CBE 182 Nanoscience and Engineering Biotechnology (Fall 2018)

TTh 5-6:30, 103 Genetics and Plant Biology Building (GBP)

Instructor:

Markita Landry, landry@berkeley.edu
Office hours: Wednesday 9-10 am in 106 Gilman Hall

Graduate Student Instructor:

Frankie Cunningham, fjc@berkeley.edu
Office hours: TBD

Course Description and Objective:

CBE 182 is an introductory course to biotechnology nanoscale engineering. This course will cover emerging topics in applied biotechnology. In the first part of the course, we will learn the fundamental principles of DNA, RNA, and protein biotechnology, and think about how analogous techniques to study, analyze, and also genetically manipulate these systems have emerged. Such topics include recombinant DNA and protein generation, cell culture, cloning, protein folding, enzyme kinetics, enzyme inhibition, and time- and length-scales in molecular biology. The second part of the course will discuss emerging topics in nanotechnology, and the relevance of using synthetic nano-tools to probe, study, and engineer biology at a molecular level. Topics include experimental design and statistical rigor, experimental reproducibility, drug design, drug delivery, gene delivery, nanotechnology in agriculture, genome editing, and biomolecular sensors. The scope of the course will also probe the interface of biology with nanomaterials, and standard microscopic and spectroscopic techniques to image both biological structures and nanoscale materials. The goal of the course is to familiarize students with emerging techniques of relevance to both industry and academic biotechnology and nanotechnology.

Student preparation:

It is expected that students have the knowledge and background equivalent of senior-level CBE or BioE students + an introductory biology course. Prerequisites include Biology 1A *or* Bioengineering 11 *and* Physics 7A.

Course structure:

- No required textbooks – reading assignments posted prior to every lecture
- Reference textbooks:
  - Biochemistry by Voet & Voet, 2010, 4th edition.
  - Bionanotechnology: Lessons from Nature by Goodsell, 2004.
  - Mechanics of motor proteins and the cytoskeleton, Jonathon Howard, 2001.
- Course website: CHM ENG 182 in bCourses.

Grading:

- Problem sets (**0 %**).
- 2 Midterm exams (MT1 in class, MT2 take home) (40%; 20 % each).
- Final presentation (30 %): In groups of 3 students, students will complete a project of literature analysis and critique on a topic in applied bionanotechnology. Students will give a 25-minute oral presentation to the class outlining the state of the field, outstanding challenges and questions, impact, and perspective on the outlook for future directions in the field. Students will be graded both on the content of their presentations, answering questions, and on providing questions of their peers' talks.
- Final project (30%): In groups of 3, students will have a choice of two final projects: 1) *Wiki or website creation on the topic of their final presentation.* For this option, students will either create or edit the Wikipedia page on the topic of their assigned presentation. Students will be provided with a grading rubric for the content of their webpage, and will be expected to publish their edits online. 2) *bioRxiv manuscript critique and engagement with corresponding author.* For this option, students will be tasked with reading through, and editing, a scientific manuscript posted to the bioRxiv preprint server. Students will be

provided with a grading rubric for their critique of the manuscript, and will be expected to email their critique to the corresponding author of the manuscript.

- Presentation guide: 25 minute presentations, with each group member presenting an equal portion. 3-5 minutes for questions at the end.
- Grading rubrics for the presentation (10 points): 3 points on clarity, including timing, 2 points on teamwork, and 5 points on understanding (Q&A).

Course Outline: 29 class meetings including 2 midterms:

Part I: Molecular engineering

1. Primer on molecular biology
2. Structures, thermodynamics, and statistical mechanics of biomolecules
   a. DNA structures, interactions, and mechanics
   b. Protein structure prediction
   c. Lipids and biological membranes
   d. Carbohydrate structures, interactions, and mechanics
3. Scales in biology: length & time
   a. Parts and organelles of cells
   b. Prokaryotic and eukaryotic cells
   c. Rates, timescales, length scales in biology
   d. Enzymes: kinetics, immobilization, inhibition
4. Fundamentals of biotechnology.
   a. Protein engineering and design
   b. Recombinant DNA technology & gene editing
5. Experimental design and statistical rigor.
   a. Designing a statistically meaningful biological assay

Midterm 1 – September 27th

Part II: Nanomaterials in biotechnology

1. Primer on nanotechnology
   a. Macro vs. nanoscale
   b. Mechanical properties at nanoscale
   c. Photonic properties at the nanoscale
2. Nano-bio interactions
   a. Nanoparticle coronas and nano-bio interface
   b. Nanomaterials for bio-delivery
   c. Nanomaterials for bio-sensing
   d. Nanoscale assembly and bio-mimicry
   e. Nanotech in agriculture
   f. Nanomaterial imaging and characterization

Midterm 2 – October 30th

Special topics: TBD

Final-project presentations (~5 class periods)