

# Biomedical Engineering 321

## (Bioreaction engineering and design)

### I. Logistics

*Semester:* Winter, 2010

*Days/Times:* Tuesday/Thursday 9:00-10:30 AM (**Starts at 9:10 AM**)

*Classroom:* G 906 Cooley

*Mediator:* Shuichi Takayama, Ph.D.; Biomed Eng & Macro Mol Sci Eng  
Mohamed El-Sayed, Ph.D.; Biomed Eng  
Meihua Rose Feng, Ph.D.; Pharmaceutical Sciences & Pharm Eng  
David E. Smith, Ph.D.; Pharmaceutical Sciences  
Duxin Sun, Ph.D.; Pharmaceutical Sciences

*Office Hours:* Ask GSI ([jackwang@umich.edu](mailto:jackwang@umich.edu)) and IA ([jscawang@umich.edu](mailto:jscawang@umich.edu))

*E-mail:* [takayama@umich.edu](mailto:takayama@umich.edu); [melsayed@umich.edu](mailto:melsayed@umich.edu)

*Prerequisites:* BME 221, BIO 310 (can be concurrent) + Curiosity, Motivation, Creativity

*Class website:* CTools. **Preprint/study notes and papers on class website. No inclass handouts.**

*Textbook:* - Shuler, M. L. and F. Kargi. Bioprocess Engineering, Basic Concepts. Prentice Hall, Inc. NJ 2002  
- Online journal articles

*OtherBooks:* - Phillips, R.; Kondev, J.; Theriot, J. Physical Biology of the Cell, Garland Science, 2008.  
- Lodish, G.; Berk, A.; Zipursky, L. S.; Matsudaira, P. *Molecular Cell Biology*, WH Freeman, 1999

*Searching:* NIH Public Medline: <http://www.ncbi.nlm.nih.gov/PubMed/medline.html>  
The Web of Knowledge: on web via UM library

### II. Course Goals

(3 credits) This course will introduce students to topics in enzyme kinetics, enzyme inhibition, materials and energy balance, cell growth and differentiation, cell engineering, bioreactor design, and analysis of the human body, organs, tissues, and cells as bioreactors. The application of bioreaction/bioreactor principles to tissue engineering will also be discussed.

- 1) Develop bioreaction and bioreactor intuition. (Lectures, homework, exams)
- 2) Learn basics of enzyme structure, function, kinetics, inhibition. Also learn how to analyze enzyme kinetics and mechanisms. (Lectures, homework, exams)
- 3) Familiarization with bioreactions/bioreactors literature and applications. (Lectures, presentation, literature research)
- 4) Learn how to design, evaluate, and analyze bioreactors (batch, continuous). (Lectures, homework, exams)
- 5) Learn basics of Pharmacokinetics and Pharmacodynamics (Lect, Probs, Exam)
- 6) Sharpen critical thinking and analysis (discussions, presentations)
- 7) Practice effective communication of ideas (presentations)
- 8) Cultivate innovative thinking (discussions)
- 9) Learn how to learn new fields (literature research, presentations)
- 10) Learn teamwork (presentations)
- 11) Learn what is available/going here at Michigan (field trips, guest lectures)

### III. Grading (subject to change)

3 credits, Breakdown: **TOTAL** possible points: 250 pt.

- (a) 3 exams: (50 pt + 50 pts + 50pts)
- (b) 1 classroom presentation on student-selected paper, 1 per student 4 some (25 pt.).
- (c) Homework (and in-class quiz) (50 pt.)
- (d) Participation/Evaluation (25 pt)

#### **Classroom Presentation (25 pt.) (may cut)**

- Student presentations are designed to promote independent investigation of research articles and to polish effective oral communication skills vital to the exchange of scientific ideas. Student pairs/trios will give a short presentation on a select **JOURNAL ARTICLE** on original research (not review articles) that involve bioreactions/bioreactors (e.g. microfluidic chips, multi-enzyme reactions, etc.).
- ca 20 minute presentations, including classroom discussion of paper (15 min presentation + 5 minutes Q&A).
- Submit electronic format of presentation (by email) (Powerpoint) on designated date (see below).
- Grading of Oral Presentation (25 pts Total; 15 pts by me; 10 by peers):
  - Good problem/topic and clear problem statement 5 pts
  - Effective explanation of technology/methods & biology 5 pts
    - use of visuals
    - equations mechanisms
  - Effective background research and Q/A's 5 pts
  - Group peer evaluation of contribution 5 pts
  - Class evaluation of quality 5 pts

Please upload onto Ctools a pdf of the article you propose to present to class.

Also, when you upload, send an email (one person email to me, cc your group) describe briefly why the paper is a good bioreactions/bioreactor paper and why you want to present on it. This email will trigger me to check Ctools for your submission.

Please just one person per group do the submission and just one email per group too.

Also, make sure that your paper is an original research article/letter/communication. Not a review paper or commentary.

- submission on time (3 pt)
- appropriate article type (1 pt)
- good bioreaction/bioreactor paper (email) (1 pt)

Also, first come first served, in that if someone else submits same pdf article as you, then the first pair to submit gets priority to present that paper and you will have to go and find a different paper. So sooner you submit the better.

**If you miss a quiz or exam, general rule is you will be allowed to do a make up quiz, report, or exam up to the minimum score others got on the quiz or exam on the day it was due.**

#### IV. Tentative Course Outline

Topics (May change some)	Tentative Dates	TextbookPages
- 1 Orientation HW1	Jan 7	Chapt 1
- 2 Cells, structure function, properties	Jan 12	Chapt 4
<b>Substrates, enzymes, pathways</b>		
- 3 Enzymes, structure, function, transition state theory HW2	Jan 14	Chapt 3
- 4 Enzyme kinetics, Michaelis-Menten equation, competitive inhibition, TS analog inhibitor	Jan 19	Chapt 3
- 5 How to determine Km, Vmax, Ki, modes of inhib HW3	Jan 21	Chapt 3
- 5 How to determine Km, Vmax, Ki, modes of inhib	Jan 26	Chapt 3
- 6 Modes of inhibition, other things that affect enzymes HW4	Jan 28	Chapt 3
Review	Feb 2	Chapt 3
- <b>Exam I</b> Enzyme kinetics and inhibition <b>1121, 1123 lbme</b>	Feb 4	
<b>Cells and bioreactors</b>		
- 7 Chemotaxis	Feb 9	Chapt 3
- 8 Feedback inhibition/Multi-enzyme systems HW5	Feb 11	Cha4,8,14
- 9 How cells grow & Cell Growth Kinetics	Feb 16	Chapt 6
- 10, Engineering Cells 11 Oxygen and Bioreactor Design HW6	Feb 18	Chapt 6, 7
- 12 Chemostat	Feb 23	Chapt 6, 9
Review	Feb 25	Chapt 9
Spring Break		
<b>EXAM II</b> Cells and Bioreactors <b>1121, 1123 lbme</b>	Mar 9	
<b>The Body and PK – PD</b>		
- 14 (1) Introduction, (2) IV Bolus PK	Mar 11	
- 15 (1) IV Infusion (2) Extravascular dose PK	Mar 16	
- 16 PK Problem set I	Mar 18	
- 17 PK Problem set II	Mar 23	
- 18 Multiple-dose PK	Mar 25	
- 19 ADME Overview	Mar 30	
- 20 (1) Non-linear PK , (2) Introduction to PK/PD	Apr 1	
- 21 Problem set III	Apr 6	
- Extra day	Apr 8	
- Presentations	Apr 13	
- Presentations	Apr 15	
- Wrap up & Review	Apr 20	

PK-PD **Exam III** on official final exam day Friday 23 1:30-3:30.