BIOE331: Protein Engineering, Spring 2015

Professor Jennifer Cochran (jennifer.cochran@stanford.edu)
Office Hours: Shriram 393, Thursday 1:15-2:15PM or by appointment

Teaching Assistants:
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Shelley Ackerman (shelley1@stanford.edu)
Office Hours: Shriram 368, Tuesday 5-6PM
(Note: TAs can discuss both previous week's critique as well as the current assignment)

Grading:
In-class discussion and/or group worksheets centered around assigned readings: 10%
(6 total, 1 absence allowed for any reason, worth 2% each, graded pass/fail)
Written critiques: 42% (6 total, due at start of class period)
Term paper proposal: 3% (graded check plus, check, or check minus)
Final term paper: 40%
Protein engineering principles used in term paper: 5%

Important dates:
May 7th, 2015: Term paper proposal due 5PM
June 5th, 2015: Final term paper due 5PM

Course Goals:
At the end of this course, students are expected to be able to:
- Describe rational and combinatorial methods of protein engineering.
- Describe various methods for biochemical and biophysical characterization of proteins.
- Critically analyze data and conclusions from the primary literature.
- Formulate an original research plan for a specific protein engineering study and describe the advantages and limitations of the proposed research.
- Converse at an advanced level about current key topics of investigation in the field of protein engineering.

Course Format:
Four types of activities will be used to achieve the course goals: interactive class lectures on selected topics (13 lectures), reading and critical analysis of peer-reviewed research manuscripts (6 assignments), in-class discussions and problem-solving sessions (6 discussions), and a final project written in the style of an independent research proposal.

Pre-Requisites:
This course is designed for graduate students and upper-level undergraduate students. All enrolled students are expected to have a background in basic biochemistry (including topics such as proteins, DNA, RNA, molecular interactions, PCR, basic thermodynamics and kinetics)

Textbooks for Supplemental Reading (Accessible through Engineering Library Reserves):
Protein Engineering and Design, eds. Jennifer Cochran and Sheldon Park, Taylor and Francis, 2009.
Methods in Enzymology- Protein Engineering for Therapeutics, Parts A and B, eds. K. Dane Wittrup and Gregory L. Verdine, Elsevier, 2012.

Assignment Policy:
There is a 10% penalty per day for late assignments (written critiques and final term paper). No extensions for late assignments will be given, and assignments more than 4 days late will not be accepted. For the term paper proposal, no late assignments will be accepted. For questions about grades, please see the TA first.

Course schedule:

March	31	T	Lecture 1: Course Introduction
April	2	TR	Lecture 2: Protein Evolution I- Cell surface and phage display technologies
	7	T	Lecture 3: Library creation and screening/selection
	9	TR	Lecture 4: Protein Evolution II- Cell-free protein engineering technologies **Critique 1 due**
	14	T	Discussion 1: Binding interactions and measurements (Reading: Liu and Cochran, *Engineering Multivalent and Multispecific Proteins*, in Engineering in Translational Medicine, 2014 -- sections 14.1 - 14.2.2)
	16	TR	Lecture 5: Therapeutic protein engineering (Reading: Kariolis, Kapur, and Cochran: Beyond antibodies: using biological principles to guide the development of next-generation protein therapeutics, *Curr. Opin. Biotechnol.* 2013) **Critique 2 due**
	21	T	Lecture 6: Bradley Pentelute Assistant Professor MIT, Department of Chemistry "Precision cellular delivery and discovery of fluorine containing abiotic macromolecules" ***NOTE special room: Munzer Auditorium in Beckman***
	23	TR	Discussion 2: Therapeutic protein engineering Lecturer: Max Cherf (gcherf@stanford.edu) **Critique 3 due**
	28	T	Lecture 7: Antibody engineering, unnatural amino acid incorporation, antibody-drug conjugates Aaron K. Sato, PhD Vice President of Research, Sutro Biopharma *Lunch with Dr. Sato after class*
	30	TR	Discussion 3: Engineering multi-functional proteins (Reading: Liu and Cochran, *Engineering Multivalent and Multispecific Proteins*, in Engineering in Translational Medicine, 2014 – read sections 14.2.3 - 14.5) **Critique 4 due**
May	5	T	Lecture 8: Enzyme Engineering Lecturer: Arvind Kannan (afk@stanford.edu) (Reading: Goldsmith and Tawfik: Enzyme Engineering by Targeted Libraries, *Methods in Enzymology*, 2013)

	7	TR	Lecture 9: Enzyme engineering II Lecturer: Luke Bawazer (bawazer@stanford.edu) **Term paper proposal due**
	12	T	Lecture 10: Alternative scaffolds for protein engineering (Reading: Koide: *Design and Engineering of Synthetic Binding Proteins Using Nonantibody Scaffolds*, in Protein Engineering and Design 2009)
	14	TR	Discussion 4: Alternative scaffolds for protein engineering **Critique 5 due**
	19	T	Lecture 11: Engineering fluorescent proteins/molecular probes – Lecturer: Dr. Spencer Alford (salford@stanford.edu)
	21	TR	Discussion 5: TBD **Critique 6 due**
	26	T	Lecture 12: Vladimir Podust, PhD, Director of Analytical Chemistry, Amunix Protein modifications – half-life extension *Lunch with Dr. Podust after class*
	28	TR	Discussion 6: Tumor targeting: interplay of affinity, molecular size, in vivo half-life. (Reading: Wittrup, Thurber, Schmidt, Rhodes: Practical Theoretic Guidance for the Design of Tumor-Targeting Agents, *Methods in Enzymology*, 2012)
June	2	T	Lecture 13: Case studies and class wrap up

Lunch with distinguished guest speakers: The shaded regions indicate a lecture that will be presented from a leader in the biotechnology industry. Students will have the opportunity to attend lunch after class with one of these guest speakers.

Students with Documented Disabilities: Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is made. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: http://studentaffairs.stanford.edu/oae)."

Course Etiquette: Lectures are key opportunities for student learning. Therefore, please do not use your smartphones, laptops, or other electronic devices during lectures. Class time is intended to be the focal point for interaction among students and teaching staff.

Final Note: As the quarter gets underway we may adjust the material to suit the composition, interest, and progress of the class. We welcome your suggestions and feedback about the class format in general, and about what topics and concepts you have for future years. We are looking forward to a great quarter!