CM4125  Bioprocess Engineering Laboratory  Sp 2006
Course No. 13847

Course Description:
An integrated biological process laboratory experience, including fermentation with
downstream bioseparation, for the production of a purified product of potential
commercial interest. Features process measurement-analysis-improvement, metabolic
pathway analysis, quality assurance, and safety. (1 credit)

Course Objectives:
Objective 1: To develop bioengineering skills for the production and purification of a
biochemical product (amino acid or protein) using integrated biochemical
processes.
Objective 2: To work effectively in laboratory teams of scientists and engineers.

Instructors:  Professor David R. Shonnard (202I CSEB)
Department of Chemical Engineering
Phone: 487-3468 (Office)
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office hours: M,W 4 – 5 pm.

Professor Susan T. Bagley (531 Dow)
Department of Biological Sciences
Phone: 487-2385 (Office)
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Teaching: Abraham Martin-Garcia (202N CSEB)
Assistant: PhD Candidate, Department of Chemical Engineering
email: armartin@mtu.edu
office hours: TBA

Time: Tue. 1505 - 1755 (3:05 pm - 5:55 pm)
Location: Room 102, Chemical Sciences and Engineering Building

Text: None, handouts provided.

Web site: http://www.chem.mtu.edu/~drshonna/cm4125/cm4125home.html

Course Policies and Procedures

Reserve Reference Material
Reference materials will be posted on the course web site by the instructors as the need
arises and will be announced in class or by email.
Attendance: Attendance at each laboratory session is mandatory unless permission is obtained 1 week in advance or in the case of an emergency.

Teamwork: Students will be assigned into teams of 3 to 4 and will remain in the same team for the entire semester. Students are expected to work effectively and collegially to complete laboratory and other course assignments. Peer evaluations will be included in the course grading.

Course Grade Policy
Grading will be assigned to each team based on written interim reports and a final report. Interim reports will be prepared and handed in soon after the assignment of specific laboratory activities (see schedule). One interim oral report will be given as well as one final oral report. Peer evaluations will be factored into the grading of interim and final oral reports as well as the final course grade in order to assign grades to each student from the team grade.

The weighting of the interim and final oral and written reports will be as follows

- Interim written reports (together) 30%
- Interim oral report 10%
- Final written report 40%
- Final oral report 20%
- Total 100%

Letter Grades will be assigned following this schedule

- 90-100% A
- 85-90% AB
- 80-85% B
- 75-80% BC
- 70-75% C
- 65-70% CD
- 60-65% D
- <60% F
# CM4125 Course Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Week</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/10/06</td>
<td>1</td>
<td><strong>Introduction, Safety, Tours, Group Assignments</strong></td>
<td>102 CSEB</td>
</tr>
<tr>
<td>1/17/06</td>
<td>2</td>
<td><strong>Microbiology Techniques</strong> (scale up from frozen vial to agar plate to shake flask), QA/QC (sterility: instrumentation for measurement of bioreactor substrates, products, and cells; endospores/endotoxin/mycoplasma)</td>
<td>710 Dow ESEB</td>
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<tr>
<td>1/24/06</td>
<td>3</td>
<td><strong>Experimental Set-up</strong> (assembly of bioreactor and sterilization)</td>
<td>102 CSEB; 710 Dow ESEB</td>
</tr>
<tr>
<td>1/31/06</td>
<td>4</td>
<td><strong>Data Analysis: Introduction to metabolic flux analysis (MFA) (for increased L-lysine production)</strong></td>
<td>102 CSEB</td>
</tr>
<tr>
<td>2/7/06</td>
<td>5</td>
<td><strong>Data Analysis: Continued Work on MFA</strong></td>
<td></td>
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</tbody>
</table>
| 2/14/06  | 6    | **Fermentations** (batch, fed batch or continuous culture); Analyses (metabolic profile) | Group 1: room 205 CSEB  
Groups 2 & 3: |
| 2/21/06  | 7    | **Fermentations** (batch, fed batch or continuous culture); Analyses (metabolic profile)  
**Microfiltrations** (separation of cells from broth and storage of filtrate for subsequent bioseparations) | Group 2: room 205 CSEB  
Group 1: room 205 CSEB  
Group 3: |
| 2/28/06  | 8    | **Fermentations** (batch, fed batch or continuous culture); Analyses (metabolic profile)  
**Microfiltrations** (separation of cells from broth and storage of filtrate for subsequent bioseparations) | Group 3: room 205 CSEB  
Group 2: room 205 CSEB  
Group 1: |
| 3/14/06  | 9    | **Lab Cancelled due to Equipment Problems**                   |                   |
| 3/21/06  | 10   | **Microfiltrations** (separation of cells from broth and storage of filtrate for subsequent bioseparations)  
Off (Data analysis) | Group 3: room 205 CSEB  
Groups 1 & 2: |
| 3/28/06  | 11   | **Interim Presentations/Discussions**  
MFA of all experiments (using software) | Group 1: room 205 CSEB  
Groups 2 & 3: |
| 4/4/06   | 12   | **Bioseparations** (cation exchange chromatography theory and operation, purification of L-lysine)  
MFA assignment and report/presentation preparations | Groups 1&2: room: 205CSEB  
Group 3: |
| 4/11/06  | 13   | **Bioseparations** (cation exchange chromatography theory and operation, purification of L-lysine)  
MFA assignment and report/presentation preparations | Group 3: room: 205 CSEB  
Groups 1 & 2: |
| 4/18/06  | 14   | **Group Presentations, Discussion and Wrap-up** | 102 CSEB          |
Executive Summary Report Format – The final report for the bioprocess experiments (Fermentation, Microfiltration, and Bioseparation) will consist of an executive summary report. This is a brief, carefully worded report in which key results are presented, conclusions drawn in comparison to theory or expectations, and final recommendations identified. The experiment objectives should determine what is included in the executive summary. The executive summary will be greater than 2 pages but no longer than 5 pages (single spaced) of text plus any tables, figures, and supporting appendices. Include the following sections in your executive summary:

1. **Title Page.**
   a. Prepare a neatly structured cover page for your executive summary.
   b. Include the course title and number, title of the experiments, when the laboratory work was performed, when the report was submitted, the group number, names of the team members, and the instructors.

2. **Table of Contents.** Include a list of figures, list of tables, and list of appendices in the table of contents.

3. **Executive Summary.**
   a. This section must be written so that it stands alone.
   b. The executive summary contains three general sections:
      i. **Abstract** – Prepare a concise narrative summarizing the background of your work, your experiment objectives, what you did, what the results were, and what the results mean. Be specific about your results when summarizing them. Give numerical values and error limits where appropriate.
      ii. **Conclusions** – Give a brief narrative statement(s) presenting your main conclusions. These conclusions must follow from your discussion and interpretation of the results and should focus on the objectives.
      iii. **Recommendations** – Prepare a brief summary of any recommendations you wish to present. These recommendations should be related to the results and based on your conclusions.
   c. Things to remember when writing an executive summary:
      i. Focus on interpreting the experimental results. This is where the reader finds out what you think the results mean.
      ii. The conclusions are the most important part of the executive summary. This is why the reader is reading your report. The conclusions should directly address the objectives and be in order of significance, from most significant to least significant.
      iii. If recommendations are suggested they should come directly from the conclusions and indicate further work or experiment improvement drawn from the conclusions. No new issues or material should be raised in the recommendations.
4. **Appendices.**
   a. Appendices contain important, but supplemental, information. Do not put results – items that directly satisfy the objectives – in the appendices. Here you may insert background information that was used in preparing the report or auxiliary information such as instrument calibrations, error analysis, and calculations of intermediate results. The reader should be able to detach the appendices and still understand the report.
   b. You must include a sample calculation showing all the details of the methods you used to obtain the results from raw data.
   c. You must include a table showing all the numerical values and raw data you used to plot your graphs, and any other data or results that might help your reader understand your work. **Note: do not include a table of the fermenter T, DO, agit., or pH data**, but do include graphs instead in the appendix.
   d. **Anything in the appendices must be referred to in the body of the report.**
   e. All appendices must be named with a letter and a meaningful title.