University Of California, Berkeley
Department of Mechanical Engineering

ME 211: The Cell as a Machine (3 units)

Graduate Course

Syllabus

CATALOG DESCRIPTION

This course offers a modular and systems mechanobiology (or "machine") perspective of the cell. Two vitally important components of the cell machinery will be studied in depth: (1) the integrin-mediated focal adhesions system that enables the cell to adhere to, and communicate mechano-chemical signals with, the extracellular environment, and (2) the nuclear pore complex, a multi-protein gateway for traffic in and out of the nucleus that regulates gene expression and affects protein synthesis.

COURSE PREREQUISITES

Math 54; Physics 7A; Graduate standing

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

- Original literature assigned, generally 1 article per topic (week)
- Supplementary Reading: Molecular Biology of the Cell (Albert), Biomechanics (Fung), Random Walks in Biology (Berg), Physical Biology of the Cell (Phillips), Models of Cell Mechanics (Mofrad and Kamm), Cellular Mechanotransduction (Mofrad and Kamm)

COURSE OBJECTIVES

The students will develop a systems biology, self-replicating machine perspective on the cell that must contain all of the key functions needed to propagate its DNA and allow the cell to grow and to maintain its current state (ion and water transport are needed to keep volume and ionic composition of the cell constant).

DESIRED COURSE OUTCOMES

The students will develop a systems mechanobiology, machine perspective on the cell. In particular, they will gain a deep insight about two vitally important components of the cell machinery: (1) the integrin-mediated focal adhesions multi-protein system that enables the cell to connect to the extracellular environment, and (2) the nuclear pore complex, a nano-highway that controls the traffic in and out of the nucleus and thereby regulates gene expression.

TOPICS COVERED

Week 1:	Cells as Robust Machines
Week 2:	Life at Low Reynolds number (diffusion and transport)

Week 3:	Cell Mechanics (Osmotic pressure, overall filament assemblies, cytoplasmic structure, integrated motor function)
Week 4:	Organization and Mechanics of Membranes (hydrophobic effect, mechanics, and diffusion in 2-D)
Week 5:	Cell Cytoskeleton (filament assembly and rigidity, motors, mechanical forces)
Week 6:	Cell Shape Control (cell-matrix interactions)
Weeks 7 & 8:	Mechanics of Focal Adhesion Machinery
Week 9:	Mechanics of Cell-Cell Adhesions
Week 10:	Nuclear Organization (DNA synthesis and packaging)
Week 11:	Nuclear Envelope and Mechanics
Week 12:	RNA Synthesis and Transport (splicing, transport)
Weeks 13 & 14:	Mechanics of Nuclear Pore Complex Machinery
Week 15:	Integration of Cell Functions (mechanical and biochemical integration)

CLASS/LABORATORY SCHEDULE

3 hours of lecture plus one discussion hour

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

Assignments	15%
Final project	25%
Midterm Exam	30%
Final Exam	30%

Homework will be assigned each week and will be due a week following the date it was assigned.

PERSON(S) WHO PREPARED THIS DESCRIPTION
Mohammad R. K. Mofrad, 10 November 2011

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): Cell as a Machine
TIE CODE: LECS
GRADING: Letter
SEMESTER OFFERED: Fall
COURSES THAT WILL RESTRICT CREDIT: None
INSTRUCTORS: Mofrad
DURATION OF COURSE: 14 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 9 Hours
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: None