

BME 599: Nano Bio-systems and Bio-mimetics

Mingjun Zhang, 408 Dougherty, mjzhang@utk.edu, 974-7620

Meeting Time: Tuesdays and Thursdays 3:40 – 4:55 PM

Office Hours: by appointment

COURSE DESCRIPTION:

Biotechnology and nanotechnology are fast emerging fields. To seek an academic or industrial career in either of these fields, students need to have systematic training in molecular and cellular engineering, especially from a systems engineering perspective. A key ingredient for success in biotechnology and nanotechnology is a fundamental knowledge of how systems engineering can help to interpret molecular and cellular biophysics and how mathematics can help to advance molecular and cellular engineering. This course is designed for engineering students to gain fundamental knowledge of molecular and cellular engineering, and employ concepts of nano bio-systems and bio-mimetics for engineering innovation. The course consists of three parts. **Part A:** Fundamentals of Cellular and Molecular Engineering. **Part B:** Nano Bio-systems and Engineering. **Part C:** Bio-mimetics.

PREREQUISITES: None.

TEXT: None.

Supplementary Readings:

1. Molecular Biology of the Cell, Alberts, et al, Garland Science; 5 th edition.
2. Medical Physiology, Guyton & Hall, Elsevier Saunders, 11 th edition.
3. Life, the science of Biology, Purves, et al, Sinauer Associates, Inc.

GRADING:

Homework assignments (30%)

Term project (60%)

Project presentation (10%)

Lecture Schedule and Topics

01/08	Welcome, syllabus, overview and projects.	
01/13	Introduction to cells and macromolecules, chemical bonds and interactions.	
01/15	DNA and DNA nanotechnology	
01/20	Introduction to RNA	
01/22	Proteins: structure, function, folding, analysis and expression.	
01/27	Introduction to the Immune System I	HW#1 Out: Project literature review
01/29	Introduction to the Immune System II	
01/27	Nucleic Acid Technology I: microarrays.	HW#1 Due
02/03	Nucleic Acid Technology II: gel electrophoresis and genetic engineering.	
02/05	Nucleic Acid Technology III: PCR.	Hw#2 Out: Clarification of the task and focus of the project
02/10	Molecular Thermodynamics	
02/12	Cellular Mechanics I: pure extension, bending, shear, adhesion and force measurements.	Hw#2 Due
02/17	Cellular Mechanics II: shear deformation, cell motility, and surface tension.	
02/19	Cellular Mechanics IV: tissue sorting and cell pattern formation.	HW#3 Out: understand key steps and techniques of the project
02/24	Cell Culture	
02/26	Immunolabeling/Immunocytochemistry	
03/03	Communication and Organization of multi-cellular and multi-organ systems I: structural and functional organization of organ systems.	HW#3 Due
03/05	Communication and Organization of multi-cellular and multi-organ systems II: from the	

	chemical level to the cellular, tissue and organ level.	
03/10	Communication and Organization of multi-cellular and multi-organ systems III: feedback control between organs.	
03/12	Molecule and Cell Based Bio-sensors I: DNA-based Bio-sensors, Glucose Sensors.	HW#4 Out: Project conceptual design
03/17	Spring Break	
03/19	Spring Break	
03/24	Molecule and Cell Based Bio-sensors II: ELISA, electrochemical molecular bio-sensors.	HW#4 Due
03/26	Molecular Probing (fluorescence, FRET, GFP, Quantum dots).	
03/31	Biophysical Methods to Biology and Biomedical Engineering	
04/02	System Methods to Biology and Biomedical Engineering	HW#5 out: Project detailed design
04/07	Gecko and ivy climbing mechanisms (nanofibres, nanoparticles, capillary action, van der Waal interactions)	
04/09	Ivy, marine mussel and barnacle surface attaching mechanism (adhesive proteins, thin films and fibers formed by nanoparticles)	HW#5 Due
04/14	Project	Project development
04/16	Project	Project development
04/21	Stem Cell Biology and Engineering I: definition, diversity, source and harvesting.	
04/23	Stem Cell Biology and Engineering II: regenerative medicine, and therapeutic applications.	
04/28	Final Presentation	Power point slides due before class
04/30	Final Presentation	
05/03	Final Project Report	Due by midnight

Suggested project topics:

1. Venus flytrap snap mechanism and inspiration for bio-robotics
2. Nanoparticle secreting mechanism of ivy.
3. Nanoparticle-enhanced molecular imaging.
4. Nanoparticle-based medical adhesive.
5. Nanoparticle-assisted controlled drug delivery.
6. Nanoparticle green manufacturing.
7. Bio-inspired mechanism for efficient energy utilization.
8. Conventional game and evolutionary game theoretical approach for controlled drug delivery.
9. Feel free to propose topic of your interest and discuss with the instructor.