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AICHE 2016 STUDENT DESIGN COMPETITION

Cell Therapy for Spinal Cord Injuries: Commercial Manufacturing Facility

Group Number: _____

Table of Contents

Abstract.....	7
Introduction.....	7
Process Flow Diagram and Material Balances	8
Material Balance	12
Process Description.....	13
Upstream Processes	13
Vial Thaw.....	14
Expansion.....	14
<i>Media</i>	14
Differentiation.....	16
<i>Media</i>	16
<i>Differentiation Process</i>	17
Oxygen Supply/Carbon Dioxide Removal	17
Virus and Bacteria Inactivation/Filtration	17
Purification.....	18
Storage	18
<i>Media</i>	18
Waste Treatment.....	18
Cleaning	19
Quality Control	19
Batch Schedule.....	19
Energy Balance and Utility Requirements.....	26
Equipment List and Unit Descriptions.....	31
Culture Hood.....	31
Incubator	31
Autoclave	31
Differentiation Media Mixing Vessel (V-101)	31
Expansion Media Mixing Vessel (V-102)	32
Electric Heater Water Bath (EH-101).....	32
1 st Expansion Vial (R-101)	32
2 nd Expansion T-Flask (R-102).....	32

3 rd Expansion Spinner Flask (R-103).....	32
4 th Expansion Spinner Flask (R-104)	32
Media Heaters (EH-102, EH-103)	33
Air-lift Bioreactor (R-105).....	33
UV Light Virus Inactivation (S-101).....	33
Chromatography Surge Vessel (V-103).....	33
Ion Exchange Chromatography Column (F-101)	33
Cross-Flow Filter (F-102).....	34
Cytometer Surge Vessel (V-104).....	34
Flow Cytometer (F-103)	34
Holding Vessel (V-105).....	34
Cryogenic Media Mixing Vessel (V-106)	34
Controlled Cryogenic Freezer (CV-101)	35
Cryogenic Freezer (CV-102)	35
Kill Tank (V-107)	35
Pumps.....	35
<i>Peristaltic</i>	35
<i>Centrifugal</i>	35
Equipment Specification Sheets	36
Equipment Cost Summary	36
Fixed Capital Investment Summary.....	38
Safety, Health, and Environmental Considerations	42
Personal Protective Equipment (PPE)	42
Hazards	43
Waste Disposal.....	45
Autoclave	46
Other Important Considerations.....	46
Facility Layout	46
Manufacturing Costs (exclusive of Capital Requirements).....	47
Economic Analysis	51
Discounted Cash Flow Analysis	51
Sensitivity Analysis	54

Conclusions and Recommendations	57
Acknowledgements.....	57
Bibliography	58
Appendix.....	64
Appendix A. Sizing and Timing.....	64
Appendix B. Energy and Utilities.....	67
Appendix C. Economics	73
Appendix D. Safety Information.....	84
<i>Safety Tables</i>	84
<i>Cameo Chemicals Interaction Matrix [57]</i>	86

Figures

Figure 1. Overview for the Process.....	8
Figure 2. Preliminary Design for Expansion, Differentiation, and Sterilization of Adult Stem Cells.....	9
Figure 3. Preliminary Design for Filtration and Packaging of Neural Stem Cells.....	10
Figure 4. Simplified Diagram of Material Flows of Growth and Metabolism of Stem Cell Cultures [2] ..	12
Figure 5. Equipment Use for Each Batch	26
Figure 6. Example Cell Culturing in a Culture Hood [33].....	31
Figure 7. Cost Distribution for Project Equipment	40
Figure 8. Cost Distribution of Process Vessels.....	40
Figure 9. Cost Distribution of Pumps	41
Figure 10. Cost Distribution for Electric Heaters	41
Figure 11. Cost Distribution for Filtration	42
Figure 12. Interaction Matrix of Hazardous Chemicals [57]	43
Figure 13. Facility Layout.....	47
Figure 14. Trend of CPI Values	48
Figure 15. Distribution of Manufacturing Costs	51
Figure 16. DCFROR Tornado Chart.....	56
Figure 17. NPV Tornado Chart.....	56

Tables

Table 1. Production of NSCs Stream Summary Table	11
Table 2. Overall Material Balances (lb/batch)	12
Table 3. Design Basis Calculations.....	13
Table 4. Expansion Media Specifications.....	15
Table 5. Expansion Media Needed for Each Passage	15
Table 6. Summary of Expansion Process.....	16
Table 7. Differentiation Media Specifications	16
Table 8. Oxygen Requirements for Vessels and Reactors	17
Table 9. Cryopreservation Media Specifications	18
Table 10. Methods for Quality Control.....	19
Table 11. Batch Schedule	20
Table 12. Overall Energy Balance	27
Table 13. Values Used in Energy Balance Calculations.....	29
Table 14. Utility Usage for Equipment in Each Batch.....	30
Table 15. Equipment Summary for Production of NSCs.....	36
Table 16. Equipment Costs in 2016 Dollars	37
Table 17. Sources for Equipment Costs.....	37
Table 18. Prediction for 2016 CEPCI Index [55]	38
Table 19. Fixed Capital Investment Summary.....	39
Table 20. Hazardous Material Properties.....	44
Table 21. Inherent Safety Table.....	45
Table 22. Predicted CPI Values for Escalation.....	48
Table 23. Yearly Manufacturing Costs in 2016 Dollars	49
Table 24. Labor Costs per Year	50
Table 25. Prices for Adult Stem Cells.....	50
Table 26. MACRS Depreciation Rates and Amounts.....	52

Table 27. Cash Flow Diagram for Production of NSCs.....	53
Table 28. Selling Price to Achieve Minimum IRR of 50%	54
Table 29. Potential Profit of NSC Production.....	54
Table 30. Percent Change for Uncertain Parameters	55
Table 31. Results of DCFROR Sensitivity Analysis	55
Table 32. Results of NPV Sensitivity Analysis	55
Table 33A. Time to Fill V-101	64
Table 34A. Time to Fill V-102	64
Table 35A. Time for S-101	64
Table 36A. Time for F-101	64
Table 37A. Time for F-102	64
Table 38A. Time for F-103	65
Table 39A. Times for Packaging	65
Table 40A. Values Used for Sizing Vessels	66
Table 41A. Values Used for Sizing Bioreactor.....	66
Table 42B. Useful Values for Utility Calculations	67
Table 43B. Utilities for V-101	67
Table 44B. Utilities for V-102	67
Table 45B. Utilities for V-103	67
Table 46B. Utilities for V-104	68
Table 47B. Utilities for V-105	68
Table 48B. Utilities for V-106	68
Table 49B. Utilities for V-107	68
Table 50B. Utilities for R-105	69
Table 51B. Utilities for S-101	69
Table 52B. Utilities for F-102.....	69
Table 53B. Utilities for F-103.....	69
Table 54B. Utilities for CV-101	69
Table 55B. Utilities for CV-102	69
Table 56B. Utilities for Refrigerator.....	69
Table 57B. Utilities for Incubator	70
Table 58B. Utilities for EH-101	70
Table 59B. Utilities for Hot Water Heater.....	70
Table 60B. Utilities for EH-102 and EH-103	71
Table 61B. Utilities for Pumps	71
Table 62B. Oxygen Supply Costs.....	72
Table 63C. MACRS Yearly Depreciation Rates	73
Table 64C. Module Costing Technique for Equipment.....	73
Table 65C. Vessel Equipment Costs.....	74
Table 66C. Capital Costs for Media Preheaters.....	75
Table 67C. Capital Cost for Hot Water Heater.....	75
Table 68C. Capital Cost for R-105	75
Table 69C. Source for CPI Values.....	76
Table 70C. Values Used for Manufacturing Cost of Cryogenic Process.....	76
Table 71C. Unit Prices for Expansion Media	77
Table 72C. Unit Prices for Differentiation Media	77
Table 73C. Unit Prices for Freezing Media	77

Table 74C. Profitability Cash Flow for Production of NSCs.....	79
Table 75C. Sensitivity: Base Case	80
Table 76C. Sensitivity: Best Case Net Revenue	80
Table 77C. Sensitivity: Worst Case Net Revenue	81
Table 78C. Sensitivity: Best Case Operating Cost.....	81
Table 79C. Sensitivity: Worst Case Operating Cost.....	82
Table 80C. Sensitivity: Best Case Capital Cost.....	82
Table 81C. Sensitivity: Worst Case Capital Cost	83
Table 82D. Potential Consequence Summary.....	84
Table 83D. Known Process and Equipment Hazards	84
Table 84D. Process Material Properties.....	85

Abstract

The following contains preliminary design considerations for the large-scale production of neural stem cells for spinal cord injury regeneration therapy. The facility is designed to meet market demand for years 2017-2021 assuming there are currently 250,000 people, plus the addition of 12,000 people each year, with spinal cord injuries. In other words, 66,222 people per year can benefit from this process. Each batch process begins with 100,000 undifferentiated induced pluripotent adult stem cells and ends with approximately 2.17×10^{11} differentiated neural stem cells that have gone through various measures to ensure quality. Each neural stem cell vial contains 1×10^7 cells and the breakeven price per vial was calculated to be \$24.04 at a hurdle rate of 50%. The overall capital cost for the process is \$871,606 with maximum recurring costs of about \$7,000,000 from media, chemicals, vials, well racks, and operating costs each year.

As can be seen in the “Sensitivity Analysis” section, the selling price of the vial has a major impact on the net present value (NPV) of the project. The cost of the media also can have a major impact on the net present value as it represents a major portion of the recurring costs. Therefore, if media costs go down, the NPV of this project will go up in response.

Three or four operators are required per shift for operation depending upon the part of the process that is occurring. Most of the process is automated and at any given time, there is no more than nine of the nineteen pieces of equipment in operation and four of those are only on for a short amount of time.

Safety considerations were of the utmost importance in designing this process. The facility is designed to minimize cross contamination by separating the sterile process from the rest of the facility. All waste is pretreated before entering city sewers to prevent the spread of possible blood borne pathogens to the community.

It is recommended from the preliminary design that a detailed design be conducted as the project is a low capital investment, has a short payback period, and is very economically attractive as can be seen from the “Conclusions and Recommendations” section of the document.

Introduction

Currently, there is roughly 250,000 people in the United States of America with spinal cord injuries and about 12,000 more occurring each year. The biotechnology company is developing spinal cord injury regeneration therapy to allow the people with these injuries to be mobile again. The team was tasked with designing a new manufacturing facility for this therapy. The production process includes a low shear bioreactor system that maintains control of pH, dissolved oxygen, and temperature. The bioreactor system is designed under cGMP conditions.

The commercialization team has designed a process that has the potential to give 66,222 people per year significant functional recovery, improved quality of life, and reduction of cost of medical care. The process starts with 100,000 adult pluripotent stem cells that are expanded and then differentiated into neural stem cells that can be injected into the injured part of the spine to aid in healing. Neural stem cells are more beneficial than other treatments because, once injected, they have the ability to differentiate into all types of neural cells [1]. Figure 1 below shows the concept of the design.

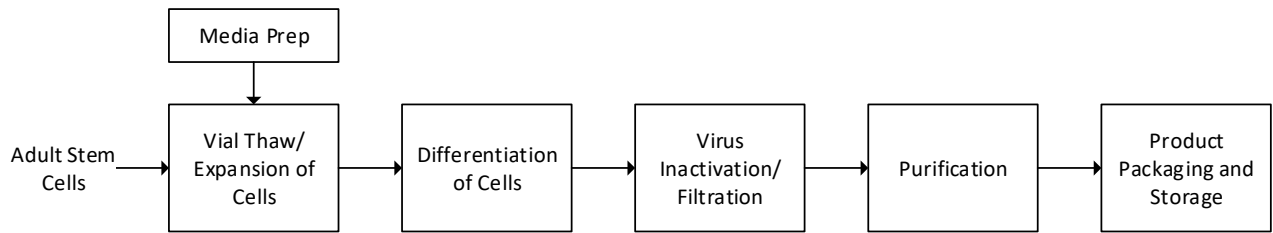


Figure 1. Overview for the Process

This process was designed to be inherently safe. Most vessels have steam in place for automatic sterilization right before each use to maintain a contaminant free environment. Units cleaned with chemicals rather than steam in place have a separate waste disposal system to avoid hazardous chemical interactions. All hazardous chemical interactions were considered in a interaction matrix.

The recommended design should be forwarded to the biotechnology company’s management team as soon as possible because time is of the essence. The following report discusses the technical specifications, economics, and gives overall conclusions and recommendations for the manufacturing facility.

Process Flow Diagram and Material Balances

The subsequent pages give a visual representation of the preliminary design for the production of neural stem cells in the manufacturing facility. Figure 2 shows the expansion, differentiation, and sterilization steps of the process while Figure 3 shows the virus filtration, purification, packaging, and storage processes.

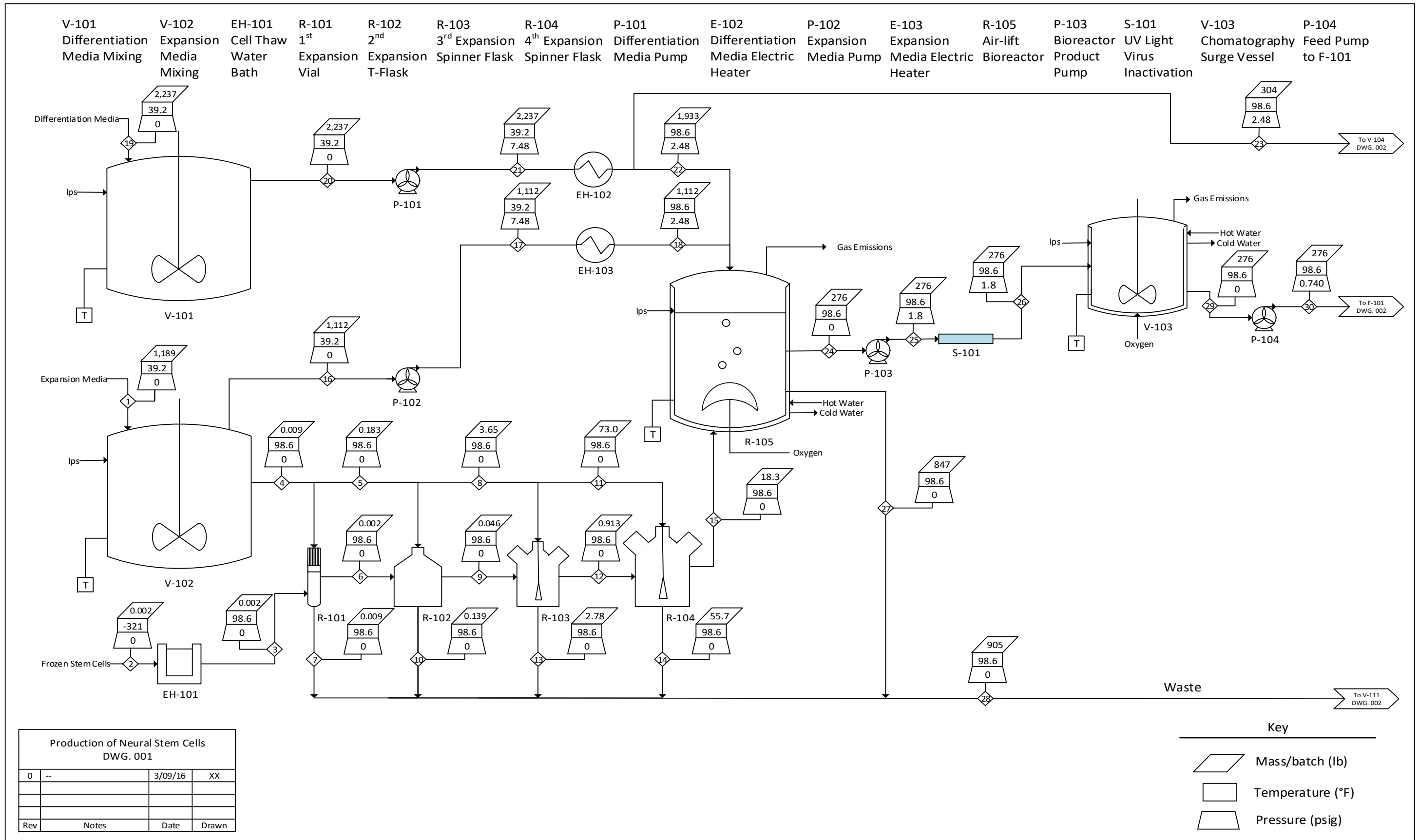


Figure 2. Preliminary Design for Expansion, Differentiation, and Sterilization of Adult Stem Cells

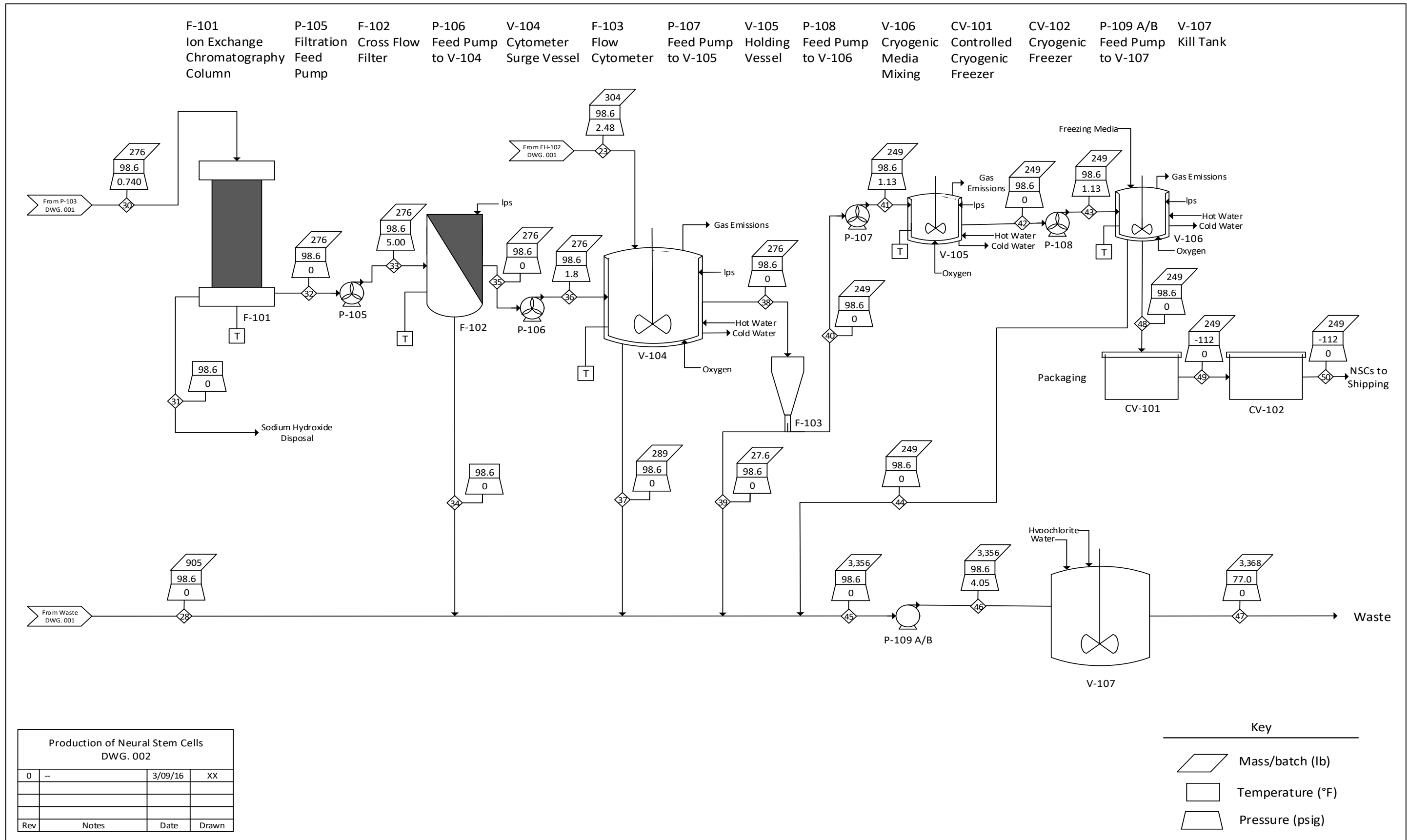


Figure 3. Preliminary Design for Filtration and Packaging of Neural Stem Cells