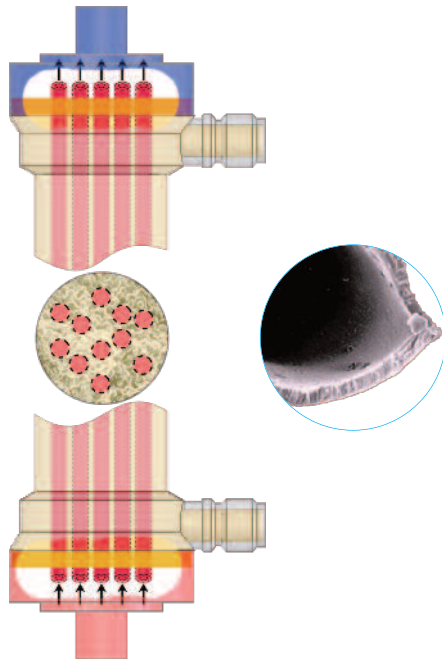


# Hollow Fiber Bioreactors

## Product Line Introduction

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### Proven Technology Cost-Effective Production

*C3 has provided hollow fiber bioreactor systems since the 1980s, and they have been used to produce numerous regulated biologics and other materials.*

This bulletin highlights the features of and differences between C3's six hollow fiber bioreactor systems. A separate bulletin provides an introduction to the unique aspects and advantages of hollow fiber bioreactor technology.

For this latter document and any other technical information, please contact C3 using the contact information on the back of this brochure.

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|  |   |
|--|---|
| <b>Introduction</b> .....                      | 2 |
| <b>System Comparison</b> .....                 | 3 |
| <b>Small-Scale Systems</b> .....               | 4 |
| <b>Pilot-Scale Systems</b> .....               | 5 |
| <b>Production-Scale Systems</b> .....          | 6 |
| <b>Predictable &amp; Linear Scale-Up</b> ..... | 7 |
| <b>Contact Information</b> .....               | 8 |

# Hollow Fiber Bioreactors

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## Introduction

Achieving high cell densities and reducing the costs to produce biologics are desirable but not always simple or inexpensive goals. C3's hollow fiber bioreactor systems are a solution to both goals. C3 has four hollow fiber bioreactor (HFBrx) systems to address a wide range of production applications. We offer one small-scale system, two pilot-scale systems and one production-scale system.



HF Primer™



AutovaxID®



AcuSyst-MAXIMIZER®



AcuSyst-XCELLERATOR™

## C3's Bioreactor Systems

A range of capacities and automation to accommodate your production needs.

|                     | Highlights  | Equipment Needed   | Achievable Cell Counts |
|---------------------|---|--|------------------------|
| <b>HF Primer™</b>   | Replaces: <ul style="list-style-type: none"> <li>• T-Flasks &amp; Spinner Flasks</li> <li>• Roller Bottles</li> <li>• Ascites</li> <li>• Wave and Others...</li> <li>• Low-Cost Feasibility System Before Scaling-up</li> </ul>   | <ul style="list-style-type: none"> <li>• CO<sub>2</sub> Incubator</li> <li>• One Masterflex Pump System</li> </ul>   | 1-10 x 10 <sup>6</sup> |
| <b>AutovaxID®</b>   | <ul style="list-style-type: none"> <li>• Simultaneous Production from 1-3 Cell Lines</li> <li>• Most Automated System, Controlling:               <ul style="list-style-type: none"> <li>- pH, Incubator Temperature,</li> <li>- Lactate, ICS &amp; ECS Perfusion and Others</li> </ul> </li> <li>• Simplest Setup &amp; Operation of all Pilot-Scale Systems</li> <li>• Web Browser Remote Control</li> <li>• Integral Refrigerator for Supernatant Storage During Collection</li> </ul> | <ul style="list-style-type: none"> <li>• CO<sub>2</sub> Supply</li> <li>• 100-240 VAC</li> <li>• One Masterflex Pump System</li> <li>• LAN Connection</li> </ul> | 1.5 x 10 <sup>11</sup> |
| <b>MAXIMIZER®</b>   | Automated Control of: <ul style="list-style-type: none"> <li>• pH, Incubator Temperature, ICS &amp; ECS, Perfusion, and Others</li> <li>• 1 Cell Line at a Time</li> </ul>  | <ul style="list-style-type: none"> <li>• CO<sub>2</sub> Supply</li> <li>• 100-240 VAC</li> </ul>   | 2-4 x 10 <sup>11</sup> |
| <b>XCELLERATOR™</b> | Automated control of: <ul style="list-style-type: none"> <li>• pH Control, Incubator Temperature, ICS &amp; ECS Perfusion, and Others</li> <li>• 1-2 Cell Lines at a Time</li> <li>• Web Browser Remote Control</li> <li>• Integral Refrigerator For Supernatant Storage During Collection</li> </ul>   | <ul style="list-style-type: none"> <li>• CO<sub>2</sub> Supply</li> <li>• 100-240 VAC</li> <li>• LAN Connection</li> </ul>                                       | 1-2 x 10 <sup>12</sup> |

# Hollow Fiber Bioreactors

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## Small-Scale Systems



**HF Primer™**

|  |  |
|--|--|
| <b>Excellent alternative to</b>              | T-Flasks, Spinners, Roller Bottles, Ascites, Wave, CelliGen... |
| <b>Runs weeks to months</b>                  | Yes  |
| <b>Uses single-use disposables</b>           | Yes  |
| <b>Culture suspension or adherent cells</b>  | Yes  |
| <b>Bioreactor culture volume and size</b>    | 80 mL ,1.1 m <sup>2</sup>                                      |
| <b>Number of bioreactors</b>                 | 1  |
| <b>Simultaneous cell lines in culture</b>    | 1  |
| <b>Cells supported</b>                       | ~5x10 <sup>10</sup>  |
| <b>pH control</b>                            | via CO <sub>2</sub> Incubator                                  |
| <b>Temperature control</b>                   | via CO <sub>2</sub> Incubator                                  |
| <b>Unsupplemented media change method</b>    | Manual, open system  |
| <b>Unsupplemented media change frequency</b> | 1-7 days   |
| <b>Supplemented media changes</b>            | Manual (using syringes)  |
| <b>Harvest supernatant</b>                   | Manual (using syringes)  |
| <b>Footprint</b>                             | 12 cm W x 20 cm D x 33 cm H                                    |

## Pilot-Scale Systems



AutovaxID®



AcuSystem-MAXIMIZER™

|  |   |  |
|--|---|--|
| <b>Excellent alternative to</b>                                      | Wave, CelliGen, Stirred-Tank Reactors and Others...   |  |
| <b>Example fed-batch STR equivalent</b>                              | 80L   | 80L or 160L  |
| <b>Runs weeks to months</b>  | Yes   |  |
| <b>Uses single-use disposables</b>                                   | Yes   |  |
| <b>Culture suspension or adherent cells</b>                          | Yes   |  |
| <b>Bioreactor culture volume and size</b>                            | 160 mL, 2.1 m <sup>2</sup>                            |  |
| <b>Number of bioreactors</b>   | 1 (2.1 m <sup>2</sup> ) or<br>3 (0.5 m <sup>2</sup> ) | 1 or 2<br>(2.1 m <sup>2</sup> )<br>Also available in 1.5m <sup>2</sup> with<br>1 or 2 cartridges |
| <b>Simultaneous cell lines in culture</b>                            | 1   | 1  |
| <b>Low-cost R&amp;D Disposables options</b>                          | Yes   | No   |
| <b>Cells supported</b>   | ~2x10 <sup>11</sup>                                   | ~4x10 <sup>11</sup>  |
| <b>Closed system operation</b>                                       | Yes   |  |
| <b>Automatic Control of: pH, temp. and others</b>                    | Yes   |  |
| <b>Automatic lactate control (automated media feed rate changes)</b> | Yes   | No   |
| <b>Integral refrigerator</b>   | Yes   | No   |
| <b>21 CFR Part 11 Compliant</b>                                      | Yes   | Not applicable   |
| <b>Touch screen and remote monitor &amp; control capable</b>         | Yes   | No   |
| <b>Footprint</b>   | 51 cm W x 51 cm D x 48 cm H                           | 70 cm W x 66 cm D x 52 cm H  |

# Hollow Fiber Bioreactors

## Production-Scale Systems



AcuSyst-XCELLERATOR™

|   |   |
|---|---|
| <b>Excellent alternative to</b>                               | Stainless Steel Stirred tank bioreactors and Single-Use bioreactors |
| <b>Example fed-batch STR equivalent</b>                       | 500-1,600L Depending on Disposable and Usage                        |
| <b>Runs weeks to months</b>                                   | Yes   |
| <b>Uses single-use disposables</b>                            | Yes   |
| <b>Culture suspension or adherent cells</b>                   | Yes   |
| <b>Bioreactor culture volume and size</b>                     | 160 mL, 2.1 m <sup>2</sup>  |
| <b>Number of bioreactors per cultureware (the disposable)</b> | 6 (2.1 m <sup>2</sup> )<br>10 (2.1 m <sup>2</sup> )                 |
| <b>Simultaneous cultureware in use</b>                        | 1 or 2<br>(One Cultureware Shown in Picture Above)                  |
| <b>Simultaneous cell lines in culture</b>                     | 1 or 2  |
| <b>Cells supported</b>  | 1-2 x 10 <sup>12</sup>  |
| <b>Closed system operation</b>                                | Yes   |
| <b>Automatic Control of: pH, temp. and others</b>             | Yes   |
| <b>Integral refrigerator</b>                                  | Yes   |
| <b>21 CFR Part 11 Compliant</b>                               | Yes   |
| <b>Touch screen and remote monitor &amp; control capable</b>  | Yes   |
| <b>Footprint</b>  | 134 cm W x 85 cm D x 203 cm H                                       |

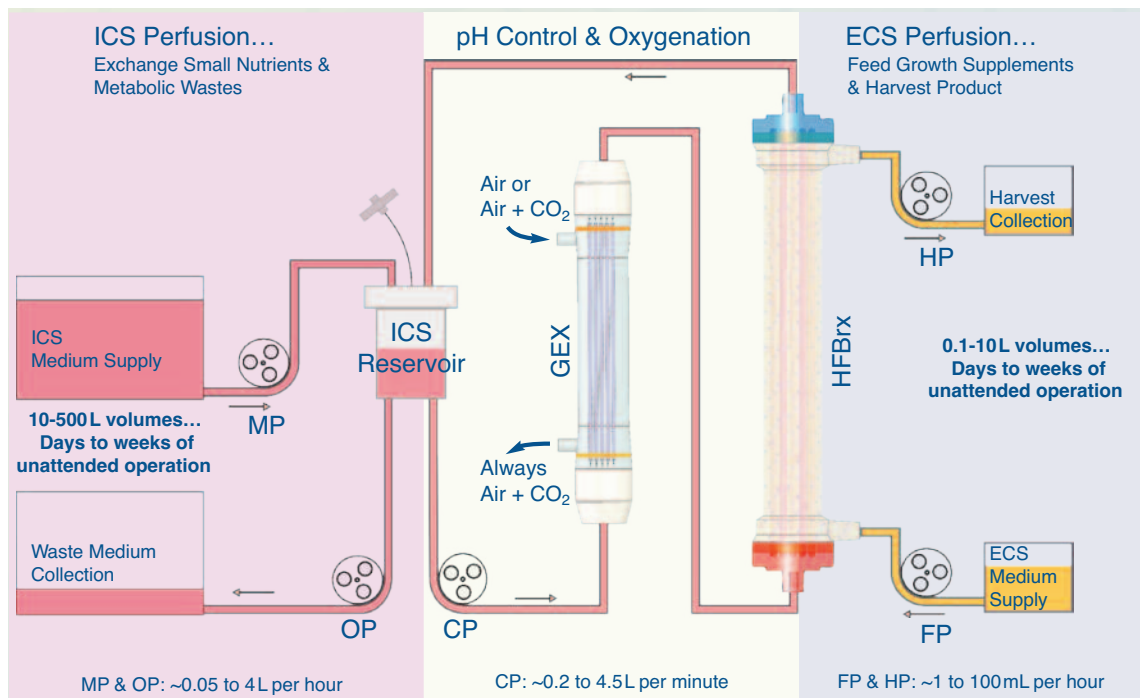
## Predictable & Linear Scale-Up

C3's pilot- and production-scale systems all use the same 2.1 m<sup>2</sup> bioreactor in their single-use disposable cultureware. Once the ICS Perfusion rate, ECS Perfusion rate and Circulation rate to support a single 2.1 m<sup>2</sup> bioreactor are determined, scale-up is a predictable, linear process because multiple 2.1 m<sup>2</sup> bioreactors are run in parallel. An example: A pilot-scale AutovaxID<sup>®</sup> run using a single 2.1 m<sup>2</sup> bioreactor determines the following steady-state rates for a cell line. A production-scale run in the AcuSyst-XCELLERATOR<sup>™</sup> using a cultureware with ten 2.1 m<sup>2</sup> bioreactors would be planned to use the following rates:



| Rate                   | AutovaxID <sup>®</sup> | AcuSyst-XCELLERATOR <sup>™</sup> |
|------------------------|------------------------|----------------------------------|
| ICS Perfusion, mL/hour | 350                    | 3,500                            |
| ECS Perfusion, mL/hour | 9                      | 90                               |
| Circulation, mL/min.   | 400                    | 4,000                            |

Photo showing five of the ten bioreactors during a production-scale run in AcuSyst-XCELLERATOR<sup>™</sup>





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*Cell Culture Company is very interested in hearing from you, and upon request, it would be our pleasure to email you with news and updates.*

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