Claims

1. A system for monitoring and controlling cell culture, the system comprising:

a cell culture apparatus configured to communicate with one or more databases containing cell culture protocol data, a controller, one or more sensors communicatively coupled to the controller, and an interface with which one or more users can interact, via associated computing devices, for determining and monitoring a cell culture protocol, wherein the controller comprises a hardware processor coupled to memory containing instructions executable by the processor to cause the controller to:

receive data associated with cells to be cultured as input from the one or more users;

communicate with the one or more databases to receive cell culture protocol data;

analyze, using a machine learning system, the cell culture protocol data and the data associated with the cells to be cultured to thereby determine a tailored cell culture protocol for the cells to be cultured; and

update the cell culture protocol based on feedback from the one or more sensors during cell culture.

2. The system of claim 1, wherein the controller is integrated.

3. The system of claim 1, wherein the controller is distributed.

4. The system of claim 1, wherein the cell culture apparatus is a single-use cell culture apparatus.

5. The system of claim 1, wherein the one or more sensors are single-use sensors.

6. The system of claim 1, wherein the feedback is associated with at least one of pH, glucose concentration, lactate concentration, dissolved oxygen, total biomass, cell diameter, temperature, cell type, media type, and fluid flow rate.

7. The system of claim 1, wherein the one or more databases is a database comprising one or

more cell culture protocols previously developed by the system.

8. The system of claim 1, wherein the one or more databases is a publicly available database comprising one or more cell culture protocols.

9. A method of determining a cell culture protocol comprising:

providing a cell culture apparatus configured to communicate with one or more databases containing cell culture protocol data, wherein the cell culture apparatus comprises a controller, one or more sensors communicatively coupled to the controller, and an interface with which one or more users can interact, via associated computing devices, for determining and monitoring a cell culture protocol;

receiving data associated with cells to be cultured as input from the one or more users;

communicating with the one or more databases to receive cell culture protocol data;

analyzing, using a machine learning system, the cell culture protocol data and the data associated with the cells to thereby determine a tailored cell culture protocol for the cells to be cultured; and

updating the cell culture protocol based on feedback during cell culture.

10. The method of claim 9, wherein the feedback is associated with at least one of pH, glucose concentration, lactate concentration, dissolved oxygen, total biomass, cell diameter, temperature, cell type, media type, and fluid flow rate.

11. The method of claim 9, wherein the one or more databases is a database comprising one or more cell culture protocols previously developed by a system for monitoring and controlling cell culture.

12. The method of claim 9, wherein the one or more databases is a publicly available database comprising one or more cell culture protocols.

13. The method of claim 9, further comprising reporting the determined cell culture protocol.

14. The method of claim 13, wherein reporting comprises providing an alert when a level falls outside specified ranges.

15. The method of claim 14, wherein the alert comprises an email alert, voice alert, text alert, or combination thereof.

16. The method of claim 14, wherein a level comprises a pH level, dissolved oxygen level, total biomass level, cell diameter level, or temperature level.

17. The method of claim 13, wherein reporting further comprises providing monitoring information to a user.

18. The method of claim 17, wherein monitoring information comprises profiles of pH, dissolved oxygen, total biomass, cell diameter, and temperature.

19. The method of claim 9, wherein determining the cell culture protocol further comprises deciding to terminate the culture process, to stop using further reagents, to alert the user, or to shut the system down.

20. A method of determining a personalized cell culture protocol comprising:

providing a cell culture apparatus configured to communicate with one or more databases containing cell culture protocol data, wherein the cell culture apparatus comprises a controller, one or more sensors communicatively coupled to the controller, and an interface with which one or more users can interact, via associated computing devices, for determining and monitoring a personalized cell culture protocol;

receiving data associated with cells to be cultured for a human subject;

communicating with the one or more databases to receive data about cell culture protocols;

analyzing, using a machine learning system, the cell culture protocol data and the data associated with the cells to thereby determine a personalized cell culture protocol for cells to be cultured for the human subject; and

updating the cell culture protocol based on feedback during cell culture.

21. The method of claim 20, wherein the feedback is associated with at least one of pH, glucose concentration, lactate concentration, dissolved oxygen, total biomass, cell diameter, temperature, cell type, media type, and fluid flow rate.

22. The method of claim 20, wherein the one or more databases is a database comprising one or more cell culture protocols previously developed by a system for monitoring and controlling cell culture.

23. The method of claim 20, wherein the one or more databases is a publicly available database comprising one or more cell culture protocols.

24. The method of claim 20, wherein the determined personalized cell culture protocol is personalized based on the received data associated with cells to be cultured for the human subject.

25. The method of claim 20, further comprising reporting the determined personalized cell culture protocol.

26. The method of claim 20, further comprising optimizing the cell culture protocol, wherein optimizing comprises:

setting a user-defined parameter at a level to be maintained during cell culture;

measuring the level of the user-defined parameter during cell culture; and

optimizing the cell culture protocol by determining whether to change cell culture conditions to maintain the level of the user-defined parameter.

27. The method of claim 26, further comprising measuring the level of the parameter periodically during the cell culture protocol.

28. The method of claim 26, wherein the user-defined parameter comprises pH, turbidity,

glucose concentration, lactate concentration, other measures of cell health or identity, or a combination thereof.

29. The method of claim 26, further comprising changing cell culture conditions.

30. The method of claim 29, wherein changing cell culture conditions comprises manipulating a flow rate of media to change glucose concentration or lactate concentration.

31. The method of claim 29, wherein changing cell culture conditions comprises adding supplements.

32. The method of claim 31, wherein supplements comprise cytokines, growth factors, and serum.

33. The method of claim 26, further comprising storing the optimized cell protocol in a database.