CHE 449 – Bioseparations

Spring 2013

Classes: Mon, Wed & Fri, 11:15 AM – 12:05 PM, Fenske 140

Course Website: www.angel.psu.edu

Instructor: Manish Kumar, manish.kumar@psu.edu, 155 Fenske Lab, 865-7519
Office hours: Walk in anytime available (door open and not in a meeting)
Tue-Thurs 5:00- 6:00 PM, also by appt.

Required Text: **None required, Hand written lecture notes (incomplete) will be posted, other materials will also be posted**

Recommended Text: *Bioseparations Science and Engineering*
Todd, Harrison, Rudge, and Petrides (on reserve as well)

Other texts (on reserve in Davey Lab, Math and Physical Sciences Library)

1. Belter, PA; Cussler, EL; and Hu, W-S, Bioseparations: Downstream Processing for Biotechnology, John Wiley and Sons, 1988
2. Juan A. Asenjo, Separation Processes in Biotechnology, Marcel Dekker, Inc., 1990
3. Garcia AA, Bioseparation Process Science, Blackwell Science

Software: SuperPro Designer (by Intelligen Inc) is a widely used design and costing software used by biotech and pharmaceutical industries. This software is (or will be) installed on all computers in the ChemE computer lab. This software will be briefly introduced in the later part of the course and should be part of your final project.

Open Fridays: On many Fridays (not all) we will focus on interactive work. We will focus on important equations and what they mean (including derivations if required), guest lectures, problem solving, tours, experimental work, or a discussion. As class progresses you can also suggest activities or specific agenda items.

Course Objectives:

The overall objective of this course is to provide students a solid background in the principles, applications and practice of important technologies used for the separation and purification of biological products, ranging from small primary metabolites and biopharmaceuticals to recombinant proteins. By the end of the course students will be able to:

1. Appreciate the complexity of biological samples and the ever-growing need for efficient separation processes to economically recover bioproducts
2. Understand the physical parameters governing mass transfer and extend this understanding to the separation of biological mixtures
3. Identify the relevant properties of a biological mixture leading to the appropriate choice of unit operations for effecting separation / Understand the relevant design parameters of each unit operation
4. Perform design and scale-up calculations for specific separations including centrifugation, filtration, chromatography, extraction, precipitation and membrane processes
5. Understand the experimental data required to design and scale-up a separation process. Provide a general experimental strategy for obtaining such data
6. Develop outlines of overall separation schemes that could be used to achieve the required removal of key impurities and contaminants

Focus Areas: I would like to emphasize two particular areas that I think are critical to career development for students in chemical engineering. This is based on the assumption that most of the class will be entering the workforce either as engineers or as graduate students, where such skills are important.

7. ***Group Work***. Almost all professional work is done in teams. Thus an important objective of the class is for you to learn how to work in teams. All homework assignments will be group work. You will be allowed to form your own group on the first day of class. Groups of 3 are recommended. For the project, two groups of three will be combined. <u>A confidential survey will be conducted two times during the semester to determine the relative contribution of group members and grading will be adjusted based on this survey.</u>
8. **Practical Experience**. In class we will focus a little more than usual Chemical Engineering classes on the practical side of technologies. The goal is to make it a practice-oriented class with emphasis on industrial scale equipment, field trips, and possibly pilot plant experiments. The primary mode of instruction will be using case studies which also lends it self to discussion of specific industry-specific practices and design.

Approximate Course Grading Outline

Homework Assignments: approx biweekly ~ 20%

Problem sets are primarily to be used as study tools, reflecting the types of questions that will show up on the exams, but may be more time consuming. Attempting to solve the problem sets in a timely manner will help you to identify topics you are not clear on. They will be due on Fridays. Each group will hand in one solution set.

Exams:	Exam 1— on or around February 25th	~ 25%
	Exam 2— on or around March 30th	~ 25%

These dates and times need to be confirmed and room locations determined. Firm times and locations will be announced in class and via Angel mail. Review sessions will be scheduled the before each exam. I am considering doing in-class exams. Please let me know what you think about this.

Class Project:

This is a group project where your combined group will demonstrate their ability to design large scale purification of bioproducts created using a novel route (using microorganisms or cell culture) or a novel bioproduct. More information will be provided later on in the semester

Project Write-up	~ 15%
Project Presentation	~ 15%

Project Deadlines:
Team and title Selection (by email): January 31st
Bibliography and overall approach (Meet with instructor): schedule by Feb 28th
Plant layout: March 31st
Presentation scheduled in last two weeks of class
Report due last day of class (April 26th)

Comments:

Late assignments will not be accepted since homework solutions will be made available after class period in which assignments are due.

Students should feel free to ask for help while working on the problem sets. Solutions to problem sets should be turned in as group effort with your team. Students within a team may work together to solve the problems but may not copy work from other teams. Solutions which are copied from another group / student will be considered as plagiarism and will be handled accordingly.

Please do not hesitate to ask for additional clarification on these policies at any time during the semester.

General Course Outline

1. **Introduction to Bioprocessing (first two lectures)**
   - Overview of biological products
     - biological products (metabolites, proteins, etc)
     - impurities and contaminants
   - Overview of separation processes
     - classification of separation processes
     - physical basis for separations

2. **Case Studies (till end of March)**
   a. **Penicillin (antibiotic)**
   b. **Herceptin (monoclonal antibody)**
   c. **Erythrocytes (red blood cells)**
   d. **Insulin (hormone)**
   e. **Gardasil (vaccine)**

3. **Scale-up, Plant Layout, and Economics** (final month, except Hueristics and Software will be introduced after first case study)
   a. **Hueristics**
   b. **Basic Plant Economics**
   c. **Software for Biotech Plant Design and Costing**
