CHEMICAL ENGINEERING 5103-1 (6103-1)
BIOCHEMICAL ENGINEERING

Spring Semester, 2016
C O U R S E S Y L L A B U S

INSTRUCTOR:

PROFESSOR ED TRUJILLO
3290H MEB, 801.581.4460,
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TEACHING ASSISTANTS:

Melissa Puga, melissa.puga@utah.edu
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Gray Bertelsen, gray.bertelsen@gmail.com
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Brad Dallin, brad.dallin@gmail.com
Office: ICC room, 2285 MEB
Office Hours: 3:30-4:30 PM, Tuesdays

SCHEDULE: MWF 9:40 AM-10:30 AM, WEB L105

CO-REQUISITES: or PRE-REQUISITES

CHEN 3553 - Chemical Reaction Engineering (C- or better)
CHEN 3603 - Mass Transfer, or equivalent courses (C- or better)
Recommended prerequisites or co-requisites are
BIOL 2020 - Cell Biology, or CHEM 3510-Biological Chemistry,

DESCRIPTION:

Introductory course to biochemical engineering and bioprocessing. Cell biology, enzyme kinetics, bioreactors, bioseparations and bioprocessing will be discussed in relation to the medical, pharmaceutical, environmental and biochemical industries. Those taking CH EN 6103 will be required to write a term paper by the end of the semester.

GRADING:

MID-TERM EXAM	25%
Homework	15%
Quizzes	20%
Participation in Class	15%
END-TERM EXAM	25%

TEXT:

Michael L. Shuler and Fikret Kargi**, "Bioprocess Engineering: Basic Concepts**," Second Edition, Prentice Hall, New Jersey, 2002.

REQUIRED EQUIPMENT:

We will be using the U of U Clicker Technology for this class (ResponseCard NXT or ResponseWare™ by Turning Technologies). This will require you to purchase a "Clicker" from the bookstore (or use your smartphone or other mobile device) and purchase a license from Turning Technologies. Used clickers are

available from the bookstore. These are the same clickers used in seminar. However, you must register your clicker for this course in CANVAS to receive credit. Registration instructions are given on the home page in CANVAS.

HOMEWORK:

Homework is to be scanned and uploaded to CANVAS as one pdf-formatted file before or on the day and time that it is due. Any associated files such as Excel files, MATLAB, or POLYMATH files should not be uploaded but the results of those programs should be contained in the homework file. Your last name and student ID number must be the first part of the filename. A scanner is available in the ICC and you may use the scanner in MEB 3271 (use access code 55).

Late Homework: No points will be deducted if the homework is submitted within 15 minutes passed the deadline but 10% will be deducted if submitted between 15 minutes and 3 hours. After 3 hours, 30% will be deducted until the solutions are posted on Canvas. Once the solutions are posted, no points can be given for the assignment.

PARTICIPATION: Participation in class will be monitored using your clicker responses to questions asked during class so no credit will be given if you forget your clicker. A point system will be established and normalized to give a final percentage for grading at the end of the semester. It is required that you bring your calculator and textbook to class as well.

IMPORTANT DATES:

Last day to drop (delete) classes (no penalty)	January 22
Last day to add classes without permission code	January 17
Last day to withdraw from term length classes	March 4

Learning Objectives:

1. Demonstrate knowledge of DNA and its structure for simple organisms and for complex organisms and how DNA is altered by genetic engineering.
2. Recognize the difference between proteins and nucleic acids and be able to calculate the isoelectric point of a protein from the dissociation constants of the ionizing side groups
3. Calculate enzymatic rate constants from initial rate data and determine if inhibition is present and of what type.
4. Apply material balances to derive and use design equations for chemostats and bioreactors.
5. Employ analytical and numerical methods for solving single or coupled differential equations that arise from bioreactor material balances.
6. Determine the stoichiometric coefficients in a chemical reaction involving biomass.
7. Calculate the volumetric mass transfer coefficient in a bioreactor from gassing-in, gassing-out experimental data and use that coefficient to determine the oxygen transfer requirements for cell growth.
8. Determine the osmotic pressure from protein concentrations and solvent characteristics using established correlations and theories.
9. Design a chromatographic column to separate a certain protein mixture.

10. Determine the time required for the separation of two proteins in an electrophoresis chamber using their electrophoretic mobilities.
11. Design a biological activated sludge process to process a certain waste water.
12. Demonstrate knowledge of contemporary biochemical engineering issues and controversies.

Topics Covered:

- Proteins, DNA, RNA, cell construction, nutrients, stoichiometry of cell growth
- Enzymes, enzyme kinetics, immobilized enzymes
- DNA replication, translation, transcription, genetic engineering, PCR
- Metabolic pathways, microbial reactions, respiration, fermentation
- Unstructured, nonsegregated cell growth models
- Continuous cultures, chemostats
- Bioreactors, non-ideal mixing, heat transfer, mass transfer, recycle
- Bioprocessing – osmotic pressure, ultrafiltration, microfiltration, centrifugation, chromatography, electrophoresis
- Tissue engineering, virus growth
- Biological Waste Treatment

Software Used in Course:

- MATLAB
- POLYMATH
- EXCEL

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TENTATIVE COURSE OUTLINE (1/10/2016)

Text: Michael L. Shuler and Fikret Kargi**, "Bioprocess Engineering: Basic Concepts**," Second Edition, Prentice Hall, New Jersey, 2002.

Day	***Subject***	***Reading Assignment***
Jan 11	Overview - Biochemical Engineering	Chapter 1
Jan 13	Biological Basics	Chapter 2
Jan 15	Cell Construction/Proteins/Nutrients	Chapter 2
Jan 18	********** MARTIN LUTHER KING/HUMAN RIGHTS DAY**********	
Jan 20	Enzymes, Polymath	Chapter 3
Jan 22	Enzymes	Chapter 3
Jan 25	Enzyme Kinetics	Chapter 3
Jan 27	**Homework #1 (Gray),** MOVIE – "The Secret of Life"	
Jan 29	How Cells Work	Chapter 4
Feb 1	DNA replication, translation, transcription	Chapter 4
Feb 3	**Homework #2 (Melissa)** – Passive and Active Transport	Chapter 4
Feb 5	Metabolic pathways, respiration	Chapter 5
Feb 8	How Cells grow,	Chapter 6
Feb 10	**Homework #3 (Brad)**, Unstructured/structured kinetic models	Chapter 6
Feb 12	Unstructured/structured kinetic models	Chapter 6
Feb 15	**********PRESIDENTS' DAY**********	
Feb 17	**Homework #4 (Gray)** Stoichiometry of microbial growth	Chapter 7
Feb 19	MOVIE – "Playing God"	
Feb 22	Recombinant DNA, genetic engineering	Chapter 8
Feb 24	**Homework #5 (Melissa),** Bioreactors	Chapter 9
Feb 26	Review	
Feb 29	########## MIDTERM EXAM ##########	
March 2	Bioreactors	Chapter 9
March 4	Bioreactors, Immobilized cell systems	Chapter 9
March 7	Immobilized cell systems	Chapter 9
March 9	**Homework #6 (Brad)** Scale-Up, Agitation,	Chapter 10
March 11	Mass Transfer, Instrumentation	Chapter 10
March 13-20	********** SPRING SEMESTER BREAK **********	
March 21	Determining volumetric mass transfer coefficient, k_{La}	Chapter 10
March 23	Bioprocessing and product recovery, cell disruption	Chapter 11
March 25	Osmotic Pressure	Chapter 11
March 28	Filtration	Chapter 11
March 30	**Homework#7 (Gray),** Microfiltration, Ultrafiltration	Chapter 11
April 1	Centrifugation –	Chapter 11
April 4	Chromatography	Chapter 11
April 6	**Homework #8 (Melissa),** Chromatography	Chapter 11
April 8	Chromatography	
April 11	Electrophoresis	Chapter 11
April 13	**Homework #9 (Brad),** Electrophoresis	Chapter 11
April 15	Mixed Cultures	
April 18	Biological Waste Treatment	Chapter 16
April 20	**Homework #10 (Gray),** Biological Waste Treatment	Chapter 16
April 22	Review	
April 25	########## SECOND EXAM ##########	

NO FINAL EXAMINATION

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References

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Bronzino, Joseph D., Editor-in-Chief, "The Biomedical Engineering Handbook - Second Edition, Volumes I and II," CRC Press, Boca Raton, 1995. Call no. QT29.B615 1995

Cooper, Geoffrey M., "The Cell: A molecular approach," ASM Press, Washington, D.C., 1997. Call no. QH581.2. C66 1997

Cutlip, Michael B. and Mordechai Shacham, "Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB," 2nd ed., Prentice Hall International Series, 2008.

Harrison, Roger C., Paul Todd, Scott R. Rudge, and Demetri P. Petrides, "Bioseparations Science and Engineering, Oxford University Press, New York, 2003. Call no. TP248.25.S47 B55 2002

Lanza, Robert P.; Robert Langer and William L. Chick, Eds., "Principles of Tissue Engineering," R. G. Landes Company, Academic Press, San Diego, 1997. Call no. TP48.27.A53.p75 1997

Lee, James M., "Biochemical Engineering," Prentice-Hall, 1992.
Call no. TP248.3.L44 1992

Nielsen, Jens and John Villadsen, "Bioreaction Engineering Principles," Plenum Press, New York, 1994. Call no. TP248.25.B55 N53 1994

Pollack, Gerald H., "Cells, Gels, and the Engines of Life," Ebner and Sons Publishers, Seattle, 2001. not in library

Shuler, Michael L and Fikret Kargi, "Bioprocess Engineering: Basic Concepts," Prentice-Hall Publishers, 2002.Call no. TP248.3.S58 2002

Stephanopoulos, Gregory N.; Aristos A. Aristidou and Jens Nielsen, "Metabolic Engineering: Principles and Methodologies," Academic Press, San Diego, 1998. Call no. TP248.3.S74 1998

Truskey, George A., Fan Yuan and David F. Katz, "Transport Phenomena in Biological Systems," Pearson Prentice Hall, New Jersey, 2004. Call no. QH509.T78 2004

Voet, Donald, Judith G. Voet an d Charlotte W. Pratt, "Fundamentals of Biochemistry – Upgrade edition," John Wiley & Sons, Inc., New York, 2002. Call no. QD415.V63 2002

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