BME 42-620: Engineering Molecular Cell Biology (12 Units)

Fall 2011

Instructor

Ge Yang, Ph.D.
Assistant professor, Department of Biomedical Engineering
Assistant professor, Lane Center for Computational Biology

Instructor Contact Information

- Email – geyang@andrew.cmu.edu
- Telephone – 412-268-3186
- Office Location – Mellon Institute 403
- Preferred communication approach is by email. Please include EMCB in the subject.

Instructor Office Hour & Location

1:00PM – 2:00PM Friday or by appointment
Mellon Institute 403

Pre-requisite or Co-requisite

- Senior or first-year graduate student standing.
- Basic knowledge of ordinary different equations.
- Proficiency in programming; Familiarity with MATLAB is helpful but not required.

Class Times & Locations

- Tuesday & Thursday, 1:30PM - 2:50PM, Porter Hall (PH) 226C

Class Website

- http://www.andrew.cmu.edu/course/42-620/

Grader and Contact Information:

Yiyi Yu
Email: yiyiy@andrew.cmu.edu
Office: Mellon Institute 401
Office hour: Not assigned.

Course description & objectives

Cells are not only basic units of living organisms but also fascinating engineering systems that exhibit amazing functionality, adaptability, yet complexity. Applying engineering perspectives and approaches to study molecular mechanisms of basic cellular processes plays a critical role in the development of contemporary biology, providing exciting opportunities for students with engineering background to make fundamental research and development contributions. On the other hand, understanding principles governing biological systems will provide critical insights into the development of engineering systems, especially in the field of micro- and nano- technology. The goal of this course is to provide basic molecular cell biology classroom training to engineering students with little or no background in cell biology. The course is divided roughly into five parts: (1) Fundamentals of molecular biology, protein structure, and molecular biophysics; (2) Internal organization of the cell (general structural and functional organization; energy generation and distribution; material production, transport and disposal; signal communication and system control); (3) Cytoskeleton and cell motility; (4) Cell cycle and mechanics of cell division; (5) Cell-cell interaction (cell adhesion; intercellular junctions;

the extracellular matrix). Regular lectures and homework assignments will be supplemented by demonstrations of cell biology experiment techniques in research labs. Emphasis will be on using quantitative and system perspectives and approaches to understand mechanisms of basic cellular processes and on developing knowledge and skills required for following contemporary cell biology literature. This course is interdisciplinary in nature and thus should provide a challenging yet exciting experience to engineering students.

Required Textbook(s)

B. Alberts et al, Molecular Biology of the Cell, 5th ed., Garland Science, 2007

References

T. D. Pollard and W. C. Earnshaw, Cell Biology, 2nd ed., Saunders/Elsevier, 2008

Classroom Policy

- Lectures will start and end on time. If you are late, please enter the class without disruptions.

- Use of cell phones during class and laboratories is not allowed.

- Class participation, performance effort and improvement are considered in grading, especially when a student's grade is borderline between letter grade^{+} and the next higher letter grade (e.g. C^{+}, and B^{+})

Academic Integrity

- University regulations will be followed. See http://www.studentaffairs.cmu.edu/acad_integ/acad_integ_text.html

Reading and Project Assignments:

- Reading and project assignments are handed out in class.
- Completed reading and project assignments should be handed in before class on due dates.

Grading

Reading assignment + problem sets (6-8 in total)	40%
Project assignment (3 in total)	30%
Exams and presentations* (2 in total)	30% (15% + 15%)
Total	**100%**

* Students will be evaluated based on their performance and engagement in class activities such as giving presentations, asking questions, and participating in discussions.

Lecture Schedule **(tentative; actual schedule will be posted on class website)**

Week	Lecture	Topics
1	Lecture 1	Course overview; universal properties of cells
	Lecture 2	Structural and functional organization of eukaryotic cells; evolution, model organisms

2	Lecture 3	Structures and dynamics of cellular molecules (I)
	Lecture 4	Structure and dynamics of cellular molecules (II)
3	Lecture 5	Methods in cell biology (I)
4	Lecture 6	Methods in cell biology (II); MATLAB Basics; Diffusion (I)
	Lecture 7	Diffusion (II)
5	Lecture 8	The Cytoskeleton (I)
	Lecture 9	The Cytoskeleton (II)
6	Lecture 10	Literature review
	Lecture 11	Chromosome organization; DNA packaging
7	Lecture 12	Nuclear structure and dynamics
	Lecture 13	Gene expression I: From DNA to RNA
8	Lecture 14	Gene expression II: From RNA to protein
	Lecture 15	Quantitative analysis and modeling of gene expression
9	Lecture 16	Literature review
10	Lecture 17	Cell signaling I: general principles; receptors
	Lecture 18	Cell signaling II: transduction proteins
11	Lecture 19	Cell signaling III: second messengers
	Lecture 20	Cell cycle I: Introduction to cell cycle
12	Lecture 21	Literature review: modeling of cell signaling
	Lecture 22	Cell cycle II: G1 phase and cell proliferation regulation
13	Lecture 23	Cell cycle III: S phase & DNA replication; G2 phase, G2-M transition; Mitosis & cytokinesis
	Lecture 24	Cancer
14	Lecture 25	Fluorescence live cell imaging
	Lecture 26	Synthetic biology I
15	Lecture 27	Synthetic biology II