BIOE 330 - Bioreaction Engineering
TTH 10:50AM-12:05PM
BRC 282
Syllabus 2024

Instructor: Ka-Yiu San E-mail:ksan@rice.edu
Office Hours: By appointment

TA: Yuhao Zhou

TA Hours: To be announced
Tutorial: To be announced

Course description: BIOE 330 covers the application of engineering principles to biological processes. Students apply mathematical and experimental techniques to quantitatively describe enzyme kinetics, metabolic and genetic networks, cell growth kinetics, and bioreactor design and operation.

Course prerequisite(s): BIOE 252 and (BIOC 201 or BIOS 201)

What are the concepts and critical skills these prerequisites imply that students must know to take this course? Integral calculus, chemical kinetics, basic chemical stoichiometry, mass and energy conservation principles, linear algebra.

Textbooks(s) and/or other required material:

1) *Bioprocess Engineering, 3nd Edition* by M. Shuler, F. Kargi, M. Delisa, Prentice Hall (2017);
2) *Lehninger Principles of Biochemistry, 6th Edition* by D.L. Nelson and M.M. Cox, W.H. Freeman and Company (2013)

Other References:

1) J. E. Bailey and D. Ollis, Biochemical Engineering Fundamentals, Second Edition, McGraw Hill, New York, 1986.
2) Stephanopoulos, A. Aristidou, J. Nielsen, Metabolic engineering: Metabolic engineering: principles and methodologies, Academic Press, c1998 (ISBN: 0126662606)

Course objectives: Students should learn:

1. To analyze the dynamics and regulation of metabolic pathway networks.
2. To derive and solve ideal bioreactor design equations using conservation principles.
3. To calculate model parameters from data collected from bioreactors and describe the engineering limitations of these systems.

Course outcomes: Students completing the course should be able to:

1. Demonstrate an understanding of their ethical and professional responsibilities as engineers
2. Understand the basic biochemical building blocks of life including amino acids, nucleotides, carbohydrates, and lipids.
3. Understand the basic metabolic pathways including glycolysis, the pentose phosphate pathway, the TCA cycle, and sample amino acid biosynthesis pathways.
4. Develop mathematical models to describe enzymatic reactions.
5. Determine enzymatic rate constants from experimental data.
6. Perform stoichiometric balances on cell growth processes.
7. Determine growth kinetics parameters from cell culturing processes.
8. Design and analyze basic bioreactor systems, including batch, fed-batch and continuous bioreactors.

9. Use of existing databases for data mining
10. Use Matlab/Simbiology to model, simulate and analyze biological systems

Topics covered (please refer to the tentative course schedule for a complete list of topics):
Basic building blocks including lipids, nucleotides, sugars
Metabolic pathways of glycolysis and TCA cycle
Enzyme kinetics and enzymatic rate constants; PSSH concept
Pharmacodynamics and pharmacokinetics
Gene regulatory networks
Cell growth models; Stoichiometry, lumped parameter growth models, energetics
Bioreactor design and operation; Batch, fed-batch, continuous, recycle

Course Organization
Homework (30%)
Quiz (20%)
Exam 1 (25%)
Exam 2 (25%)

Homework will be due at the time specified on the Homework Assignment front page (upload the completed homework to the appropriate Assignment folder on Canvas). No late homework will be accepted without permission of the instructor before the homework is due*. Illness and family emergencies will be dealt with on an individual basis. Grades on other late homework will be reduced 25% per day (including weekends). Individuals turning in late homework are expected not to consult the posted homework solutions (Honor Code). Students may not consult homework or examination from previous years (Honor Code).

Homework and Exam regrade policy

You must submit your written regrade request to the TA and the course instructor within five working days of the date when the graded materials were returned. Due to grade reporting schedule, a request for a regrade of Exam 2 must be submitted within two days when it is returned. Your written request should explain clearly the reasons for a regrade. A regrade request may lead to a regrade of your entire work and may result in a lower grade.

Honor Code Policy

Students are encouraged to talk to each other, the teaching assistants, the instructors, or anyone else about any assignment in the course that is not specifically designated as pledged. This assistance is limited to the discussion of the problem and perhaps sketching of a solution. Students must complete their own work. Students are **not** allowed to look at homework or examination problems or solutions from previous years.

Any student with a disability requiring accommodations in this class is encouraged to contact the instructor after class or during office hours. Additionally, students should contact the Coordinator for Disabled Student Services.