Course Syllabus: BIOE150

Introduction of Bionanoscience and bionanotechnology

Spring 2014 Fall

University of California, BerkeleyDepartment of Bioengineering

Course Number: BioE 150
Course Title: Introduction of Bionanoscience and bionanotechnology

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Location: 310 HMMB
Class time: Tuesday, Thursday 9:30-11:00AM
Discussion Session: Wednesday (10-11AM)
Office Hour: Thursday 11:00-12:00 PM or appointment by e-mail
*Whenever sending an e-mail, please put"**BIOE150:-------**" on your subject line.*
GSI: Mr. Malav Desai, UCB Bioengineering Graduate Student (**mdesai@berkeley.edu**)
Prerequisites: Chemistry (1A) and Biology (1A) or E45

All lecture slides will be uploaded after the class.

Important Date:
Mid Term: October 7 (9:30-11am)
Final Exam: December 2 (9:30-11am)
Final Term Paper: December 12 (5pm)

Grading: Letter
•Home works 10%
•Term group project (Finding Nano I): 10%

•Term individual project (Finding Nano II): 10%
•Mid-term exam 30%
•Final exam 35%
•Attendance 5%

Late submission policy of homework and term papers:
Late submission is allowed within a week with 25% deduction of the points;
No submission is allowed after posting the answer sheet.

Text books: No specific text book is required.
Reference text books:
1 *Nanobiotechnology***,** Edited by C. Niemeyer, C. Mirkin, Wiley-VCH (2007). ISBN: 978-3-527-30658-9
2 *Introduction to Protein Structure, 2nd ed*. Carl Branden & John Tooze (1999) Garland Publishing, Inc., New York.
3 *Protein-based Materials*. Kevin McGrath & David Kaplan, Editors (1997), Birkhüaser, Boston
4 *Self-assembling Peptide Systems in Biology, Engineering and Medicine*. Aggeli, A., Boden, N. & Zhang, S., Ed. (2001) Kluwer Academic Publishers, Dordrent, The Netherlands

Course Description:
Three hours of lecture and one hour of discussion per week. This course is intended for the bioengineering or engineering undergraduate students interested in acquiring a background in recent development of bio-nanomaterials and bio-nanotechnology. The emphasis of the class is to understand the properties of biological basis building blocks, their assembly principles in nature, and their application to build functional materials and devices. The goal is for the bioengineering students to gain sufficient chemical and physical aspects of biological materials through the case study of spider webs, silks, sea shells, diatoms, bones, and teeth, as well as recently developed self-assembled nanostructures inspired by nature. The course covers the structures and properties of amino acids, DNAs, sugars, lipids, and their natural and artificial assembly

structures. It also covers nanoscale inorganic materials used to develop nano medicines, bio-imaging, bio-sensors, bioelectronics, and machinery.

There are three major parts in this course:
I. Basic building blocks and governing forces: This part is intended to enhance the understanding of the structures and properties of biological basic building blocks and their governing forces to assemble the biological materials. This part covers the chemical structures of amino acids, ribonucleic acids, hydrocarbonates, and lipids, and their physical properties depending on the chemical and physical structures. In addition, governing forces (hydrogen bonding, ionic interaction, van der Waals interaction, hydrophobic interactions, etc) to assemble the basic building blocks to form nanostructures will be covered. Tools and methodologies to analyze the chemical structure of the molecules will be introduced. Quantitative analysis of the properties of biological basic building blocks will also be addressed.

II. Case study of the molecular level structures of biological materials: This part is intended to study the examples of biological molecules to enhance understanding the assembly principle of biological materials, including collagens, keratins, spider webs, silks, bio-adhesives as protein based robust materials, bones, sea shells, diatoms, sponges, and, other biominerals as hierarchical nanostructures, and butterfly wings and insect eyes, other periodic structures for optical applications. Through the case study, we will learn how natural materials are designed to solve the challenging problem to be faced in the natural environments and exploit their design principle to develop novel functional materials and devices.

III. Case study of the artificial nanomaterials and devices inspired by biological nature. This part is intended to enhance understanding the recently developed nanostructures and devices to mimic the natural biological materials and organisms. Hybrid functional nanomaterials and devices, such as biological basic building blocks conjugated with inorganic nanocomponents, such as quantum dots, nanowires, nanotubes will be discussed to fabricate various devices including, bio-sensor, bio-nano electronic materials and devices, bio-computing. Nano medicine and bio imaging will also be covered.

Topics will be covered in the classes:

Part 1 (Week 1-10).

1. Introduction of Bionanoscience and Bionanomaterials
2. Structures and properties of DNA/RNA
3. DNA Nanotechnology
4. DNA Nanomaterial designs
5. Structures and properties of amino acids
6. Peptide Nanotechnology
7. Peptide Nanomaterials
8. Polypeptide Nanomaterials
9. Protein Nanomaterials
10. Virus-Cell based Nanotechnology

Part 2. Case Study(Week 11-15):

Finding Nano Project I (Team Project):

•**Examples:**

•Collagen
•Keratin
•Spider Silk
•Iridescent color of butterfly
•Squid or octopus
•Adhesive Gecko Feet
•Water floating bugs
•Compound insect eyes
•Bioluminescence jelly fish
•Camouflage cuttlefish
•…

Part 3:

Special topics:

- **Surface Probe Microscopy Techniques**
- **Electron Microscopy Techniques**
- **TBD**

Finding Nano Project II (Due at 5pm on 12/12/14):

Finding Nano Project II (Individual Project):

Write a creative original proposal: Write a creative, original, logical

proposal to design a new molecular machine or device using biological materials (DNA/RNA, peptide, polypeptide/protein, viruses or cells) or their conjugates with any nanoscale material (nanoparticle or any nanomaterial), which can solve the conventional engineering problems in bioengineering fields, such as bio-nanomedicine, bio-nano energy, bio-nano sensor, bio-computing, bio-nano electronic device and etc. Identify challenges in science and engineering and demonstrate your creativity using the tools that you learned from the classes or inspired from nature, which clearly demonstrate biological characteristics, such as specificity, high-efficiency, self-assembly, self-evolve, self-healing or etc.

1. **Format of the Proposal:** 2 page writing with 11 font size, Arial, single space, 1 inch margin top, bottom, left, and right).
2. **Components of the writing:** Proposals must contain clear statements of goals, motivation, work done so far with references, how your proposed materials or device will be made, how to characterize the proposed work, and their expected results.
3. **Page 3:Two figures:**

a. Figures1. Schematic diagram of your proposed work to depict the principle including schematic design of your basic building block.

b. Figure 2: Expected results from functional performance of your proposed machines or devices.

4. **Page 4**: **Reference**: Include 10 references that you think the most related with your proposed work).

Notice:

- **Do not submit any duplicated proposal from other classes.**
- **Do not submit any collaborative proposal.**

=> Any similarity between proposals will be graded as "F".