

BSEN 445: Bioprocess Engineering

General Information:

Class Time: 12:30-1:45 pm; Tuesday and Thursday
Location: 149 Chase Hall
Instructor: Mark Wilkins, 211 Chase Hall, 402-472-8250
mwilkins3@unl.edu
Office Hours: TBD
Theory lectures will be posted on-line

Catalog Description: Engineering topics related to processing of biological materials into valuable products. The course covers enzyme kinetics, microbial kinetics, application of enzymes in industrial processes, bioreactor design, equipment scale-up, gas transfer in reactors and bioseparations.

3 credit hours

Prerequisites: BSEN 344; BIOC 401; BSEN 303

Learning Outcomes:

1. Understand and model enzymatic kinetics and apply the models for analysis of immobilized enzymatic bioreactors (ABET Outcome 1).
2. Utilize material balances to evaluate cell growth and substrate/product utilization in bioreactors (ABET Outcome 1).
3. Design bioreactors to achieve desired results (i.e. specified cell concentration, production rates) (ABET Outcome 7).
4. Understand and apply scale-up methods for designing bioreactors (ABET Outcome 7).
5. Develop and conduct experiments to obtain appropriate data, analyze and interpret obtained data, develop conclusions, and apply conclusions for bioprocess operation, development and design (ABET Outcome 6).
6. Present technical information on enzymatic and microbial processes in both written and oral form in a manner that allows others to comprehend the information and replicate procedures performed to obtain data.

ABET Outcomes covered in this course:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Required Materials: Bioprocess Engineering: Basic Concepts, 3rd ed. Shuler, Kargi and DeLisa.
Scientific Calculator

Communication with Instructor: All email communication will be to your huskers.unl.edu email address.

Policies:

Attendance. No policy. Theory lectures will be posted as videos on Canvas. There will be in-person classes each Tuesday and Thursday from 12:30 pm – 1:45 pm. During these classes, I will work on example problems, we will discuss questions about homework, and we can discuss the lecture material, particularly any questions.

Homework. Homework assignments will be due each Tuesday at 5:00 pm on Canvas. You may post a picture of your homework, a PDF, MS Word document, and/or MS Excel spreadsheet as appropriate. No late work will be accepted. You are encouraged to study and do homework together; although, each student must turn in their own homework assignment.

Exams. There will be two exams during the semester and a comprehensive final exam. The exam due dates are listed in the class schedule. NO early, late, or make-up exams will be given unless approved by the instructor. A missed exam will be counted as a score of zero.

Quizzes. None.

Grading

Homework: Homework assignments covering topics discussed in lecture and in the textbook will be given each week. You will have one week to complete each homework assignment. Points will be given for homework assignments based on completing the problems. The assignment will be corrected to help you learn from mistakes made in the solutions, but points will not be deducted for incorrect answers.

Exams: There will be two written exams during the semester and one final written exam. These exams are done individually. Exam problems are based on problems assigned for homework. Grading of exam questions is based on using the correct methodology to solve problems and obtaining the correct answer. Partial credit is awarded for correctly solving parts of each problem.

Labs: Two laboratory sessions will be conducted. A lab report will be submitted by each lab group according to the assignment description that will be given to all students for each lab.

Grading scheme:

Exam I	150 pts
Exam II	150 pts
Exam III	200 pts
Project	200 pts
Labs	100 pts
<u>Homework</u>	<u>200 pts</u>
Total	1000 pts

Diversity & Inclusion: The University of Nebraska-Lincoln does not discriminate on the basis of race, ethnicity, color, national origin, sex (including pregnancy), religion, age, disability, sexual orientation, gender identity, genetic information, veteran status, marital status, and/or political affiliation.

Academic Honesty Policy: Students are expected to adhere to guidelines concerning academic dishonesty outlined in Article III, Section B, Item 1 of the University's Student Code of Conduct (<http://stuafs.unl.edu/ja/code/>). The BSE Department process for grade and academic dishonesty appeals can be found at: <http://engineering.unl.edu/bse/bse-academic-resources/> in the Planning for Success section. Students are encouraged to contact the instructor for clarification of these guidelines if they have questions or concerns.

Mental Health and Wellbeing: UNL offers a variety of options to students to aid them in dealing with stress and adversity. Counseling and Psychological & Services (CAPS) is a multidisciplinary team of psychologists and counselors that works collaboratively with Nebraska students to help them explore their feelings and thoughts and learn helpful ways to improve their mental, psychological and emotional well-being when issues arise. CAPS can be reached by calling 402-472-7450. Big Red Resilience & Well-Being provides one-on-one well-being coaching to any student who wants to enhance their well-being. Trained well-being coaches help students create and be grateful for positive experiences, practice resilience and self-compassion, and find support as they need it. BRRWB can be reached by calling 402-472-8770.

ADA and Accommodation: Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 232 Canfield Administration, 472-3787 voice or TTY.

Face Coverings Syllabus Statement

An individual in this course has a documented need for face coverings to be required in this course. Without divulging personal or identifying information, such a documented need might be that a member of their household is unable to be vaccinated or has a health condition that makes vaccines less effective for them. As a result, the College of Agricultural Sciences and Natural Resources has determined that face coverings will be required in this course. If you are unwilling to comply with this requirement, please visit with your advisor about different sections or possible alternative courses that you might take in lieu of this one.

Tentative Schedule

Date	Subjects Covered	Reading
Aug. 24	Introduction to Bioprocess Engineering, Vaccine Manufacturing, Ethical Considerations	
Aug. 26	Enzymes: Single substrate kinetics	3.1-3.3.3
Aug. 31	Enzymes: Inhibition	3.3.4
Sep. 2	Enzymes: pH and Temperature	3.3.5
Sept. 7	Enzymes: Multiple substrate kinetics	Handout
Sept. 9	Enzyme Immobilization	
Sept. 14	Enzyme Applications (Class ends by 1:15 pm)	3.4
Sept. 16	Cell Kinetics	6.1-6.2, 9.1
Sept. 21	Stoichiometry and Yields (End of Exam 1 material)	6.2, 7
Sept. 23	Batch Reactors	6.3
Sept. 28	Continuous Culture Reactors	9.1-9.2
Sept. 30	Enzyme Lab in Chase 150	
Oct. 5	Exam 1	
Oct. 7	Modifying Batch and Continuous Reactors	9.3; Handout
Oct. 12	Immobilized Cells	9.3.4
Oct. 14	Plug Flow, Packed Bed, Immobilized Cell	Handout
Oct. 19	NO CLASS	
Oct. 21	Applications of Bioprocessing – Fuel Ethanol	
Oct. 26	Oxygen Transfer	10.1- 10.2
Oct. 28	Scale-Up (End of Exam 2 material)	10.2.4
Nov. 2	Microbial Lab	
Nov. 4	Mixing in reactors	Handout
Nov. 9	Exam 2	
Nov. 11	Heat Transfer in reactors	Handout
Nov. 16	Sterilization in bioprocessing	10.3
Nov. 18	Life Cycle Analysis	
Nov. 23	Project Work	
Nov. 25	Thanksgiving – NO CLASS	
Nov. 30	Applications of Bioprocessing – Vaccine Development	
Dec. 2	NO CLASS	
Dec. 7	Applications of Bioprocessing - Bioplastics	
Dec. 9	845 Seminar, Project Presentation	
Dec. 17	FINAL 7:30 AM – 9:30 AM	