CBE 195 Nanoscience and Engineering Biotechnology (Fall 2017)

TTh 8-9:30, 3105 Etcheverry

Instructor:

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Office hours: Wednesdays 5:30-6:30 pm & by appointment

Graduate Student Instructor:

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Office hours: Thursday 5-6 pm @, Fridays 11am-noon @ library seminar room 100E

Course Description and Objective:

CBE 195 is an introductory course to nanoscale science and biomolecular 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 biochemistry, and think about how analogous techniques to study and analyse these systems have emerged. Such topics include recombinant protein generation and purification, cell culture, cloning, protein folding, and time- and length-scales in molecular biology. The second part of the course will discuss emerging topics in nanomaterials in biology, and the relevance of using synthetic nano-tools to probe, study, and engineer biology at a molecular level. Topics include bio-toxicity, nanotechnology in agriculture, nanotechnology in gene delivery, 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. Students are expected to become familiar with the terminologies and mechanisms presented in class and in the reading assignments.

Student preparation:

It is expected that the students have the knowledge and background equivalent of senior-level CBE students. Reading of course references may be helpful.

Course structure:

- No required textbooks – reading assignments posted prior to every lecture
- References
  - 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: look for CHM ENG 195 in bCourses.

Grading:

- Problem sets (**0 %**).
- 2 Midterm exams (written) (15 % each).
- Final exam (written) (20%).
- Final project (50 %): In groups of 3-4 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. Each student will also independently write a term paper up to 10 pages on analysis and critiques of the assigned topic. The oral and written part each counts 25% of the final grading.

- 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.
- Term paper guide: 1" margins, font size no smaller than Times New Roman 11 pt. The entire report cannot exceed 10 pages.
- Grading rubrics for the term paper (10 points): 2 points on clarity, including organization (sub-sections should at least include Abstract, Introduction, Analysis, Conclusion), 2 points references/literature search, 4 points on quality of analysis and general understanding, and 2 point on conclusion, including your perspectives.

Course Outline: 23 class meetings (including 2 midterms and ~5 presentation days)

Part I: Molecular engineering

1. Primer on biochemistry
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. Protein metabolism and engineering
   d. Enzymes: catalysis, kinetics, immobilization
4. Fundamentals of biotechnology.
   a. Protein engineering and design
   b. Recombinant DNA technology

Midterm 1

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

Final-project presentations (~4-6 class periods)