ChE 471/593A Biochemical Engineering
Fall Semester 2013

Instructor: Ray Y. K. Yang (Room 441, ESB; ryang@mail.wvu.edu; 304- 293-9365)

Lectures: 3:00–4:15pm, MW (Room 249A ESB); **Office hour**: 2:00-2:50pm, F (Room 441 ESB)

Prerequisite: Undergraduate-level Chemical Reaction Engineering course (WVU's ChE325 or its equivalent); **Or** instructor's consent.

Course Goal: Students will learn the fundamentals of bioprocess and biotechnology that use enzymes and microorganisms for the production of biofuel, food, pharmaceutical and other health-care biological.

Textbook: Shuler, M. L. and F. Kargi, *Bioprocess Engineering - Basic Concepts*, 2nd Ed., 2002, Prentice Hall (Required).

Course Outline*:

1. Enzymes and Enzyme catalysis
   Brief reviews of proteins, enzymes, carbohydrates, lipids, nucleotides, and nucleic acids; Mechanisms and kinetics of enzymic reactions; Michaelis-Menten and other types of rate expression; Experimental determination of enzymatic kinetic parameters; Reversible inhibition of enzyme; Effects of pH and temperature on enzyme catalysis; Activity and stability of enzymes, Enzyme nomenclature.

2. Microorganisms and Microbial Growth
   Classification, nomenclature, taxonomy, and characteristics of microorganisms; Growth kinetics of microorganisms; Monod and other types of growth; Effects of temperature, pH, and inhibitors on growth; Fermentation kinetics: product formation and substrate utilization.

3. Analysis and Design of Bioreactors
   General balance equation; Batch and continuous culture; Steady-state operation of a chemostat; Cell recycle.

4. Microbial Interactions and Dynamics of Bio-systems
   Dynamic responses of pure and mixed cultures; Stability analysis and dynamic operation of a chemostat. Multistage continuous culture; Competition, neutralism, and predator-prey interactions; Self-sustained oscillations.

***** Topics may not be presented in exactly the same order as listed.

Assessment
1. Homework Problems: 35%
2. Mid-Term Exam: 25%
3. Final Exam: 40% (8-10 am, December18, Wednesday)

Electronic Reserve in Evansdale Library for This Course:

1. Mosier, N. S. and M. R. Ladisch, *Modern Biotechnology – Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals*, 2009, E-book, Wiley.

Print Reserves in Evansdale Library for This Course:

1. Shuler, M. L. and F. Kargi, *Bioprocess Engineering - Basic Concepts*, 2nd Ed., 2002, Prentice Hall.
2. Mosier, N. S. and M. R. Ladisch, *Modern Biotechnology – Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals*, 2009, Wiley.
3. Blanch, H. W. and D. S. Clark, *Biochemical Engineering*, Dekker, 1997.
4. Bailey, J. E. and D. F. Ollis, *Biochemical Engineering Fundamental*, 2nd Ed., 1986, McGraw-Hill.

Expected Learning Outcomes: Upon successful completion of this course:

1. Students will understand the mechanisms of enzyme catalysis and be able to determine the kinetic parameters associated with Michaelis-Menten and other more complicated rate expressions.
2. Students will understand various types of inhibition to enzyme reactions.
3. Students will understand the effects of pH and temperature on the activity and stability of enzymes.
4. Students will comprehend the complexity of microbes and yet be able to use Monod and other types of growth patterns to describe their growth.
5. Students will understand the effects of temperature, pH, and inhibitors on microbial growth and the importance of sterilization in bio-related experimental work.
6. Students will understand the kinetics of substrate utilization and product formation during fermentation.
7. Students will understand pure culture of microorganisms in batch/continuous operation.
8. Students will understand steady-state operation of a single or multiple chemostats with or without cell recycle.
9. Students will understand the dynamics of mixed cultures, including self-sustained oscillations, and their implications to other bio-systems.

Academic Integrity Statement:

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code http://studentlife.wvu.edu/office_of_student_conduct/student_conduct_code. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me *before* the assignment is due to discuss the matter.

Social Justice Statement:

"West Virginia University is committed to social justice. I concur with that commitment and expect to foster a nurturing learning environment based upon open communication, mutual respect, and non-discrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with Disability Services."