BIOE 140
Biomolecular Engineering
Fall, 2021

Instructor: Prof. Victor Muñoz
Office Hours: F 4:00 pm – 6:00 pm in Room 383 SE2
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Teaching Assistants: Kevin Ramirez (Labs)
Office Hours: F 8:20 am-10:20 am in SE2 lobby
Email: kramirez39@ucmerced.edu
Jesse Rodriguez-Reyes (Discussion)
Office Hours: W 5:00 pm -7:00 pm in SE 2 lobby

Lecture: TR 6:00 pm – 7:15 pm

Computer Lab: M 9:30 am - 11:20 am (Section 1)
M 11:30 am - 1:20 pm (Section 2)
M 5:30 pm - 7:20 pm (Section 3)

Discussion: F 1:30 pm - 2:20 pm (Section 1)
F 2:30 pm - 3:20 pm (Section 2)
F 3:30 pm - 4:20 pm (Section 3)

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 for biomedical and biotechnological applications, 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 pressing problems in biotechnology, medicine and bioengineering. The covered approaches range from DNA technology, recombinant

protein production, protein engineering and design 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 (PLOs 1, 7, 8, 11)
2. Compare and contrast various experimental and computational strategies for engineering and designing biomolecules (PLOs 1, 2, 6, 7, 8, 11)
3. Learn the basic concepts of biomolecular structure and function and their connection with the strategies for engineering and designing new biomolecules (PLOs 2, 5, 6, 7, 8)
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 (PLOs 1, 2, 3, 5, 6, 7, 8, 9, 10, 11)
5. Articulate the scientific vocabulary used in communicating scientific information in biomolecular engineering and design (PLOs 3, 6, 7)

Relation to the following PLOS of the Bioengineering program:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
8. Experience in applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics.
9. Experience in solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems.

10. Experience in analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes.
11. Experience in making measurements on and interpreting data from living systems.

Prerequisites: Students must take BIOE 135 prior to BIOE 140

Course Policies: Attendance is mandatory. Scientific calculator, computer or equivalent will be needed for the review/discussion sessions. No cell phone or recording devices are allowed in class.

*We will be using **Top Hat Pro** (www.tophat.com) response system in class (lectures). You will be able to submit answers to in-class questions using Apple or Android smartphones and tablets, laptops, or through text message. For instructions on how to create a Top Hat account and enroll in our Top Hat Pro course, please refer to the invitation sent to your school email address or consult Top Hat's Getting Started Guide (https://bit.ly/31TGMlw). Additionally, we will be using Top Hat's remote proctoring functionality to run digitally invigilated exams. You can visit the Top Hat Overview (https://success.tophat.com/s/article/Student-Top-Hat-Overview-and-Getting-Started-Guide) within the Top Hat Success Center which provides a brief overview to get you up and running on the system.*

If you already have a Top Hat account, go https://app.tophat.com/e/959272 to be taken directly to our course. If you are new to Top Hat, go to https://app.tophat.com/register/student and search for our course with the following join code: **959272**

Top Hat Pro may require a paid subscription. A full breakdown of all available subscription options can be found here: www.tophat.com/pricing.

Should you require assistance with Top Hat at any time please contact their Support Team directly by way of email (support@tophat.com), the in-app support button, or by calling 1-888-663-5491. Specific user information may be required by their technical support team when troubleshooting issues.

Grading for BIOE 140

50% Exam:

Midterm Exam	(20%)
Final Exam	(30%)

20% Class Participation (Students will be quizzed regularly during each lecture and/or discussion sessions using Top Hat classroom response system. The students will be informed of their cumulative score to date from class participation at mid-term and two weeks before the final exam)

30% Computer Lab 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. 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, 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 it 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 2021

Week 1		
Aug 26	Lecture (zoom)	***Course Introduction***
Week 2		
Aug 30	Lab	Intro to Matlab in BIOE 140
Aug 31	Lecture	***Nucleic Acid Chemistry, DNA Structure***
Sep 2	Lecture	***DNA Hybridization, RNA Types and Structure***
Sep 3	Discussion	
Week 3		
Sep 6	Holiday	*Veterans Day*
Sep 7	Lecture	***Transcription, Translation, Control of Gene Expression***
Sep 9	Lecture	***Genetic Engineering I: Cloning***
Sep 10	Discussion	
Week 4		
Sep 13	Lab	*DNA Denaturation-Hybridization*
Sep 14	Lecture	***Genetic Engineering II: Genome Editing***
Sep 16	Lecture	***Synthesis and Amplification of DNA***
Sep 17	Discussion	
Week 5		
Sep 20	Lab	*RNA Structure Modeling*
Sep 21	Lecture	***DNA Sequencing***
Sep 23	Lecture	***Bioinformatics, Genomics, Proteomics I***
Sep 24	Discussion	
Week 6		
Sep 27	Lab	*DNA Primers, PCR, Sequencing*
Sep 28	Lecture	***Bioinformatics, Genomics, Proteomics II***
Sep 30	Lecture	***Recombinant Protein Expression in Prokaryotes***
Oct 1	Discussion	
Week 7		
Oct 4	Lab	*Bioinformatics*
Oct 5	Lecture	***Heterologous Protein Expression in Eukaryotic Cells***
Oct 7	Lecture	***Protein Engineering: Directed Mutagenesis***
Oct 8	Discussion	
Week 8		
Oct 11	Lab	*DNA Cloning, Plasmids, Recombinant Proteins*
Oct 12	Exam	***Combinatorial Protein Engineering***
Oct 14	Lecture	***MIDTERM EXAM***
Oct 15	Discussion	
Week 9		
Oct 18	Lab	*Protein Structure Analysis I*
Oct 19	Lecture	***Protein Structure***

Oct 21	Lecture	***Protein Folding and Stability***
Oct 22	Discussion	
Week 10		
Oct 25	Lab	*Protein Structure Analysis II*
Oct 26	Lecture	***Protein Design***
Oct 28	Lecture	***Protein Function I: Biomolecular Recognition***
Oct 29	Discussion	
Week 11		
Nov 1	Lab	*Protein Folding and Stability*
Nov 2	Lecture	***Protein Function II: Cooperativity and Allostery***
Nov 4	Lecture	***Protein Function III: Enzyme Catalysis***
Nov	Discussion	
Week 12		
Nov 8	Lab	*Ligand Binding and Cooperativity*
Nov 9	Lecture	***Protein Optimization***
Nov 11	Holiday	*Veterans Day*
Nov 12	Discussion	
Week 13		
Nov 15	Lab	*Enzyme Catalysis*
Nov 16	Lecture	***Biosensors***
Nov 18	Lecture	***Antibodies: Structure, Function and Genetics***
Nov 19	Discussion	
Week 14		
Nov 22	Lab	*Protein Modeling-Design*
Nov 23	Lecture	***Molecular Diagnostics***
Nov 25	Holiday	*Thanksgiving*
Nov 26	Holiday	*Thanksgiving*
Week 15		
Nov 29	Lab	*All Computer Labs Review*
Nov 30	Lecture	***Protein Therapeutics***
Dec 2	Lecture	***Nucleic Acid Therapeutics***
Dec 3	Discussion	
Week 16		
Dec 7	Lecture	***Regulatory and Societal Issues in Biomolecular Engineering***
Dec 9	Lecture	***Final Review***

Final Exam: R Dec 16 6:30 pm - 9:30 pm, Kolligian 209

Homework will be assigned after each computer lab (or in occasion discussion session). Homework will be due the following Friday at 6:00 pm and will be submitted via CatCourses.