BIOE 140
Biomolecular Engineering
Fall, 2018

Instructor: Prof. Victor Muñoz
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Lecture: F 10:30 am - 1:00 pm, CLSSRM 110
Discussion: F 1:30 pm - 2:20 pm, CLSSRM 281 (Section 1)
F 2:30 pm - 3:20 pm, CLSSRM 281 (Section 2)

Required Text: This course requires the textbook:
Molecular Biotechnology: Principles and Applications of Recombinant DNA 4th Edition (2010) by Bernard R. Glick, Jack. L. Pasternak & Cheryl L. Patten. ASM Press, Washington DC
ISBN: 978-1-55581-498-4

Additional Reading: **1-** Fundamentals of Biochemistry 5th Edition by Donald Voet, Judith G. Voet & Charlotte W. Pratt. (2016) Wiley ISBN: 978-1-118-91840-1
2- Protein Engineering and Design by Sheldon J. Park & Jennifer R. Cochran. (2010) CRC Press ISBN: 978-1420076585.

Additional readings can be found at the UC Merced Kolligian Library, or through the ILL system.

Course Overview: This course focuses on the structural and quantitative analysis as well as the design of custom biomolecules, including proteins, nucleic acids, and macromolecular complexes. The students will learn the fundamental concepts of biomolecular structure and function and the experimental and computational tools/approaches for engineering biomolecules and how to apply these new technologies to solving some of the most pressing problems in biotechnology, medicine and bioengineering. The covered approaches range from rational and computational design to combinatorial and evolutionary optimization and biophysical characterization, whereas the target products span customized enzymes, molecular switches and actuators, recombinant biosensors, therapeutic antibodies, and protein and DNA assemblies.

Course Learning Goals and Outcomes: *By the end of this course, students will be able to:*

1. Describe, understand and use the fundamental tools and techniques employed for the structural and functional analysis of biomolecules
2. Compare and contrast various experimental and computational strategies for engineering and designing biomolecules
3. Learn the basic concepts of biomolecular structure and function and their connection with the strategies for engineering and designing new biomolecules
4. Show mastery of fundamental topics in biomolecular engineering and design, including sequence/structure/function relationships; physical factors determining biomolecular structure, folding and stability; methods and techniques for structural and functional analysis of biomolecules; enzymatic catalysis; protein chemistry; directed molecular evolution; combinatorial biochemistry; computational approaches to biomolecular design. At the end of the course, the students should be able to converse with scientists and read technical literature about all these topics
5. Articulate the scientific vocabulary used in communicating scientific information in biomolecular engineering and design.

Relation to the following BIOE Problem Learning Outcomes (PLOs):

The course learning outcomes relate to the following BIOE program learning outcomes:

PLO #1 An understanding of biology and physiology. (Course objectives #1 and 4)

PLO #2 The capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve problems at the interface of engineering and biology; (Course objectives #2 and 4)

PLO #3 The ability to make measurements on, and interpret data from, living systems. (Course objectives #1, 3 and 4)

PLO #4 The ability to address problems associated with the interaction between living and non-living materials and systems. (Course objective #4)

PLO #5 Professional and ethical responsibility. (Course objective #3)

PLO # 6 The ability to communicate effectively in written, spoken, and visual formats with technical, professional, and broader communities. (Course objective #5)

Relation to the following ABET Problem Learning Outcomes (PLOs):

(a) an ability to apply knowledge of mathematics, science, and engineering (b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning (j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for

engineering practice.

Prerequisites: It is highly recommended to take BIOE 135 prior to BIOE 140

Course Policies: Attendance is mandatory. This course requires the user of clickers to answer questions during class, so each student is responsible for bringing a clicker in properly operating condition. Scientific calculator will be needed for the review sessions. No cell phone or recording devices are allowed in class.

Grading for BIOE 140

50% Exam:
- Midterm Exam (20%)
- Final Exam (30%)

25% Class Participation (Students will be quizzed regularly during each class using clicker technology. The students will be informed of their cumulative score to date from class participation at mid term and two weeks before the final exam)

25% Homework Assignments

The final course grade will be calculated from the overall numerical score obtained during the course converted onto a letter grade according to the following recipe:

A : 85-100%	C+ : 60-65%
A- : 80-85%	C : 55-60%
B+ : 75-80%	C- : 50-55%
B : 70-75%	D : 45-50%
B- : 65-70%	F : <45

Academic Dishonesty Statement:

a. Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work. b. You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action.

c. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in

failure of the exam, and may lead to failure of the course and University disciplinary action.

Disability Statement: Accommodations for Students with Disabilities: The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. I am available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations.

Lecture Schedule: Fall 2018

Week 1		
Aug 24	Lecture	***Course Introduction*** ***Development of Biomolecular Engineering***
	Disc.	Matlab tutorial for Biomolecular Engineering
Week 2		
Aug 31	Lecture	***DNA, RNA and Protein Synthesis***
	Disc.	Computer lab: pH titrations and buffers
Week 3		
Sep 7	Lecture	***Recombinant DNA Technology***
	Disc.	Discussion topics: DNA, RNA, Protein Synthesis and Recombinant DNA Technology
Week 4		
Sep 14	Lecture	***Bioinformatics, Genomics, Proteomics***
	Disc.	*Computer lab:* bioinformatic analysis of DNA sequences
Week 5		
Sep 21	Lecture	***Synthesis, Amplification and Sequencing of DNA***
	Disc.	Computer lab: sequencing DNA and designing oligos for PCR
Week 6		
Sep 28	Lecture	***Manipulation of Gene Expression in Prokaryotes***
	Disc.	Discussion topics: synthesis, amplification and sequencing of DNA, gene expression and protein production
Week 7		
Oct 5	Lecture	***Heterologous Protein Production in Eukaryotic Cells***
	Disc.	*Review of materials, preparation for Midterm Exam*
Week 8		
	Oct 12	**MIDTERM Exam**
Week 9		
Oct 19	Lecture	***Protein Purification and Structure Determination***
	Disc.	Computer lab: analyzing protein structure
Week 10		
Oct 26	Lecture	***Protein Folding and Stability***
	Disc.	Computer lab: analyzing stability and folding kinetics
Week 11		
Nov 2	Lecture	***Protein Function: Biomolecular Recognition, Cooperativity and Allostery***
	Disc.	Computer lab: ligand binding and cooperativity
Week 12		
Nov 9	Lecture	***Protein Engineering 1: Site Directed Mutagenesis***
	Disc.	Computer lab: mapping protein-protein interactions
Week 13		
Nov 16	Lecture	***Protein Engineering 2: Combinatorial Approaches***
	Disc.	Discussion topics: protein purification, structure

		determination, folding and stability, binding and cooperativity
Week 14		
	Nov 23	*Thanksgiving*
Week 15		
Nov 30	Lecture	***Computational Protein Design***
	Disc.	Computer lab: stereo-chemical design of a coiled-coil
Week 16		
Dec 7	Lecture	***Molecular Diagnostics and Protein Therapeutics***
	Disc.	*Review of materials, preparation for Final Exam*

Final Exam: Dec 12 11:30 am - 02:30 pm, CLSSRM 110

Discussions sessions will be delivered in CLASSRM 281 and will be either computer practicum associated to the lecture topics discussed that week or review of covered materials for preparation for midterm and final exams. Homework will be assigned during each discussion session. Homework will be due the following Friday at 6:00 pm and will be submitted via Catcourses.