Cellular Biomechanics
42502-Biomedical Engineering
24759- Mechanical Engineering
Spring, 2007

Instructor

Philip LeDuc	415 Scaife Hall, 412-268-2504, prleduc@cmu.edu
Office Hours:	Tues. 2 PM – 3 PM or Thurs. 2 PM – 3 PM (we will vote on which one in class) or by appointment

Class Meetings

Lecture: Tuesday and Thursday, 12:00-1:20 PM, SH 220

Prerequisites

None. A background in cell and molecular biology as well as mechanics will be helpful in this class (although not required)

Course Objectives

This course discusses how mechanical quantities and processes such as force, motion, and deformation influence cell behavior and function, with a focus on the connection between mechanics and biochemistry. Specific topics include: (1) the role of stresses in the cytoskeleton dynamics as related to cell growth, spreading, motility, and adhesion; (2) the generation of force and motion by moot molecules; (3) stretch-activated ion channels; (4) protein and DNA deformation; (5) mechanochemical coupling in signal transduction. If time permits, we will also cover protein trafficking and secretion and the effects of mechanical forces on gene expression. Emphasis is placed on the biomechanics issues at the cellular and molecular levels; their clinical and engineering implications are elucidated.

During this course we will introduce you to these subjects, train you to use them in real world applications, allow you to address a specific project, ask you to present and write about the project, and give you experience working as a team. We will also introduce how nanobiotechnology and microbiotechnology can be integrated with cellular and molecular mechanics (in areas such as BioMEMS) for understanding cell structure and mechanotransduction. We will integrate a laboratory experience with at least 2 specific hands-on labs during class so that students will get a true feel and understanding for cellular and molecular work (the first lab will be on Tues., Feb. 13).

This course will be a learning experience for you. We will have fun, but I demand a high level of application from my students in order to get the most out of it for everyone.

Text
Suggested but not required textbooks:

"Mechanics of the Cell" by David Boal, Cambridge University Press
“Molecular Biology of the Cell” by Alberts and Bray, Garland

Grading
You are guaranteed to get at least the letter grade designated by the following averages:

A	100% to 90%
B	80% to 89%
C	70% to 79%
D	60% to 69%
R	<59%

Grading Percentages

Homework:	30%
Midterm Report	5%
Midterm:	25%
Final Report	15%
Final Presentation:	15%
Class Presence / Participation	10%

Homework Policy
Homework will be assigned and due every other week unless the effort and understanding level is determined to be unacceptable in which case, we will increase the amount of homework. Homework is due at the beginning of class on the day it is due. Late homework will not be accepted without prior approval by the instructor.

Examination
Midterm: Thurs., March 8, 12:00 – 1:20 PM

Class Presence and Participation
Class presence and participation points are given to encourage your active class participation and discussion. You will be rewarded with a perfect score as long as you frequently come to class and actively contribute to the class discussions. Students who repeatedly arrive late or are absent will have there participation grade lowered. If you find it uncomfortable to speak up in class, I encourage you to come visit me in office hours to work on this skill.

Important
Only official medical excuses will be accepted as a reason to miss deadlines (homework, exams, etc.). Also, classroom activities may be taped or recorded by a student for the personal use of that student, but may not be further copied,

distributed, published or otherwise used for any other purpose without the express written consent of the instructor.

Project

The project requirement for this course will consist of preparing and presenting a research presentation on an application of mechanics in cellular or molecular biology. This can include a variety of topics related to something that interests you. Some examples are diffuse axonal injury of the brain, protein deformation in ligand binding, cytoskeletal dynamics, BioMEMS, and bionanotechnology. Hopefully, this can be related to your current or future research interests. There are three major milestones for this project:

1. Submission of 3 potential ideas with a title and a one-paragraph description (DUE Feb. 6). I will select one project from this list.
2. Literature search and written description of proposed project with background material (DUE March 22).
3. Final project will be a written and formal presentation (May 1 and 3). This will consist of proposed studies and preliminary data (if applicable) on the particular subject whether it is experimental or theoretical in nature.

You will work together in groups of 2-3 on this project and will be graded on the written and formal presentation as part of your final grade.

Feedback

It is my goal to make this an excellent course for you. If at any time you feel that the course is not meeting your expectations or you want to provide feedback on how the course is progressing for you, please contact me (whether it is in person or an anonymous note, etc.).

COURSE SCHEDULE

Jan 16-Jan 23:	Why mechanics matters to biology and medicine?
Jan 25-Feb 15:	Basic mechanics and biochemistry
Feb 20-Feb 27:	Cell movements and deformation
Mar 1-Mar 20:	Cytoskeleton dynamics
Mar 22-Mar 29:	Motor molecular and force generation
Apr 3-Apr 12:	Protein and DNA deformation
Apr 17-Apr 19:	Stretch-activated ion channels
Apr 24-Apr 26:	Mechanochemical coupling in signal transduction
May 1-May 3:	Presentations