INTRODUCTION TO BIOCHEMICAL ENGINEERING (CBE:5205); FALL 2018

General Course Policy

This course is given by the College of Engineering. This means that class policies on matters such as requirements, grading, and sanctions for academic dishonesty are governed by the College of Engineering. Students wishing to add or drop this course after the official deadline must receive the approval of the Dean of the College of Engineering.

Accommodations for Disabilities

If you feel that you may need an accommodation based on the impact of a disability please contact Prof. Murhammer privately to discuss your specific needs. You may also contact the Office of Student Disability Services (319/335-1462 or sds-info@uiowa.edu) to discuss the accommodations that are available for students with documented disabilities.

1. Time and Place of Course

Lecture: 11:30 a.m. – 12:20 p.m. on Mondays, Wednesdays, and Fridays in 3505 Seamans Center (SC)

Discussion (Problem Solving Session): 6:30 p.m. on Wednesdays in 3505 SC

Laboratory: Time to be determined in 3244 SC

2. Course Web Site

Course information can be found on the course web site that is found on the ICON system (http://icon.uiowa.edu).

3. Instructor

David W. Murhammer

Office: 4132 Seamans Center (SC)

Phone: 335-1228

Email: david-murhammer@uiowa.edu

Office Hours: Th 12:30-1:30 p.m. and F 9:30-10:30 a.m.

4. Teaching Assistant

Hanley Sayavong

Email: hanley-sayavong@uiowa.edu

5. Textbook

None. Course materials will be made available on the course website.

6. Course Learning Goals

By the end of the course, the student will:

* Have a fundamental understanding of pharmaceutical and biotechnology businesses, including the range of products produced and how products get to the marketplace.
* Have a fundamental understanding of cell chemistry, cell metabolism (including yield coefficients and metabolic quotients), recombinant DNA methods, and cell structure and function.
* Be able to choose and apply the simple models of enzyme kinetics, cell growth, and product formation that yield accurate results for the problem under consideration, including the Michaelis-Menten Equation with and without inhibition and the Monod growth equation.
* Be able to evaluate mass transfer limitations in immobilized enzymes and cell reactors.
* Have a fundamental understanding of chemostats and their applications, and be able to perform the corresponding calculations.
* Be able to formulate a medium for a specific application and to design the corresponding sterilization process.
* Have a fundamental understanding of mixing and oxygen transport in agitated bioreactors and be able to perform corresponding calculations.
* Be able to scale up agitated bioreactors based on various criteria.
* Have a basic understanding of the major issues and techniques involved with purifying biologics and be able to perform corresponding calculations.
* Be able to collect and analyze experimental data.
* Have a fundamental understanding of batch and continuous processes involved in producing fermentation (e.g., antibiotics and biofuels) and recombinant products (e.g., recombinant proteins).
* Have had opportunities to further his/her professional development through practicing written communication skills.

7. Tentative Course Outline

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| **Date** | **Topic** |
| M, Aug. 20 | Introduction/Pharmaceutical and Biotechnology Products and Businesses |
| W, Aug. 22 | Cell Chemistry |
| F, Aug. 24 | Cell Chemistry/Homework 1 Due |
| M, Aug. 27 | Cell Chemistry/Quiz 1 |
| W, Aug. 29 | Cell Structure and Function |
| F, Aug. 31 | Cell Structure and Function/Homework 2 Due/Quiz 2 |
| M, Sept. 3 | **Labor Day/No Class** |
| W, Sept. 5 | Cell Metabolism/Metabolic Control |
| F, Sept. 7 | Cell Metabolism/Metabolic Control/Homework 3 Due |
| M, Sept. 10 | Cell Growth/Product Formation/Quiz 3 |
| W, Sept. 12 | Cell Growth/Product Formation |
| F, Sept. 14 | Cell Growth/Product Formation/Homework 4 Due |
| M, Sept. 17 | Media Formulation/Sterilization/Quiz 4 |
| W, Sept. 19 | Media Formulation/Sterilization |
| F, Sept. 21 | Media Formulation/Sterilization/Homework 5 Due |
| M, Sept. 24 | Strain Development/Recombinant DNA Technology/Quiz 5 |
| W, Sept. 26 | Strain Development/Recombinant DNA Technology |
| F, Sept. 28 | Strain Development/Recombinant DNA Technology/Homework 6 Due |
| M, Oct. 1 | Enzymes & Enzyme Kinetics/Quiz 6 |
| W, Oct. 3 | Enzymes & Enzyme Kinetics |
| F, Oct. 5 | Enzymes & Enzyme Kinetics/Homework 7 Due |
| M, Oct. 8 | Enzymes & Enzyme Kinetics/Quiz 7 |
| W, Oct. 10 | Common Fermentations |
| **Th, Oct. 11** | **Exam, 6:30-8:30 p.m., 140 SH** |
| F, Oct. 12 | Common Fermentations |
| M, Oct. 15 | Common Fermentations |
| W, Oct. 17 | Biofuels Production |
| F, Oct. 19 | Chemostats/Homework 8 Due |
| M, Oct. 22 | Chemostats/Quiz 8 |
| W, Oct. 24 | Chemostats |
| **F, Oct. 26 & M, Oct. 29** | **No Class - AIChE Meeting** |
| W, Oct. 31 | Chemostats |
| F, Nov. 2 | Transport in Bioreactors/Homework 9 Due |
| M, Nov. 5 | Transport in Bioreactors/Quiz 9 |
| W, Nov. 7 | Transport in Bioreactors |
| F, Nov. 9 | Bioreactor Scaleup & Design/Homework 10 Due |
| M, Nov. 12 | Bioreactor Scaleup & Design/Quiz 10 |
| W, Nov. 14 | Bioreactor Scaleup & Design |
| F, Nov. 16 | Animal & Plant Cell Culture/Product Formation/Homework 11 Due/Quiz 11 |
| **M, Nov. 19; W, Nov. 21 & F, Nov. 23** | **No Class - Thanksgiving Break** |
| M, Nov. 26 | Animal & Plant Cell Culture/Product Formation |
| W, Nov. 28 | Introduction to Bioseparations |
| F, Nov. 30 | Introduction to Bioseparations/Homework 12 Due |
| M, Dec. 3 | Introduction to Bioseparations/Quiz 12 |
| W, Dec. 5 | Special Topics (as time permits) |
| F, Dec. 7 | Special Topics (as time permits) |

8. Homework and Quizzes

There will be weekly homework assignments due on Fridays. Homework should be handed in at the beginning of the period that it is due. Late homework will not be accepted. A total of 12 quizzes (15-20 minutes) will usually be on Mondays (exceptions: Friday, August 31st and Friday, November 16th) covering material included in the homework handed in the previous Friday. Only the top 10 scores will count towards the student’s final grade. There will be no make-ups for missed quizzes. You are encouraged to work together on homework assignments; individual solutions must be handed in, however.

9. Laboratory Component

There will be laboratory experiments conducted in groups, including a recombinant DNA experiment and a cell growth/metabolism experiment. Each experiment will include brief individual laboratory reports. Details to come.

10. Project Report (Due December 7th)

This will be a group project describing the design of a process to produce a specified amount of a given product (fermentation product, recombinant protein, etc.) as given in a previous AIChE Design problem. This will consist of (1) consulting the literature to determine all currently known information pertinent to the problem and (2) using this information along with the procedures (e.g., bioreactor design, medium formulation, genetic engineering, etc.) learned in class to develop the requested design. The design should include all pertinent steps from genetic engineering through product purification, including medium development, medium sterilization, etc. All of the equipment through product production should be properly sized (to the extent possible), etc., by using the techniques learned in our course (cost estimations should not be included). Product purification only needs to include the equipment used and the sequence thereof (i.e., no sizing or cost estimates). The final report should have the following format:

1. Title Page – which includes the names of all group members, project title, course number and course name, and date.
2. Abstract – which summarizes the overall conclusions of the project.
3. Introduction – which briefly describes the project, including the goals and approach used to achieve these goals and a summary of all pertinent literature.
4. Process Design – which includes the results of the design (obtainable with literature information and the techniques learned in class), including figures, diagrams, etc. This section should also include a Process Flow Diagram (PFD), preferably drawn with use of the ChemCad or similar software.
5. Safety and Environmental Issues - This should include identification of major hazards, including toxicity, flammability, reactivity, biological hazards, environmental hazards and how these can be addressed (e.g., PPE, procedures, training, control systems, sensors, relief devices, etc.) for the entire process. Compatibility of chemicals should also be evaluated, e.g., through use of the CRW software, and a HAZOP should be conducted.
6. Inherently Safer Design – a discussion of applying inherently safer design principles (minimize, substitute, moderate, and simplify) to the process. This should include (i) designing the plant for easier and effective maintainability, (ii) designing the plant with less waste, (iii) designing the plant with special features that demonstrate inherent safety, and (iv) incorporating design concepts that take into account the entire life cycle.
7. Conclusion – which includes all the conclusions, including potential market value of the proposed design.
8. Appendix – which includes sample calculations, etc.

11. Examination Schedule

Material Covered Date Place

Midterm Exam Aug. 20 – Oct. 5 Lectures Thursday, Oct. 11th @ 6:30 p.m. 140 SH

Final Exam All Materials Covered in Course TBD TBD

Exams will be a combination of closed book and open book. No excuses for missed exams will be accepted other than certified medical excuses. If you cannot take the exam at the scheduled time, then please contact Professor Murhammer at least one week prior to that date so that an alternative exam time can be scheduled.

12. Grading

Letter grades will be assigned on a curve. However, there will be a "gray area" between each two letter grades in the final distribution, so that two people getting the same weighted average grade could get different letter grades. If you are in one of these gray areas, whether you get the higher or lower grade depends on two factors: (i) your performance on the homework and quizzes and (ii) whether your homework and quiz performance has been improving (your grade goes up) or declining (your grade goes down). The weighting of the various components of the course is as follows:

1. Attendance 5%
2. Homework 10%
3. Quizzes 25%
4. Lab Reports 10%
5. Project 15%
6. Midterm Exam 15%
7. Final Exam 20%