REQUEST FOR INFORMATION

Montgomery County Community College
Procurement Department

Proposal Title: Virtual Downstream eLearning Plan to Support Biomanufacturing

This is Montgomery County Community College’s Request for Proposal No. RFP#06-102714RFP-1, issued October 13th, 2014. Direct inquiries for information to: Marie Ryan, Email: mryan2@mc3.edu. **Sealed proposals will be accepted prior to 3:00 p.m., Monday, October 27th, 2014.** Proposals received after the stated due date and time shall not be considered.

**All questions/requests for information shall be submitted in writing via email to mryan2@mc3.edu,** and to be assured consideration must be received prior to 5:00 p.m., Monday, October 20, 2014. Questions may be emailed to the attention of Marie Ryan at mryan2@mc3.edu. After reviewing any questions/requests submitted, College will issue an addendum if necessary on the College’s website at [www.mc3.edu](http://www.mc3.edu), drop down to the bottom of the page and click on purchasing. Changes to this Request for Proposals will be made only by written addendum issued by the College Procurement Department.

Submit Proposals: **BY MAILTO:**
Montgomery County Community College, Procurement Dept., Room 121 - College Hall, 340 DeKalb Pike, Blue Bell, PA 19422

**BY HAND DELIVERY OR EXPRESS CARRIER TO:**
Montgomery County Community College, Procurement Dept., Room 121 - College Hall, 340 DeKalb Pike, Blue Bell, PA 19422

Firms shall ascertain prior to submitting a response that all Addenda issued have been received and shall **acknowledge receipt and inclusion of all Addenda here:**

<table>
<thead>
<tr>
<th>Addendum No.</th>
<th>Date:</th>
<th>Addendum No.</th>
<th>Date:</th>
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</table>

**Information the Firm deems Proprietary is included in the proposal response in the separate section of the response identified immediately below.** See page five, paragraph B for additional information.

All proposed exceptions to College’s CONTRACT and to the General Terms and Conditions included in this Request for Proposals are included in the section identified immediately below. See page five, paragraph C for more information.
In compliance with this Request for Proposals and all the conditions imposed therein, the undersigned offers and agrees to furnish the goods/services in accordance with the attached proposal or as mutually agreed upon by subsequent negotiations. By my signature below, I certify that I am authorized to bind the Firm in any and all negotiations and/or contractual matters relating to this Request for Proposals. Sign in ink and type or print requested information.

INCLUDE PAGES 1 AND 2 OF THIS RFP AS THE FIRST 2 PAGES OF YOUR PROPOSAL RESPONSE

THIS PROPOSAL RESPONSE IS SUBMITTED BY:

Full Legal Name of Firm: 
Mailing Address: 
Remittance Address (If Different): 

Fed ID OR Soc. Sec. No. 
Phone: ( ) 
Signature: 
(Person signing must be authorized to bind the Firm in contractual matters) 
Typed/Printed Name: 

Date: 
Fax: ( ) 
Title: 
(Applicable to Partnership/Corporation)

INDICATE THE TYPE OF BUSINESS:

______ Individual Trading in Own Name
______ Individual Trading Under Trade Name

(Individual and Trade Name must be listed below as “legal name”)

______ Partnership
______ Corporation

CORPORATE SEAL:

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I. SUBMISSION OF PROPOSALS

A. NUMBER OF COPIES
An original, so marked, and 5 copies, so marked, for a total of 6 of your proposal document are required. Submit proposals in a sealed envelope, and put the RFP number, title, due date and time on the outside of the envelope. Firms are responsible for having their proposal stamped by Purchasing Department staff before the deadline for receipt of proposals. College will not assume responsibility for reproduction where an insufficient number of copies have been supplied. In any such case, College will notify the Firm of the deficiency and request that the appropriate number of copies be delivered within 24 hours. Failure to comply with this or other requirements of this Request for Proposal shall be grounds for College to reject such proposals. Telegraphic or facsimile submission of proposals is not acceptable and any such proposals will not be considered. Nothing herein is intended to exclude any responsible Firm or in any way restrain or restrict competition. All responsible Firms are encouraged to submit proposals. No decision on this RFP will be made until after the November 2014 Board of Trustees Meeting.

B. SUBMISSION OF PROPRIETARY INFORMATION

Trade secrets or proprietary information submitted by a Firm in connection with this procurement transaction shall not be subject to public disclosure; however, the Firm must invoke protection prior to or upon submission of the data or the materials, and must identify the data or other materials to be protected and state the reason why protection is necessary. Firms shall submit, in a separate section of the proposal, any information considered proprietary and any copyrighted material and clearly identify the information as proprietary and/or copyrighted information. Firms may not declare their entire proposal proprietary nor may they declare proposed pricing to be proprietary. References may be made within the body of the proposal to proprietary information; however all information contained within the body of the proposal not in the separate section labeled proprietary shall be considered Public Information.

C. USE OF CONTRACT FORM, GENERAL TERMS AND CONDITIONS

1. This Request for Proposals contain terms and conditions that College favors and intends to use for the resultant contract. If the Firm has contractual language and/or contractual documents it wishes to have considered, such contractual language/documents must be submitted as part of the Firm’s proposal response. Any Firm receiving a contract award shall be required to execute a contract in substantial compliance with College’s standard contract and will be required to furnish an original Certificate of Insurance and all other required contact documents within fifteen days after receipt of notification that the contract is ready for signature; otherwise, College may award the work to another Firm.

2. Mandatory provisions of this Request for Proposals are indicated by the inclusion of the words "shall" or "must" to identify the Firm's obligations. Firms who take exception to mandatory provisions will be requested to withdraw the exception(s). Firms not agreeing to withdraw exceptions to mandatory provisions may be deemed nonresponsive or may receive a lower evaluation score.

D. FIRM CERTIFICATIONS

1. By submitting its proposal response, the Firm certifies that it has not combined, conspired or agreed to intentionally rig, alter or otherwise manipulate, or to cause to be rigged, altered or otherwise manipulated its proposal response for the purpose of allocating purchases or sales to or among persons, raising or otherwise fixing the prices of the goods or services, or excluding other persons from dealing with College.

2. By submitting its proposal response, the Firm certifies that its proposal is made without collusion or fraud and that it has not offered or received any kickbacks or inducements from any other Firm, supplier, manufacturer or related entity in connection with its proposal; and that it has not conferred on any public employee having official responsibility for this procurement transaction
any payment, loan, subscription, advance, deposit of money, services or anything of more than nominal value, present or promised.

E. OTHER

1. College will not be responsible for any expense incurred by any Firm in preparing and submitting a proposal response. All proposals submitted will become the property of the College.

2. Proposals having any erasures or corrections must be initialed by the Firm in ink.

II. GENERAL INFORMATION

A. Purpose/Rational

The purpose of this Request for Proposal is threefold:
1) Provide background information on the Department of Labor (DOL) Trade Act Assessment (TAA) Community College Consortium for Bioscience Credentials (c3bc) grant;
2) Detail the rational for the development interactive simulation-based virtual downstream processing module for biomanufacturing education; and
3) Request additional details on estimated costs and timelines from interested service providers for the design and development of the virtual platform for downstream processing in Biomanufacturing.

This document details the proposal for the design and development of the virtual platform for downstream processing in Biomanufacturing in support of the DOL c3bc TAACCCT grant initiative. The proposal for this virtual instruction platform (learning management system, LMS) in downstream processing is requested with the support of DOL TAACCCT c3bc federal grant funds. These virtual modules are to be developed as part of the global biomanufacturing curriculum and are to serve as valuable teaching and learning tools to advance biomanufacturing educational initiatives.

B. Background

The Community College Consortium for Bioscience Credentials (c3bc) is a multistate consortium of 12 Community Colleges funded by the Department of Labor (DOL) that has several aims which include:
- Harmonize core skills and competencies across the biosciences, including biotechnology, biomanufacturing, and medical devices;
- Expand and improve the delivery of education and career training programs at the Community College level; and
- Assist grant participants to obtain employment in high-wage, high-skill occupations, such as biotechnology and biomanufacturing.

C. Proposed schedule of Implementation

** The College retains the right to adjust or revise the referenced implementation schedule.

<table>
<thead>
<tr>
<th>Description (Deliverable; personnel; Bill rate)</th>
<th>Estimated Invoice Date, Hours, and Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated sum of hours to complete deliverable:</td>
<td>Total cost $</td>
</tr>
</tbody>
</table>
| #1 Provide a LMS platform and curate learning content  
(Enable remote domain, hosting, and server capabilities) | November 30, 2014 |
| Number of Personnel assigned the task: | |
| Estimated sum of hours to complete deliverable: | |
| Billing-rate per hour: $ | |

| #2 Provide a device-friendly interface (mobile preferred) | November 30, 2014 |
| Number of Personnel assigned the task: | |
| Estimated sum of hours to complete deliverable: | |
| Billing-rate per hour: $ | |

| #3 Provide instructional design elements & visualizations for major elements of equipment: | January 30, 2015 |
| Number of Personnel assigned the task: | |
| Estimated sum of hours to complete deliverable: | |
| Billing-rate per hour: $ | |

| #4 Provide instructional design elements / visualizations of the flow of product, Ab IgG, through the stages of: | January 30, 2015 |
| Number of Personnel assigned the task: | |
| Estimated sum of hours to complete deliverable: | |
| Billing-rate per hour: $ | |

| #5 Provide instructional design visualizations / detail the purification of Ab IgG with affinity chromatography: | March 30, 2015 |
| Number of Personnel assigned the task: | |
| Estimated sum of hours to complete deliverable: | |
| Billing-rate per hour: $ | |
### #6 Provide interactive scenario-based learning outcomes

<table>
<thead>
<tr>
<th>Number of Personnel assigned the task:</th>
<th>Estimated sum of hours to complete deliverable:</th>
<th>Billing-rate per hour: $</th>
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<tbody>
<tr>
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<td>March 30, 2015</td>
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<td>Bill-rate (per hour):</td>
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<td>Billing Amount:$</td>
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</tbody>
</table>

### #7 Provide user management, web security, patches, & other services:

Provide user training, user support, content updates, security patches, software updates, user statistics, and on-going services.

<table>
<thead>
<tr>
<th>Number of Personnel assigned the task:</th>
<th>Estimated sum of hours to complete deliverable:</th>
<th>Billing-rate per hour: $</th>
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<tr>
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<td>April 30, 2015</td>
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<tr>
<td></td>
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<td>Total # of Hours:</td>
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<td></td>
<td>Bill-rate (per hour):</td>
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<tr>
<td></td>
<td></td>
<td>Billing Amount:$</td>
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</tbody>
</table>

### #8 Support, update, provide security, and maintain the portal / content for the LMS up to September 30th 2015

<table>
<thead>
<tr>
<th>Number of Personnel assigned the task:</th>
<th>Estimated sum of hours to complete deliverable:</th>
<th>Billing-rate per hour: $</th>
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<tbody>
<tr>
<td></td>
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<td>April 30, 2015</td>
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<td>Total # of Hours:</td>
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<td>Bill-rate (per hour):</td>
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<td>Billing Amount:$</td>
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**Billing:**
- 10% upon signing of the MOU
- 10% upon completion of #1,#2 as stated above
- 25% upon completion of #3,#4 as stated above
- 25% upon completion of #5,#6 as stated above
- 10% upon completion of #7,#8 as stated above
- 20% upon execution and testing of the platform

**Summary**
- Total cost $ (# hours * bill-rate/hour): $

### III. SCOPE OF SERVICES

In support of the objectives of the grant, the service provider will perform the following services *(but not limited to):*

- **Provide a Learning Management System (LMS) that enables domain, hosting, and server capabilities**
  - Provide a portal/website as point of entry
  - Provide login/registration and curation
  - Collect and store participant progress and status
  - Provide assessments, decision trees, and curation
  - Track participant’s progress in downstream processing educational modules
  - Enable multimedia and interactive simulations for key outcomes
• **Collect data from participants:** The platform will facilitate the collection of specific information (contact details, assessment status, and assessment results) from participants.

• **Curate data from participants and assessments:** The platform will facilitate the storage and recall of specific information (contact details, assessment progress, and assessment results) from participants.

• **Develop a user-friendly interface:** Design and develop an open, portable, and user-friendly platform interface (preferably mobile Web-based solution) for participants/users. This platform will have the ability to enter/verify/update data with various devices, including mobile phones, iPad, or similar devices.

• **Provide ongoing-support and maintenance:** Provide user training, user support, content update, security patches, software updates, database analytics, user statistics, and on-going support services as necessary and requested.

**Technical requirements.** This proposal has the following requirements:

- An LMS platform that is compliant with requirements from IT for platform capability and services
- Access to domain, server, and hosting services
- Use of a portable, adaptable, and flexible *open platform* (compatible with various mobile and PC/tablet devices (Mac or android)
- Platform compatibility with internet browsers such as Internet Explorer, Firefox, and Chrome

**Additional requirements**

- Receive original learning outcomes and curriculum content from various SME
  - **Note:** Learning outcomes are provided in a separate document
- Develop the downstream work-flow diagram
  - Example of Workflow Summary for downstream processing elements
    - Bioreactor (20K Liter unit)
    - Harvest by Continuous Centrifugation
    - Clarification by Depth Filtration
    - Sterile Filtration
    - Holding Tank (5-10K Liter unit)
    - Sterile Filtration
    - Liquid Column Chromatography >>> Protein-A Affinity
    - Eluate Hold Tank
    - Tangential Flow Filtration
    - Holding Tank for Storage
  - **Note:** More details on the sequence of processes and the user interface are described as text under Supporting Materials at the end of this document.

**Additional information**

- It is the expectation that the SME’s (with the option of contracted consultants) will provide content and learning assessments. The selected vendor will be expected to coordinate with the SME and/or contracted consultants to build approximately 2 hours of content into the LMS and provide an attractive and interactive learning environment for trainees.
- The selected vendor will be expected to coordinate with the SME’s to deliver an interactive learning environment to ensure trainee participation and ensure trainee outcomes.
• Approximately 300 potential trainees from various Biomanufacturing programs may access the LMS/system at a given time from multiple locations across the nation.

• The development of the virtual modules in Downstream Processing would commence immediately after vendor selection. Deployment of the learning modules would occur upon execution and be over a period of the next six months.

• It is the option of the services team to provide more than a singular solution to the proposal to ensure a successful outcome on the deliverables. Conversations and consultations with the MCCC c3bc team are expected to commence immediately after the initial submission date. Upon receipt of feedback, it is expected that a prepared presentation of the capabilities of the vendor be shared with the MCCC c3bc team prior to final vendor selection.

• Vendor access to industrial biomanufacturing equipment/sites for equipment illustrations, workflow, and scenario development processes.
• Compliance with the DOL TAA c3bc federal grants and MCCC reporting requirements, standard, data security, privacy, policy, etc.
• Commitment to deliver products and services as described within the timeframes of the RFP
• Familiarity with associated other portals including “Biomanufacturing.org and BiomanOnline
• Participation in weekly meeting and monthly reports to stakeholders

Reporting requirements/communications. In support of this work, it is recommended that several types of communications be conducted to monitor progress and resolve project challenges. These include (but are not limited to):
• The service provider be available via electronic and phone communications
• Weekly progress meetings be held among project representatives from both MCCC and the _______________ development team.
• Monthly progress reports will be submitted by the service provider on the 15th day for the preceding month. These monthly status reports include the following information:
  • A milestone chart detailing the preceding months accomplishments
  • A description of challenges/difficulties encountered during the current reporting cycle with root-cause delay details and current solutions
  • A listing of significant tasks to be completed during the next reporting cycle
  • A summary of funds: spent during the last reporting cycle, spent to date, and appropriated to be spent during the next reporting cycle
  • Additional information as appropriate and necessary to detail the project

Change control. The Service provider and MCCC shall utilize a change control process to manage project alterations. To maintain project timelines, change controls will be limited to no more than three modifications in total and will include:
• Documentation: A change request must be documented in writing with detailed descriptions of potential alteration and explanations/rational for modifications. The process change will include an estimate of the activities/modifications, impact to costs, schedules, scope, and outcomes.
• Submission and tracking: A change request must be submitted to the project Director, logged, and tracked in the management log. Until the process change is accepted and implemented, work will continue on the project under the original agreement.
• Review: A change request must be reviewed and accepted by the project Director before any changes to the original agreement are implemented and new activities are initiated. Any changes will be recorded in the management log and signatures provided as acceptance of any changes/modifications.
• **Implementation:** Once accepted, new activities may begin as agreed upon.

If/when the contract is awarded to the contractor, a **Memorandum of Understanding (MOU)** will be prepared and signed among representatives of ___________________ and Montgomery County Community College, detailed above. The **Memorandum of Understanding** will be based upon the RFP and detail the services to be performed hereunder and shall detail the starting and termination dates for the work herein at which time this agreement shall terminate.

**Price and Method of Payment.** The constitution of costs will include materials, supplies, and time-and-effort (T-&-E) for personnel to complete tasks and deliverables. The cost per T-&-E for personnel will be determined based upon personnel assigned the task, the billing-rate per hour, and the estimated sum of hours to complete the assigned deliverable. The contract price will be based upon the sum of all the costs (materials, supplies, and T-&E).

The payments shall be based upon submission of an invoice following the Payment Schedule as detailed in the final MOU and once agreed milestones are met and approved by the TAA c3bc Project Director and an Administrator (TBD). The invoice must outline the activities engaged in, the Personnel assigned the activities (title only), the number of days or hours spent on each activity, and the corresponding cost (the billing rate). The service provider will provide supporting documentation, such as a representative sample of the work invoiced for, with the invoice.

**Ownership.** Upon payment for deliverables met, the College will have rights to the deliverables and all forms of supporting materials, such as the source code, within 30 days of written request.

**IV. PROPOSAL PREPARATION**

A. **General**

1. The proposal response should address the items included in the General Information and Scope of Services. Proposals should be prepared simply, providing straightforward and concise responses to requests for information and descriptions of qualifications and capabilities. Each copy of the proposal should be bound with all documentation in a single volume where practical. Failure to do so will result in a lowered evaluation. Incomplete proposals may be determined nonresponsive.

2. Each page should be numbered (preferably sequentially through proposal response).

3. Each of the following items should start on a new page, providing as much pertinent information as necessary.

B. **Title Sheet**

Furnish the information requested on the **REQUEST FOR PROPOSALS TITLE PAGES** of this solicitation and include it at the first of your proposal response. The name on the Title Page must be the full legal name of the Firm and the address must be that of the office which will have the responsibility for the services provided. **Firms shall specify the section(s) containing trade secrets or proprietary information and section(s) containing exceptions.**

C. **Table of Contents**

Include a complete Table of Contents

D. **Project Methodology**
Provide a complete description of the proposed methodology for implementation of and providing the required services under this contract.

E. Experience of the Firm in Providing This Service

1. Include a brief statement of the Firm’s experience in providing the services stated in the Scope of Services. If any sub-Firms will be used, they should be identified and their qualifications included in the proposal response. Include experience of key individuals to be assigned to this contract, emphasizing their experience in working with similar contracts and local governments. Show only experience directly related to their assigned duties under the proposed contract.

2. Include a list of clients for which work similar or related to that called for in this solicitation by identifying the clients for which your Firm or its members, while employed with your Firm or elsewhere, have provided services in the past three years.

3. Please provide specific information of your Firm’s organization structure, personnel and resources dedicated to advising services.

4. Give an overview of current workload, the priority to be assigned for oversight of College projects and staffing available relative to the Firm’s ability to respond to College’s requests for services on an “as needed” basis.

F. References

Provide a list of three clients for whom similar services have been provided and dates when the service was provided. Include client name, address, telephone number, facsimile number, description of type of services performed, and the person the College may contact.

G. Fees/Compensation

1. Please fill in fees in proposed schedule of implementation and make sure that a total is given.

H. Insurance

The Firm shall be required to maintain in force such insurance, in amounts acceptable to MCCC, as will protect himself and College from claims which may arise out of or result from the execution of the work, whether such execution be by himself, his employees, agents, sub Firms or by anyone for whose acts any of them may be liable. This coverage should include, at a minimum, Worker's Compensation, General Liability (including premises/operations, independent Firms, products and completed operations, contractual liability and personal injury liability) and Automobile Liability. All insurance shall be provided by companies authorized to conduct business in the Commonwealth. The Firm shall furnish College with an original Certificate of Insurance upon request. The Certificate should name College as additional insured. The Firm shall notify College at least 30 days prior to policy cancellation, non-renewal or reduction of coverage.

I. Other Information

1. Include other relevant information the Firm deems necessary to provide the services needed to successfully complete the Scope of Services or which the Firm feels are relevant to its selection.

2. Based on the information provided in this Request for Proposal, the Firm should identify what might be expected from College over and above general assistance.

3. Contractual information, see the section titled Contract Form, General Terms and Conditions.
V. CONTRACT TERM AND RENEWAL

The term of this contract shall be upon completion of the project.

VI. GENERAL TERMS AND CONDITIONS

A. Independent Firm

The Firm is an independent Firm and nothing contained in the CONTRACT shall constitute or designate the Firm or any of its agents or employees as employees of College.

B. Rejection and Award of Proposals

College reserves the right to accept or reject any or all proposals, to waive informalities, and to reissue any request for proposals and to award contracts to multiple Firms if so stated in the method of award section. Any contract resulting from this Request for Proposal shall not be exclusive to the successful Firm. College reserves the right to contract with firms not party to the resultant contract for similar work if it determines this to be in its best interest. If this is a cooperative procurement, each entity referenced will award a contract in accordance with its respective independent procurement policies and procedures and as it deems will best serve its interests.

C. Withdrawal of Proposals

1. A Firm may withdraw its proposal prior to the deadline for submission upon written request and presentation of proper identification.

2. By submitting a proposal response, the Firm agrees that the proposal response will not be withdrawn for a period of 120 days following the due date for proposal responses.

D. Contract Termination

1. Unless specified otherwise, any resultant contract may be terminated by College, in whole or in part, whenever College determines that such a termination is in its best interests. Any such termination shall become effective on the date stated in a written notice of termination mailed to the Firm as provided in the Notification paragraph below. The notice of termination shall state the extent to which performance shall be terminated. The Firm shall be paid for all goods delivered or services successfully completed prior to the termination date.

2. Any resultant contract shall terminate immediately upon:
   a. Board of Trustees / Supervisors determines that the project does not align with the ; and/or
   b. Exhaustion of properly appropriated funds should the Board of Supervisors fail to appropriate sufficient funds for its continuation.

E. Ownership of Documents

1. All finished or unfinished information or materials, documents, data, studies, surveys, drawings, maps, models, photographs, and reports or other materials prepared by or for the Firm under any resultant contract shall, at the option of College, become County property and shall be delivered to and remain the property of College upon completion of the work or termination of the Contract. College shall have the right to use and reproduce the data and reports submitted hereunder, without additional compensation to the Firm.

2. Any documents provided to the Firm by College shall be returned to College upon request.
F. **Royalty And License Fees And Copyright, Trademark And Patent Protection**

1. In submitting its proposal response, the Firm certifies that there has been no violation of copyrights or patent rights in manufacturing, producing, or selling the commodities or services to be ordered as a result of this Request.

2. Unless specified otherwise in the CONTRACT, the Firm shall pay all royalty and license fees relating to the items covered by the contract.

3. In the event any third party shall claim that the manufacture, use and sales of these goods offered hereby constitutes an infringement of any copyright, trademark, or patent, the Firm shall indemnify and hold harmless College from any cost, expense, damage or loss incurred in any manner by College on account of such alleged infringement.

G. **Taxes**

College is exempt from Federal Excise and State Sales and Use Tax on all tangible personal property purchased or leased by it for its use or consumption. The Firm shall pay all County, City, State and Federal taxes required by law enacted at the time proposals are received and resulting from the work or traceable thereto, under whatever name levied. Said taxes shall not be in addition to the contract price between College and the Firm, as the taxes shall be an obligation of the Firm and not of College, and College shall be held harmless for same by the Firm. Exemption certification will be supplied upon request.

H. **Contract Changes**

Any changes to the CONTRACT must be approved through issuance of a written contract addendum or change order. College will not assume responsibility for the cost of any changes made without issuance of a written contract addendum or change order.

I. **Payment For Services**

Payments to the Firm shall be made within 30 days after receipt of an approved invoice, with invoices submitted no more often than monthly, unless other payment and/or billing terms are specified in the CONTRACT. Backup documentation for each invoice shall be provided in detail satisfactory to College. The Firm's records and documentation supporting such invoices shall be made available to College upon reasonable request. The Firm agrees to retain all records, documents and support materials relevant to the CONTRACT for a period of five years following final payment.

J. **Compliance With All Requirements**

The Firm shall comply with all applicable Federal, State and Local laws, codes and regulations. The Firm shall give notice and comply with all laws, ordinances, rules, regulations, and lawful orders of any entity having authority over the performance of the work.

K. **Legal Proceedings**

Any legal proceedings arising out of or related to this agreement shall be filed by the parties in the Court of Common Pleas of Montgomery County and shall not be subject to arbitration, except for compulsory arbitration as provided by Montgomery County Civil Rule 1301.

L. **Additional Services**
College may add to the Scope of Services or make changes in the Scope of Services any services of a similar nature to those specified in the Scope of Services of this Request for Proposals as mutually agreed to at a price mutually agreed upon.

M. Subcontracting And Assignment Of Work

The Firm shall not subcontract or assign the CONTRACT, in whole or in part, other than that specifically stated in the CONTRACT, without the express written consent of College. A description of any work the Firm proposes to subcontract shall be submitted to College for review and approval along with the name and address of the individual, firm, or corporation that is the proposed sub-Firm. This submittal shall also include a list of the key personnel that the sub-Firm will assign to the project. All work performed by any sub-Firm shall be coordinated by the Firm and the Firm will be responsible to College for all work performed by any sub-Firm or special consultant.

N. Notification

Any notice required by the Contract shall be effective if given by registered mail, return receipt requested, to the Firm in the name and at the address given in its proposal submission; provided that change of address shall be effective if given in accordance with this paragraph. Unless otherwise specified, any notice to College shall be given to Montgomery County Community College, Vice President for Finance & Administration, 340 DeKalb Pike, Blue Bell, PA 19422. The Firm agrees to notify College immediately of any change of legal status or of address. Any notice provided in accordance with this paragraph shall be deemed to have been completed five calendar days after the date of mailing.

O. Severability

Each paragraph and provision of the resultant contract will be severable from the entire agreement and if any provision is declared invalid, the remaining provisions shall remain in effect.

P. Nondiscrimination

If the resultant contract exceeds $10,000, during the performance of the contract, the Firm agrees as follows:

1. The Firm will not discriminate against any employee or applicant for employment because of race, religion, color, sex or national origin, except where religion, sex or national origin is a bona fide occupational qualification reasonably necessary to the normal operation of the Firm. The Firm agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of this non-discrimination clause.

2. The Firm, in all solicitations or advertisements for employees placed by or on behalf of the Firm, will state that such Firm is an equal opportunity employer.

3. Notices, advertisements and solicitations placed in accordance with federal law, rule or regulation shall be deemed sufficient for the purpose of meeting the requirements of this section.

4. The Firm will include the provisions of the foregoing paragraphs T.1., T.2., and T.3. in every subcontract or purchase order of over $10,000.00 so that the provisions will be binding upon each sub-Firm or vendor.

Q. Anti-Terrorist Collusion Clause

The College must require that investment advisers, investment service providers and/or investment entities guard against making investments with banks and companies that may have
Learning Objectives and Outcomes. Upon successful participation with the virtual learning module, the participant will be able to:

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>Learning Activities</th>
<th>Evaluation Methods</th>
<th>Notes/Comments</th>
</tr>
</thead>
</table>

R. Supplemental Material
Describe the elements of equipment, processes, and control systems involved in the biomanufacturing process for a typical monoclonal antibody-based therapeutic, starting with the bioreactor harvest pool and finishing with pre-formulation to drug product.

Define the specific methods, in-process tools and materials, and physical/chemical mechanisms used in the downstream process, including:
- harvest of product by continuous centrifugation
- clarification of the bioreactor harvest by depth filtration
- ultrafiltration and diafiltration of the product at various stages in the downstream process
- purification chromatography
- final polishing and storage

Explain the overall goals of the purification process from the standpoint of purity, yield, and efficiency as well as the general strategies employed to achieve these goals.

During the manufacturing process of pharmaceutical agents, awareness and use of major cGMP regulations and documentation strategies, such as SOPs, batch records, and training records.

| Virtual biomanufacturing learning modules; textbook; lab tours; Small group/team exercises | Completion of the virtual modules Virtual assessments or ‘Check your knowledge’ | Textbook: *Introduction to Bio manufacturing*; NBC2, 1st Edition, November 2011; Lab scale SOP’s Small group/team exercises: Operator and verifier |
| Completion of the virtual modules Virtual assessments or ‘Check your knowledge’ | Virtual biomanufacturing learning modules; textbook; lab tours; Small group/team exercises | Virtual biomanufacturing learning modules; textbook; Small group/team exercises |
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| Virtual biomanufacturing learning modules; textbook; Small group/team exercises | Completion of the virtual modules Virtual assessments or ‘Check your knowledge’ | Textbook: *Introduction to Bio manufacturing*; NBC2, First Edition, November 2011; Lab scale SOP’s Small group/team exercises: Operator and verifier |

**Potential Learning Credentials:**
Electronic badges and/or Certificates

**Downstream - Process Flow - Support Material and Content**

**Introduction.** Support material for the development of an interactive simulation-based virtual downstream processing module for biomanufacturing education and training:

**Definitions of Processes / components**
Ab – Antibody, IgG, the protein product of interest that is secreted from the CHO cells. Close-up visualization of the Ab is schematically represented as small orange-colored ‘Y’. At the base of the stem of the ‘Y’, the Ab covalently binds/attaches to Protein A.

Affinity Chromatography – a purification method that separates molecules based on the reversible interaction between target protein and the specific ligand attached to a chromatography matrix (such as IgG binding reversibly to protein A / Sepharose resin)

Bioburden – any microbial bacteria that does not include the product of interest

Bioreactor (20 K unit) – the stainless steel vessel that houses biomaterials of interest

Bulk fill – the process of filling containers with product of interest, typically the last step in the bioproduction process

CHO cells – Chinese Hamster Ovary cells, the bio-factory that make/secrete the Antibody

Contaminants – any cellular debris that does not include the Ab IgG, such as cells, debris, endotoxin, lipids, & Nucleic acids. Schematically represented in various shapes and colors.

Continuous Centrifuge – a unit that spins rapidly to harvest cells from media solution

Depth filtration – a process that uses filters to separate the product from contaminants

Eluate – the liquid that has passed through the chromatography stage of the purification process and contains the biomaterial of interest. In this case, Antibody is purified.

Equilibration solution – the buffered liquid that conditions the resin to bind the Ab IgG

Holding tank – a stainless steel vessel used to hold liquids

Ligand – the molecule that binds reversibly to a specific molecule or group of molecules, enabling purification by affinity chromatography

Load solution – the buffered liquid containing the Ab IgG along with contaminants that is applied to the affinity chromatography column. Schematically colored as a red/brown liquid

Media – the buffered solution that contains an energy source, trace minerals, and salts

Protein A – a cell wall protein derived from Staphylococcus Aureus that is covalently attached to agarose resin and binds the Ab IgG reversibly and with high affinity. Protein A is schematically represented as the green colored spots on the ‘white’ round resin beads.

Piping – the various steel tubes used to pump various liquids among different processes

Sepharose resin – Sepharose is a bead-formed agarose-based gel filtration matrix. It serves as a platform for binding Protein A and facilitating the separation process. It is schematically represented as small ‘white’ round beads (with green spots for Protein A).

Skid platform – a type of wheeled platform that is used to move various pieces of equipment during the downstream processing

Sterile filtration – a type of filtration process that removes bacterial contaminants, virus particles, and endotoxins from the product of interest using specific filters

TFF – Tangential flow filtration is a separation process that occurs along a membrane surface. As the feed stream passes parallel to a membrane face, portions of the feed pass through the membrane (permeate) and are separated from the remainder (retentate). The retentate is recirculated back to the feed reservoir. Various uses of TFF include buffer exchange, concentrating the product, and the removal of bacteria/endotoxin/virus particles.

Wash solution – the buffered liquid that flows across the resin that facilitates the removal of contaminants during the affinity chromatography process. Schematically colored as a clear liquid.

1) Summary of Processes / Components (from pictures, display an interactive 3-D visualization where the user can zoom on any one of these pieces and potentially view the inside)

- Bioreactor (20K Liter unit)
- Harvest by Continuous Centrifugation
- Clarification by Depth Filtration
- Sterile Filtration

‘Hard pipe’ connections
• Holding Tank (5-10K Liter unit)

• Sterile Filtration
• Liquid Column Chromatography >>> Protein-A Affinity
• Elute Hold Tank
• Tangential Flow Filtration
• Holding Tank for Storage

2) Upstream / Production

Cellular Culture

• Overview: Growth/production of material of interest, Protein Ab IgG, in the Bioreactor
  o Process
    ▪ Visualize how CHO cells grow from seed stock in the Bioreactor (20 K)
  o Illustration >>> #.1 (use 20000 L working volume picture – use of link to Upstream)
    ▪ Visually show the flow of red/brown liquid (harvest) that includes protein (IgG) and contaminants into the unit.
  o Experience detailed / Deliverables
    ▪ Visually show the outside of the Bioreactor unit in 3-D, piping
    ▪ Detail/display how the unit operates, i.e., it serves as a reservoir for the production of product, IgG Antibody
      o Provide a detailed close-up zoom visualization of the IgG ‘Y’ flowing alongside cells, contaminants (‘off’-colored and shaped materials) in a harvest liquid (schematically colored in red/brown)
      o For visualization, detail the IgG ‘Y’ (35%) in solution alongside cells (35%), and contaminants (30% ‘off’-colored and shaped materials, including bacteria)

3) Down Stream Processes >>> Recovery, Purification, and Polishing Phases:

Recovery with Continuous Centrifugation

• Overview: The fluid from the final production Bioreactor is pumped to the Continuous Centrifuge unit, where CHO cells are harvested (collected) from the media / solution.
• Illustrations from Facilities Chapter:
  ▪ Picture from Facilities Chapter (BMS biomanufacturing process) pg 75 >>> #.2
  ▪ Picture from the ESI website >>> #.3
• Experience with the User / Deliverables
  • Visually show the outside of the centrifuge unit in 3-D, in/out ports, piping
  • Detail/display how the unit operates, i.e., mechanism
    o Fluid, cells, IgG Ab, debris flow into the unit as feed through “in’ port
      ▪ Visually show the flow of red/brown liquid (harvest) that includes IgG Ab protein and the contaminants into the unit.
      ▪ As the liquid moves into the unit, provide a close-up zoom visualization/schematic of the IgG ‘Y’ flowing alongside cells, contaminants (‘off’-colored and shaped materials)
    o Fluid, cells, IgG Ab, debris separate during the process
    o Whole cells and contaminants/debris concentrate as sludge during the process
    o Sludge is discharged and discarded (from the bottom/side of unit)
    o Protein of interest, IgG Ab, flows in solution to the ‘Out’ port
  ▪ Process Detailed
    • CHO cells / IgG Ab / contaminants flow as a ‘harvest’ liquid in through the top ‘in’ port as ‘feed’ and continue to flow down main stem into the unit
      ▪ Visually show the flow of red/brown liquid (harvest) that includes protein (IgG ‘Y’) and contaminants into the unit.
- As the liquid moves into the unit, provide a close-up zoom representation of the IgG ‘Y’ (35%) flowing alongside cells (35%), and contaminants (30% ‘off’-colored and shaped materials, including bacteria)
- As the unit spins, sludge (solids made up of mostly cells, some bacteria, and minimal protein) is collected and concentrated along the edge of the unit, where it is discharged / discarded. Note, most cells are intact and form a white/tan milky solution/paste
- IgG ‘Y’ protein (35%) continues to flow in solution back up the stem to the ‘out’ port; add visuals with a few cells (5%), bacteria (30%), and some ‘different’ shapes/colors of contaminants (30%) for interest
- The IgG protein Ab is within the ‘enriched’ liquid media and moves to the next stage of the process. The solution is colored (dark pale red/brown) & opaque.

**Notes:** Is it possible to get ancillary support in the form of video from David (BTEC)

### 3.1. Depth Filtration

#### 3.1.1. Overview:
Depth Filtration is used to further clarify (separate) the IgG Ab protein from the cellular contaminants (any cells, cellular debris) still in the liquid solution and concentrate the product, Ab IgG. During this process, cellular contaminants & any remaining cells are captured on the filters, the liquid is clarified (clear and transparent), and the Ab solution is piped to the next stage.

#### 3.1.2. Illustrations from Power-Point deck:
- 3.1.2.1. Apparatus and filter >>> #.4
- 3.1.2.2. Housing unit and piping >>> #.5

#### 3.1.3. Experience with the User / Deliverables
- 3.1.3.1. Visually show the outside of the unit in 3-D, in/out ports, piping
- 3.1.3.2. Visually show the inside of the unit in 3-D, including the filter disks
- 3.1.3.3. Visually show the inside/components of the filter disks (pancakes)
- 3.1.3.4. Demonstrate/display how the unit operates / mechanism
  - 3.1.3.4.1. Fluid, a couple of cells, protein (IgG Ab), and debris flow into the unit
  - 3.1.3.4.1.1. Visually zoom to detail the flow of red/brown liquid that includes protein (IgG), contaminants, and a few cells into the unit.
- 3.1.3.4.2. The same fluid flows across the filter units
- 3.1.3.4.3. Any cells, some bacteria affix to the filter & are removed from solution
- 3.1.3.4.4. Fluid with protein of interest, IgG Ab are collected and flow out of the unit

#### 3.1.4. Process Detailed
- 3.1.4.1. As the liquid flows into the ‘in’ port, visually detail the flow as a lightly colored red/brown opaque solution that contains Ab, cells, bacteria, and contaminants.
  - 3.1.4.1.1. As the liquid moves into the core of the unit, provide a close-up zoom schematic of the IgG ‘Y’ (35%) flowing alongside a few cells (5%), bacteria (30%), and contaminants (30%) of various ‘different’ shapes/colors for interest.
- 3.1.4.2. The liquid flows over the filters and through the pores of the filter. Meanwhile, any cells (and a few bacteria) are shown bound/retained on the filters.
- 3.1.4.3. As the solution continues to flow, provide a detailed zoom of the IgG ‘Y’ Ab (50%), along with bacteria (25%) and contaminants (25%). This ‘clarified’ liquid is collected and piped to the next stage.

**Notes:** The clarified liquid is red/brown in color and now transparent (not opaque)

### 3.2. Sterile Filtration

#### 3.2.1. Overview:
The goal is to use filtration (with 0.22 micron pores) to remove any remaining bio-burden (bacteria) still in the liquid solution from the protein of interest (Ab).

#### 3.2.2. Illustrations from Power Processing Power-Point deck:
- 3.2.2.1. Apparatus, housing unit, and filter >>> #.6

#### 3.2.3. Experience with the User / Deliverables
- 3.2.3.1. Visually show the outside of the unit in 3-D, in/out ports, piping
- 3.2.3.2. Visually show the inside of the unit in 3-D, including the filter
3.2.3.3. Visually zoom to show the pores of the filter
3.2.3.4. Demonstrate/display how the unit operates/mechanism
   3.2.3.4.1. Fluid, some cellular debris, protein (Ab), and bacterial contaminants flow into the unit
   3.2.3.4.2. Zoom to detail fluid as it flows across the filter units
   3.2.3.4.3. Bioburden (bacteria) affix to the filter and are removed from solution
   3.2.3.4.4. Zoom out to show the protein solution, the IgG Ab, as it is collected and sent out of the unit.

3.2.4. Process Detailed
   3.2.4.1. As the liquid flows into the ‘in’ port, visually detail the flow as a lightly colored red/brown transparent solution that contains Ab, bacteria, and contaminants.
      3.2.4.1.1.1. As the liquid moves into the core of the unit, provide a close-up zoom visualization of the IgG ‘Y’ (50%) flowing alongside bacteria (25%), and contaminants (25%) of various ‘different’ shapes/colors.
   3.2.4.2. Zoom to provide detail as liquid flows over the filters and through the pores of the filter. Meanwhile, any detail bacteria becoming bound/retained on the filters.
   3.2.4.3. Visually show a zoom representation of the IgG Ab (75%) and contaminants (25%) as continuing to flow as a liquid solution as it is collected into a Holding Tank.

Notes: The solution is red/brown in color, transparent, and sterile

3.3. Holding Tank
3.3.1. Overview: The goal is to use a stainless vessel to hold any liquid solution with the protein of interest (Ab) at a constant temperature until the next staging process is ready.
3.3.2. Illustrations:
   3.3.2.1. Stainless steel vessel (size 5-10K L) >>> #.7

3.3.3. Experience with the User / Deliverables
   3.3.3.1. Visually show the outside of the vessel in 3-D, piping, skid
   3.3.3.2. Visually show a zoom representation of the IgG Ab (75%) and contaminants (25%) as a liquid solution in the Holding Tank.

3.4. Sterile Filtration (as above in 4.3, except unit is on a skid rather than hard piping)
3.4.1. Overview: The goal is to use filtration (with 0.22 micron pores) to remove any remaining bio-burden (bacteria) still in the liquid solution from the protein of interest (Ab).
3.4.2. Illustrations from Power Processing Power-Point deck:
   3.4.2.1. Apparatus, housing unit, and filter >>> #.8

3.4.3. Experience with the User / Deliverables
   3.4.3.1. Visually show the outside of the unit in 3-D, skid (rather than hard piping)

4) Phase #3: Purification
4.1. Affinity Chromatography using Protein A coupled to Sepharose resin
4.1.1. Overview: The goal is to use affinity chromatography to reversibly bind the Ab IgG and purify it from any remaining contaminants still in the liquid solution.
4.1.2. Background:
The basis for purification of IgG using affinity chromatography is the high affinity interaction of protein A (a cell wall protein derived from Staphylococcus aureus) with the Fc region of polyclonal and monoclonal IgG-type antibodies. Protein A binds to the Fc region of IgG immunoglobulins through various multi-faceted covalent interactions with the heavy chain. The binding of protein A has been well documented for IgG from a variety of mammalian species, including Human IgG. Sepharose is a bead-formed agarose-based gel filtration matrix. It serves as a platform for binding Protein A and facilitating the separation process. Protein-A Sepharose resin makes use of recombinant protein A engineered to contain a C-terminal cysteine that enables a single-point coupling to the Sepharose resin. As such, protein-A Sepharose is a powerful tool to isolate and purify IgG classes, subclasses and immunoglobulin fragments from biological fluids and from cell culture media. During the purification process, the antibody solution is added across the protein A–Sepharose column under high-affinity binding conditions, i.e., near neutral pH conditions (pH 8.0). Upon washing of the column resin and the near complete removal of contaminants, the IgG is eluted/purified under low-affinity binding conditions, i.e., a low pH condition (pH 4).
4.1.3. Illustrations
4.1.3.1. Industrial Scale Unit, (90 cm diameter) from Power-Point deck: >>> #9

What are the dimensions of the unit / equipment? Volume of resin, CV?

4.1.3.2. Schematic of Protein A bound to IgG as example for visualization development (www.dunesciences.com/...). >>>

4.1.3.3. Schematic of binding, washing, and eluting from resin as example for visualization development (Alves NJ et al., Anal Chem. 2012 Sep 18; 84 (18):7721-8.) >>> #11

4.1.4. Experience with the User / Detailed

4.1.4.1. Visually show the outside of the unit in 3-D, platform, column, resin, IgG “Y”

4.1.4.2. Zoom in/out - visualization of the ‘white’ resin beads packed into the column; from a distance, the column resin is plain white. Upon zoom, the resin is schematically represented as small ‘white’ round beads with green colored spots. The colored spots represent Protein A attached to the surface of the beads / resin.

4.1.4.3. Demonstrate/display the chromatography process / mechanism

4.1.4.3.1. Step #1: Equilibrate the white-colored resin with 10X buffer (determine HTEP as in the supplemental material section)

4.1.4.3.1.1. Visually show 10X CV equilibration buffer (blue) liquid flowing across the resin/column; once the 10X CV liquid has moved across, color the resin ‘light’ blue.

4.1.4.3.2. Step #2: Apply the load solution, liquid containing IgG, to the column.

4.1.4.3.2.1. Visually show the flow of red/brown liquid (load) that includes protein (IgG) and contaminants onto and across the column resin.

4.1.4.3.2.2. Zoom to provide a close-up visualization detailing the IgG ‘Y’ (75%) flowing alongside contaminants (25%) of various ‘different’ shapes and colors

4.1.4.3.2.3. As the liquid moves through the column, the Ab binds (‘sticks’) to the resin, while the ‘off’-colored and shaped materials (contaminants) do not bind. Provide a close-up detailed zoom representation of the IgG ‘Y’ reversibly attaching to the green areas on the bead resin.

4.1.4.3.2.4. As the liquid flows across the resin, detail the binding of IgG ‘Y’ to the resin. Meanwhile, the contaminants (the ‘off’-colored and shaped materials) continue to flow with the liquid. As the flow continues, the resin color changes to a light orange.

4.1.4.3.3. Step #3: Wash the resin (3X CV) to remove any unbound contaminants.

4.1.4.3.3.1. Visually show 3X CV wash buffer (clear/white) liquid flowing across the resin/column; detail a zoom representation of the solution to include the flow of unbound contaminants moving across and down the column as the wash proceeds. Furthermore, as the 3X CV wash continues, the resin subtly changes color from a light to a ‘faint’ and lighter orange.

4.1.4.3.4. Step #4: Elute the Ab IgG with 3X CV of elution buffer at pH 4 and collect the product into a Holding Tank (on a skid)

4.1.4.3.4.1. Visually show the elution buffer (clear/white) liquid flowing across the resin/column; detail the solution to include illustrations of the flow of ‘Y’ Ab molecules gently dislodging from the resin (gently bumped off the resin with elution buffer – low pH). As the elution continues, the resin subtly changes color from a ‘faint’ orange to white (original resin color) and the elution buffer subtly changes from a clear white to faint orange color.

Notes: After purification, the eluate is clear transparent and a faint orange. Provide a close-up visualization/schematic of purified IgG ‘Y’ (100%) in the eluate solution.

4.2. Holding Tank

4.2.1. Overview: The goal is to use a stainless vessel to hold eluate solution with the purified protein antibody (IgG) at a constant temperature until the next staging process.

4.2.2. Illustrations:

4.2.2.1. Stainless steel vessel (size 5-10K L) >>> X12

4.2.3. Experience with the User / Deliverables

4.2.3.1. Visually show the outside of the vessel in 3-D, skid

4.2.3.2. Visually show a zoom representation of the IgG Ab (100%) as a liquid solution in the Holding Tank.

4.3. Tangential Flow Filtration
4.3.1. **Overview:** Tangential flow filtration is a separation process that makes use of a membrane surface to produce non-laminar fluid dynamics. As the feed stream passes parallel to a membrane face, portions of the feed pass through the membrane (permeate) and are separated from the remainder (retentate). The retentate is recirculated back to the feed reservoir. Various uses of TFF include buffer exchange, concentrating the product, and the removal of any remaining bacteria/endotoxin/virus particles. In this case, the use of a nano-filtration cartridge eliminates microbial organisms and insoluble proteins, removes virus particles, concentrates the antibody, and sterilizes the product.

4.3.2. **Illustrations** from Facilities Chapter:
- 4.3.2.1. Tangential Flow Filtration unit on skid (from page #75 of Facilities Chapter)
  Picture from the Facilities Chapter page # 75

4.3.3. **Experience with the User / Deliverables**
- 4.3.3.1. Visually show the outside of the unit in 3-D, skid
- 4.3.3.2. Demonstrate/display how the unit operates / mechanism
  - 4.3.3.2.1. Fluid with IgG Ab protein, flow into the unit as feed through “in’ port
  - 4.3.3.2.2. As the feed stream passes parallel to the membrane face, portions of the fluid only pass through the membrane (permeate) and are separated from the remainder (the retentate with IgG). The retentate (liquid solution with concentrated IgG) is recirculated back to the feed reservoir.
  - 4.3.3.2.3. The protein of interest, IgG Ab, is now 10X more concentrated and flows in solution to the ‘Out’ port and is **collected into a Hold tank for Storage.**

4.3.4. **Process Detailed**
- 4.3.4.1. Visually show the outside of the unit in 3-D, platform, skid
- 4.3.4.2. Fluid with IgG Ab protein, enter and flow into the unit as feed through “in’ port
  - 4.3.4.2.1. Visually detail a close-up zoom of purified IgG ‘Y’ (100%) flowing in solution
- 4.3.4.3. As the process proceeds, the feed stream is pumped along the interior of the membrane column and it flows parallel to the membrane face. Portions of the feed (fluid only) pass through the membrane (permeate) and are separated from the remainder (retentate with IgG). The retentate (liquid with more concentrated IgG solution) is recirculated back to the feed reservoir for another pass through the unit.
  - 4.3.4.3.1. As the liquid with IgG flows within the membrane column, provide a close-up zoom visualization as liquid passes through the pores of the filter & becomes permeate.
  - 4.3.4.3.2. As the liquid with IgG flows within the membrane column, provide a close-up zoom visualization of IgG not passing through the pores of the filter and flowing along the membrane to become more concentrated in the retentate.
  - 4.3.4.4. As the process continues, visually show the IgG Ab becoming more and more concentrated in the retentate solution. As such, the liquid solution becomes more and more orange as it is ‘enriched’ with IgG.
  - 4.3.4.5. Collect the concentrated IgG product and place into a **Holding Tank (skid)**

4.3.5. **Notes:** Confirm the final concentration factor.

4.4. **Holding Tank**
- 4.4.1. **Overview:** The goal is to use a stainless vessel to hold the IgG liquid solution at a constant temperature as necessary (until QC).
- 4.4.2. **Illustrations:**
  - 4.4.2.1. Stainless steel vessel (size 5-10K L) >>> X.13

4.4.3. **Experience with the User / Deliverables**
- 4.4.3.1. Visually show the outside of the **Holding Tank vessel** in 3-D, piping, skid
- 4.4.3.2. Visually show a zoom representation of the IgG Ab (100%) as a liquid solution in the **Holding Tank for final storage prior to fill/finish (QC and delivery).**

4.4.4. **Notes:** Confirm the final concentration factor & size of the unit relative to other tanks.

5) **Resources:**
- **Purification** – refer to the GE Healthcare website for both the *Affinity Chromatography Handbook* and the *Antibody Purification Handbook* for more detailed information:

**Downstream Processing** – refer to the NBC2 website for more detailed information:
http://biomanufacturing.org/old/biomancurriculum.html links to SOP’s
SOP: Protein A Chromatography of IgG
SOP: Preparation of Protein A Chromatography Column
SOP: Biologic LP Protein A Chromatography Equipment SOP
SOP: Programming of Biologic LP Chromatography System for Protein A Chromatography

Schematic Example

Login Page

Presents

BioManufacturing Online

Email Address
Welcome to Biomanufacturing Online!

Please fill out the brief registration form below. Your information is not sold, it’s only used to identify high interest areas and to provide the user with exciting opportunities in the Biomanufacturing area.

Name

E-mail Address

Password
This information will be saved securely with access provided to administrator to use for dissemination and analysis.

Clicking on “Go!” will take the user to the character selection screen.
An E-mail will be sent shortly with a link to create a new password

Clicking the “Go!” button will generate a link that will be emailed to the address on file. Clicking that link will take them to a page to create a new password.

New Password Page

So you forgot your password? No problem, we will let you create a new one!

Enter New Password

Re-Enter New Password
Once signed in the user will be directed to the character selection page.

**Character Selection Page**

Choose the technician to represent you

Male
Characters should have a look similar to a graphic novel to bring some bit of fun to the simulation without making it “too cartoonish.” Nationalities will not be listed, they are there as place holders for artist rendition.

Clicking “Proceed to the Production Floor” will take the user directly to the “Character Selection Page”

Introduction Scene

Artist rendition of a Caucasian woman with shoulder length brown hair and glasses in similar style to the user selectable characters. This character’s name will be Maggie and she will be the manager of the user who decides whether they will receive a promotion to senior technician based on their performance in the interactive lab. The cut scenes will fluctuate between the Maggie character and the user selected character based on who’s speaking at the moment. The dialogue will be written only and will appear on screen until the user selects “Reply” if they are finished reading what Maggie is saying and “Listen” when they are finished reading what their character has said. The Maggie character will have head placement on the left and dialogue box on the right. User character will have head placement on the right and dialogue box on the left. There will be laboratory double doors in the background of both individuals.

Maggie Screen

User Screen
Script for Cut Scene

Maggie: [Insert user chosen character name] with Sheila retiring we need to select a new senior technician and I think you are a great candidate.

User: Thank you Maggie, I work very hard here at NBC2 and while no one could take Sheila’s place, I would love to be the new senior technician.

Maggie: Before I can give you the position you need to show me you have the necessary skills. I’m going to watch you on the production floor as you purify Protein A during the downstream portion of production.

User: I have no doubts you will leave impressed!

At the last cut scene instead of “Listen” the button will read “Time to prove your skills” once clicked on by the user the scene will show the two double doors opening and the camera view will follow through exactly as the characters would see walking through them. This will then shift into the main selection page.
Harvest

Diagram in PIC manual starting with Product hold tank then showing continuous centrifuge, depth filtration, sterile filtration, Protein A chromatography, and finally TFF ending in bulk tank.

This is the default page: “Virtual Processes” tab selected and “Real View” tab selected on the bottom.

Clicking “Theory” will bring up a PDF copy of Chapter 11 in a new window that can be read or saved for future viewing.

Clicking Lab Scale will bring a drop down menu with TFF Equipment SOP, TFF Process SOP, Applikon Equipment SOP, and Applikon Process SOP as selectable items. Clicking on one of these selections will bring up a PDF copy of the corresponding selection in a new window that can be read or saved for future viewing.

Clicking “Virtual Processes” tab will by default display the “Real View” tab diagram. Clicking the “Work Flow Diagram” tab will switch to the work flow diagram which is set up in a flow chart manner. Clicking the “Process” tab will bring up the interactive lab.

“Troubleshoot” is a placeholder for future work.

“Assessment” is a place holder for future work.

“?” is a place holder for future work.

Work Flow Diagram
Downstream Process
Harvest

Real View Workflow Diagram Process

Biomanufacturing Online
Downstream Process

Harvest

Interactive Lab

Default is Continuous Centrifuge

Clicking on each of the tabs will bring up the corresponding interactive lab. At the completion of each portion of downstream processing a button on the bottom will read “Proceed to [next step in the process].

Final Cut Scene

After completing the TFF portion of the interactive lab the button on the bottom will read “How did you do?” Clicking that will then bring up a cut scene conversation identical to the introduction scene but with the following dialogue.

Maggie: You were right [Insert user chosen character name], you truly have a grasp of downstream processing.

User: Thank you Maggie! Are you leaving impressed?

Maggie: Extremely senior technician [Insert user chosen character name].

User: I got the job, that’s amazing!
Maggie: No, your biomanufacturing skills are amazing!

The characters high five. A button appears on the bottom of the screen reading “Finish.” Clicking that takes the user to the start of the process.