BIM 217: Mechanobiology in Health and Disease

Course Meetings: TR 2:10-4:00, GBSF 2202

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Office Hours: By appointment.

Course Website: *smartsite.ucdavis.edu*

Resources: To be maintained on the course website. Several texts from which lecture materials are derived may be borrowed from me. There is no *required* text for the course.

Prerequisites: Minimum undergraduate transport phenomena (BIM 106) or fluid mechanics (ENG 103) (required), molecular biology (BIS 101), and/ or physiology (NPB 101) or their equivalent (recommended).

Course Description: The course explores the principles by which biomechanical forces affect cell and tissue function to impact human health and disease. The emphasis is on linking biomechanics to cell and molecular level phenomena and relationships to disease mechanisms. We start with a review of the physical laws and principles governing behavior (e.g. blood flow in arteries), examine the mechanisms by which a cell coverts a mechanical input to a biochemical signal (i.e. mechanotransduction), and study the impact on cell biology and functional outcomes related to normal function or pathophysiology. Research methods are also emphasized, including the development of *in vitro* models to study the biomechanical response of cells, and an understanding of modern tools applied to the study of mechanobiology.

Summary of Topics:

1. Review of concepts in biofluid mechanics, particularly the development of equations describing blood flow in the cardiovascular system, with emphasis on the large arteries and heart valves.
2. Blood rheology and hemodynamics.
3. Review of concepts in cell and tissue mechanics, particularly, stress and strain in a continuum, viscoelasticity, constitutive modeling and Hooke's Law.
4. Models of cellular biomechanical behavior (lumped parameter models) and cellular mechanotransduction, (e.g. tensegrity, decentralized model).
5. Cellular and molecular responses to mechanotransduction.
6. Structure and function of the cardiovascular system. Regulation of normal vessel function, dysfunction and disease, therapeutic interventions with emphasis on the role of mechanobiology.
7. Mechanobiology of bone, cartilage and other systems.
8. Research methods including the development of *in vitro* models to study the biomechanical response of cells. Modern tools applied to the study of mechanobiology.
9. New frontiers in mechanobiology, e.g. growth and development, tissue engineering, stem cell differentiation, developing countermeasures for manned space flight.

Learning Objectives:

1. Demonstrate an understanding of the physical forces that affect cell and tissue behavior
2. Demonstrate an understanding of how these forces impact normal physiology and pathology
3. Understand research methods in mechanobiology, including their strengths and limitations
4. Understand the design of experiments to address relevant hypotheses
5. Practice critically evaluating research articles
6. Practice presentation skills

Grading:

Item	**% Course grade**
Homework & Participation	25
Presentation	25
Exam 1	25
Exam 2	25

Homework might include derivations and problem solving you wouldn't necessarily be asked to reproduce on an exam, or summarization of a physiological mechanism from a research article.

Participation includes both attendance and preparation for/ contribution to class discussions by reading assigned research and review articles.

The presentation typically focuses on a review article on an approved topic relevant to the course. The presenter will introduce the topic and lead a discussion of the important findings or takeaways.