent mode on the substrate, while circulating the cell culture media about the cells at a rate of less than 50 mL of media per m^2 substrate area per day.

~~12~~6. The method of claim ~~11~~5, wherein the cells in adherent mode produce a recombinant polypeptide.

~~13~~7. The method of claim ~~12~~6, wherein the cells in adherent mode produce a virus.

~~14~~8. The method of claim ~~13~~7, wherein the virus comprises a viral capsid containing a non-viral transgene.

~~15~~9. The method of claim ~~11~~5, the substrate comprising at least 60 m^2 of surface area.

~~16~~10. The method of claim ~~11~~5, the substrate comprising at least 400 m^2 of surface area.

~~17~~11. An adherent cell culture bioreactor comprising a substrate for adherent cell culture, a feed-in pump and a feed-out pump, wherein the feed-in pump and the feed-out pump are configured to provide a constant-rate output of cell culture media from the bioreactor sufficient to exchange the cell culture media in the bioreactor less than once every 3 ½ days, the bioreactor configured to contain at least 20 liters of cell culture media.

~~18~~12. The adherent cell culture bioreactor of claim ~~17~~11, wherein the feed-in pump and the feed-out pump are configured to provide a constant-rate output of cell culture media sufficient to exchange the cell culture media in the bioreactor less than once every 4 ½ days.

~~19~~13. The adherent cell culture bioreactor of claim ~~17~~11, the substrate comprising at least 60 m^2 of surface area.

~~20~~14. The adherent cell culture bioreactor of claim ~~17~~11, the substrate comprising at least 400 m^2 of surface area.

~~21~~15. A method for culturing adherent cells on a substrate comprising:

a. obtaining the bioreactor of claim ~~17~~11, and then

b. adding to the bioreactor cell culture media and cells, and then

c. culturing the cells in adherent mode on the substrate, while circulating the cell culture media about the cells at a rate ~~of less than 50 mL of media per 1,800 cells per day~~sufficient to exchange the cell culture media in the bioreactor less than once ever 3 ½ days.

~~22~~16. The method of claim ~~21~~15, wherein the cells in adherent mode produce a recombinant polypeptide.

~~23~~17. The method of claim ~~21~~15, wherein the cells in adherent mode produce a virus.

~~24~~18. The method of claim ~~23~~17, wherein the virus comprises a viral capsid containing a non-viral transgene.

19. The method of claim 15, wherein the substrate comprises at least 400 m^2 of surface area.

~~25. A method for culturing adherent cells on a substrate comprising:~~

~~a. obtaining an adherent cell culture bioreactor comprising a substrate for adherent cell culture, a feed-in pump and a feed-out pump, wherein the feed-in pump and the feed-out pump are configured to provide a constant rate output of cell culture media from the bioreactor sufficient to exchange the cell culture media in the bioreactor less than once every 3 ½ days, the bioreactor configured to contain at least 20 liters of cell culture media , and then~~

~~b. adding to the bioreactor cell culture media and cells, and then~~

~~c. culturing the cells in adherent mode on the substrate, while circulating the cell culture media about the cells at a rate of less than 50 mL of media per 1,800 cells per day, the substrate comprising at least 400 m^2 of surface area.~~

~~26. The method of claim 25, wherein the cells in adherent mode produce a recombinant polypeptide.~~

~~27. The method of claim 25, wherein the cells in adherent mode produce a virus.~~

~~28. The method of claim 27, wherein the virus comprises a viral capsid containing a non-viral transgene.~~