BioE 11: Engineering Molecules I

Course Number: BioE 11

Course title: Engineering Molecules I

Instructor: John Dueber (jdueber@berkeley.edu)

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Offered: Spring 2018

Units: 3

Course Format: (3 hours lecture)

Prerequisites: Chem 3A or Chem 112A

Grading: Letter

John's office hours: Wednesdays 10:15-11:15am, 416 HMMB. If possible, email me to ahead of time.

Short Course Description for General Catalog

This course focuses on providing students with a foundation in organic chemistry and biochemistry needed to understand contemporary problems in synthetic biology, biomaterials, and computational biology.

Course Objectives: The goal of this course is to give students the background in organic chemistry and biochemistry needed understand problems in synthetic biology, biomaterials and molecular imaging. Emphasis is on basic mechanisms.

Desired Course Outcomes: Students will learn aspects of organic and biochemistry required to begin the rational manipulation and/or design of biological systems and the molecules they are comprised of.

Grading Policy: Grading: The students will be graded based on their performance on 2 midterms (30% of grade each) and a final (30% of grade). Homework will be 10% of the grade.

Final Exam for undergraduate course: written final exam conducted during the scheduled final exam period

Textbooks:

Organic Chemistry: "Organic Chemistry" 2nd edition. Clayden, Greeves, Warren and Wothers.

Biochemistry: "Biochemistry" 4th edition. Voet and Voet.

Class Syllabus and Full Course Description:

Lecture Outline:

Weeks 1-6 Organic chemistry

Week 1: Chapters 2 and 4. *001. What do you know? Introduction to functional groups and basic molecular orbital theory.*

Week 2: Chapter 5, 6, 7, and 8. *002. Organic reaction mechanism, nucleophilic addition to the carbonyl group, delocalization, conjugation and pKa.*

Week 3: Chapters 10, 11, 12. *003. Nucleophilic substitutions, equilibria and rates.*

Week 4: Chapters 14, 20. *004. SN1 and SN2, Stereochemistry, and enolates.*

Week 5: Catch-up and Midterm (on Feb 15)

Weeks 6-13 Biochemistry

Useful cites:

http://bionumbers.hms.harvard.edu/default.aspx (Links to an external site.)Links to an external site.
http://www.brenda-enzymes.org/all_enzymes.php (Links to an external site.)Links to an external site.

Week 6: *001.Life - Applied Chemistry*

Chapter 1, 2

Week 7: *002.Chemical Structure of DNA, RNA, amino acids, and proteins.* How the structures of life's biomolecules enable the properties of their polymers.

Chapter 4, 5, 8

Week 8: *003.Enzyme catalysis and metabolism.* How enzymes work. Quantification and measurement of enzyme kinetics (e.g., Michaelis-Menten).

Chapter 3, 13, 14

Week 9: 004. Glycolysis as an example of various enzymes and their mechanisms.

Chapter 17

Week 10: *005. Engineering proteins.* Overview of directing evolution for engineering proteins with desired protein substrate specificities and properties.

Not textbook

Week 11: Catch-up and Midterm (March 22)

Weeks 12: *006.Protein biosynthesis and regulation.* Consideration of regulation at all levels: DNA replication, transcription, and translation, with a focus on transcription and translation regulation. Principles and uses of engineered regulatory mechanisms (e.g. Lac promoter or T7 promoter for maximizing protein production levels).

Chapter 30, 31, 32

Week 13: 007. Methods for protein purification and methods for DNA biosynthesis. Various strategies for synthesis and assembly of DNA at the short oligo (e.g., phosphoramidite method), 1-3kb, 3-25kb, and >25kb scales (e.g., Golden Gate, Gibson methods).

Chapter 6 and material not in textbook

If time, *008. DNA structure and enzymatic manipulation.* Packaging of DNA, DNA silencing, and epigenetic mechanisms in eucaryotes and procaryotes. Methods for editing existing DNA (e.g., CRISPR). Implications for engineered systems.

Not in textbook

Week 14: RRR

Week 15: Final Thurs, 5/10/18 3-6pm.