Engineering Molecules 1
Instructors: John Dueber and Niren Murthy
Units : 3
Course Format: (3 hours lecture)
Prerequisites : Chem 3A
Grading: Letter

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

Final Exam will be written

Textbook:
ORGANIC CHEMISTRY: Clayden, Greeves, Warren and Wothers, "Organic Chemistry" 2nd edition and additional readings
BIOCHEMISTRY: "BIOCHEMISTRY" 4TH EDITION. VOET AND VOET.

Class Syllabus and Full Course Description:

The lectures will be rolling through the below as time permits given questions, etc. in class. The below dates are estimates and likely to change as conditions dictate. The lone exception is Reviews and Exams, these will be given on the dates listed and will cover the material taught up to that point (organic chemistry for the organic chemistry midterm, biochemistry only for the biochemistry midterm, and all course material for the final exam). In particular, it is likely the material for Week 13 will be excised if the time is needed for better pacing/coverage of the other listed lectures.

Week 1 Wednesday January 20-Monday January 25th.
Introduction and Chapters 5 and 6 of the Clayden book.
Chapter 5 Organic reactions.
Chapter 6 Nucleophilic addition to the carbonyl group.

Week 2: Wednesday January 27-Monday February 1st. Chapter 7 of the Clayden book and biological applications of hemiacetals and pi conjugated systems.

Biological applications of hemiacetals: Discussion of tenofovir
Chapter 7 Delocalization and conjugation
Biological applications of pi conjugated molecules: Imaging of reactive oxygen species and tumors with fluorescent dyes

Week 3: Wednesday February 3rd-Monday February 8th. Chapter 8, biological applications of pKa and Chapter 9.
Chapter 8 Acidity, basicity and pKa
Biological Applications of pKa: Solubility of drugs and lysosomal targeting
Chapter 9 Using organometallic reagents to make C-C bonds

Week 4: Wednesday February 10th-Monday February 15th. Chapters 10 and 11 of the Clayden book, and biological applications of carbonyl substitution reactions.
Chapter 10 Nucleophilic substitution at the carbonyl
Chapter 11 Nucleophilic substitution at carbonyl with a loss of carbonyl oxygen Biological applications of carbonyl chemistry: Schiff bases and acetals as linkers in targeted drug delivery.

Week 5: Wednesday February 17th-Monday February 22nd. Chapter 13, solid phase DNA synthesis, synthesis of triphosphate bases and nucleoside prodrugs.
Chapter 13 H-NMR proton nuclear magnetic resonance
Solid phase DNA synthesis, synthesis of triphosphate bases, and synthesis of tenovofir and other nucleoside prodrugs

Week 6 : Wednesday February 24th-Monday March 1st. Review and Exam I
Exam 1 will be administered via Bcourses from 2.10-3.00PM PST on Friday February 26.

Week 7: Wednesday March 3rd-Monday March 8th. *001. Life - Applied Chemistry.*
Viewing life through a chemist's eyes.

Chapter 1	p. 3-17, introduction to the biochemistry part of this course
	p. 31-34, chemical evolution
Chapter 2	p. 40-45, aqueous solutions

Week 7, 8: Wednesday March 10th-Monday March 15th.*002. Chemical Structure through Central Dogma (DNA, RNA, amino acids, and proteins).* How the structures of life's biomolecules enable the properties of their polymers.

Chapter 4	p. 82-96, nucleic acids, DNA replication, transcription
Chapter 5	p. 67-71, amino acids
Chapter 8	p. 259-266, protein stability

Week 9: Wednesday March 17th-Monday March 29th. *003. Enzyme catalysis and metabolism.* How enzymes work.

Chapter 3	p. 469-472, introduction to enzymes
Chapter 13	p. 510-516, enzyme catalysis

p. 525-535, serine protease as an example of an enzyme mechanism
Chapter 16 p. 559-569, introduction to metabolism

Week 10: Wednesday March 31st -Monday April 5th. *004 .Glycolysis as an example of various enzymes and their mechanisms.*
Chapter 17 p. 593-619, glycolysis as 10 examples of enzymes

Week 11 Wednesday April 7th-Monday April 12th. *005. Review, Midterm*
Review and Exam 2
Exam 2 will be administered via Bcourses from 2.10-3.00PM PST on Friday April 9th.

Week 12: Wednesday April 14th-Monday April 19th. *006. Protein biosynthesis and regulation.* Consideration of regulation at all levels of Central Dogma: DNA replication, transcription, and translation, with a particular 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 p. 1173-1194, DNA replication
Chapter 31 p. 1260-1262, Transcription, Lac operon inducibility
p. 1265-1267, promoters for transcription initiation
p. 1283-1286, promoters used for regulation
Chapter 32 p. 1338-1349, genetic code and tRNA
p. 1371-1388, translation by the ribosome

Week 13: Wednesday April 21st-Monday April 26th *007.* Methods for protein purification and methods for DNA sequencing.
Chapter 6 p. 129-143, protein purification
p. 147-150, gel electrophoresis, Western blots
p. 176-180, DNA sequencing

If time permits, *DNA structure and enzymatic manipulation.* Packaging of DNA, DNA silencing, and epigenetic mechanisms in eucaryotes and procaryotes.
Not in textbook

Week 14: Wednesday April 28th-Friday April 30th *008. Examples of biochemical tools for engineering (Synthetic Biology)*
Not in the textbook, materials I assembled.

Final Tues, 5/11/21 at 11:30-2:30pm

Course Policies
Inclusion: We are committed to creating a learning environment welcoming of all students. To do so, we intend to support a diversity of perspectives and experiences and respect each others' identities and backgrounds (including race/ethnicity, nationality, gender identity, socioeconomic class, sexual orientation, language, religion, ability, etc.).

To help accomplish this:

- If you feel like your performance in the class is being impacted by a lack of inclusion, please contact the instructors, your ESS advisor, or the departmental Faculty Equity Advisor (list and information at: https://diversity.berkeley.edu/faculty-equity-advisors). An anonymous feedback form is also available at https://engineering.berkeley.edu/about/equity-andinclusion/feedback/.
- If you have a name and/or set of pronouns that differ from your legal name, designate a preferred name for use in the classroom at: https://registrar.berkeley.edu/academic-records/your-name-records-rosters.
- As a participant in this class, recognize that you can be proactive about making other students feel included and respected.

Berkeley honor code: Everyone in this class is expected to adhere to this code: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others."

Academic honesty. You are encouraged to form study groups and work together to understand course material, but all written work as well as responses to in-class questions should be your own.

Student Conduct: Ethical conduct is of utmost importance in your education and career. The instructors, the College of Engineering, and U.C. Berkeley are responsible for supporting you by enforcing all students' compliance with the Code of Student Conduct (https://sa.berkeley.edu/code-of-conduct) and the policies listed in the CoE Student Guide (https://engineering.berkeley.edu/students/undergraduate-guide/policiesprocedures/). The Center for Student Conduct is set up to support you when you have been affected by actions that may violate these community rules. This includes an organized and transparent process, student participation in the process, mechanisms for appeals, and other mechanisms to protect fairness (https://sa.berkeley.edu/conduct).

Accommodation policy: We honor and respect the different learning needs of our students, and are committed to ensuring you have the resources you need to succeed in our class. If you need accommodations for any reason (e.g. religious observance, health concerns, insufficient resources, etc.) please discuss with your instructor or academic advisor how to best support you. We will respect your privacy under state and Federal laws, and you will not be asked to share more than you are comfortable sharing. The disabled student program is a related resource, listed below.

Support during Remote Learning:
We understand that your specific situation may present challenges to class participation. Please contact the instructors if you would like to discuss these and co-develop strategies for engaging with the course.

The Student Technology Equity Program (STEP) is available to help access a laptop, Wi-Fi hotspot, and other peripherals (https://technology.berkeley.edu/STEP).

You will be alerted as to when synchronous sessions are about to be recorded. If you prefer not to be recorded, you may turn your video and microphone off.

Please set your Zoom name to be the name you would like the instructors to call you. You may optionally include your personal pronouns.

Please set your Zoom picture to an appropriate profile picture of you to foster a sense of community and enhance interactions. If you are not comfortable using an image of yourself, you may use an appropriate picture of an avatar.

We encourage participating with your video on to foster a sense of community and enhance interactions. However, we understand that some students are not comfortable with video or may not be able to participate by video.

Resources

Center for Access to Engineering Excellence (CAEE) The Center for Access to Engineering Excellence (227 Bechtel Engineering Center; https://engineering.berkeley.edu/student-services/academic-support) is an inclusive center that offers study spaces, nutritious snacks, and tutoring in >50 courses for Berkeley engineers and other majors across campus. The Center also offers a wide range of professional development, leadership, and wellness programs, and loans iclickers, laptops, and professional attire for interviews.

Disabled Students' Program (DSP)
The Disabled Student's Program (260 César Chávez Student Center #4250; 510-6420518; http://dsp.berkeley.edu) serves students with disabilities of all kinds. Services are individually designed and based on the specific needs of each student as identified by DSP's Specialists. If you have already been approved for accommodations through DSP, please know that DSP is ready to quickly adjust your accommodations if your situation changes.

Counseling and Psychological Services
University Health Services Counseling and Psychological Services staff are available to you at the Tang Center (http://uhs.berkeley.edu; 2222 Bancroft Way; 510-642-9494) and in the College of Engineering (https://engineering.berkeley.edu/students/advisingcounseling/counseling/; 241 Bechtel Engineering Center), and provide confidential assistance to students managing problems that can emerge from illness such as financial, academic, legal, family concerns, and more. Long wait times at the Tang Center in the past led to a significant expansion to include a 24/7 counseling line at (855) 817-5667. This line will connect you with help in a very short time-frame. Short-term help is also available from the Alameda County Crisis hotline: 800-309-2131. If you or someone you know is experiencing an emergency that puts their health at risk, please call 911.

The Care Line (PATH to Care Center)
The Care Line (510-643-2005; https://care.berkeley.edu/care-line/) is a 24/7, confidential, free, campus-based resource for urgent support around sexual assault, sexual harassment, interpersonal violence, stalking, and invasion of sexual privacy. The

Care Line will connect you with a confidential advocate for trauma-informed crisis support including time-sensitive information, securing urgent safety resources, and accompaniment to medical care or reporting.

Ombudsperson for Students The Ombudsperson for Students (102 Sproul Hall; 642-5754; http://students.berkeley.edu/Ombuds) provides a confidential service for students involved in a University-related problem (academic or administrative), acting as a neutral complaint resolver and not as an advocate for any of the parties involved in a dispute. The Ombudsman can provide information on policies and procedures affecting students, facilitate students' contact with services able to assist in resolving the problem, and assist students in complaints concerning improper application of University policies or procedures. All matters referred to this office are held in strict confidence. The only exceptions, at the sole discretion of the Ombudsman, are cases where there appears to be imminent threat of serious harm.

UC Berkeley Food Pantry
The UC Berkeley Food Pantry (#68 Martin Luther King Student Union; https://pantry.berkeley.edu) aims to reduce food insecurity among students and staff at UC Berkeley, especially the lack of nutritious food. Students and staff can visit the pantry as many times as they need and take as much as they need while being mindful that it is a shared resource. The pantry operates on a self-assessed need basis; there are no eligibility requirements. The pantry is not for students and staff who need supplemental snacking food, but rather, core food support