

CAMB711/BE711 Integrative plant and animal mechanobiology

Director: Rebecca Wells (rgwells@penncmedicine.upenn.edu; 215-573-1860)

Site directors:

WUSTL: Guy Genin
 UC Merced: Kara McCloskey
 NJIT: Treena Arinzeh

Site directors will organize local journal clubs and are responsible for grading problem sets and tests, and for overall course grades.

Summary: This course aims to provide students with an understanding of biomechanics that spans the plant and animal kingdoms, with the goal of emphasizing principles common to both. The course will be broadcast remotely and taken by students at different sites, with lectures from Penn Wash U, and

Format: Lectures, with journal club discussion sessions during modules 1 and 3.

Meetings: Tuesday/Thursday 10:30-11:50 EST, LRSM CEMB conference room (last room on the left)

Remote Access: Use GoToMeeting

Recordings: Link to be provided

Course materials: on BOX

Graduate Level course: Undergraduates permitted rarely and only with permission.

Prerequisites: None

Grading:

50% midterm exams (x2, one each after modules 1 and 2)

25% problem sets (modules 1 and 2) and journal review sessions (1 each modules 2 and 3)

25% final project (Written/oral assignment based on journal article (students choose topic, identify relevant publication, critically review paper, then propose additional research directions/ideas and give presentation)

Useful reference:

<http://www.bionumbers.hms.harvard.edu/>

Textbooks: Readings selected from the literature and several texts, including:

- Jacobs/Huang/Kwan *Introduction to Cell Mechanics and Mechanobiology*
- Bower *Solid Mechanics* (solidmechanics.org)
- Niklas *Plant Biomechanics*
- Taiz/Zeiger *Plant Physiology*

Module 1: Basic cell biology and mechanics

Request each lecturer to come up with 1 or 2 synthetic/open-ended questions for students

Note: This section has 1 problem set

August 27:

- Course introduction
- Basic biochemistry (structure of proteins, lipids, CHO), including concepts of scale (**Janmey**)

August 29:

- Basic cell structure/anatomy (similarities and differences) of plant and animal cells, including concepts of scale (**Dixit**)

Sept. 3:

- Introductory concepts in mechanics; include time and length scales (**Carlsson**)

Sept. 5:

- Membrane trafficking and vesicle transport (**Dixit**)

Sept. 10:

- Cytoskeleton (**Ostap**)

Sept. 12:

- Physical properties of matter in motion (**Genin**)

Sept. 17:

- Motor proteins (**Goldman**)

Sept. 19:

- Membrane physiology and ion channels, electrophysiology (**Haswell**)

Sept. 24: EXAM ON MODULE 1

Module 2: Tissue and nuclear mechanics

Note: This section has 1 problem set

Sept. 26:

- Animal ECM and plant cell walls (key components, structure-property-function relationships, connections to solid mechanics and concepts of stress, strain, and modulus, matrix piezoelectricity) (**Wells and Foston**)

Oct. 1:

- Adhesion receptors and signal transduction (**Assoian**)

Oct. 3:

- Balance laws (**Alisafaei**)

Oct. 8:

- Tissue structure and mechanics in plants and animals (**Janmey (date?) and Braybrook**)

Oct. 10: No Class at Penn (Fall Break)

WUSTL: Journal article discussion (Genin) (Students required to post discussion questions in advance, and are graded on this exercise)

Oct. 15: No Class at WUSTL (Fall Break)

PENN: Journal article discussion (Wells) (Students required to post discussion questions in advance, and are graded on this exercise)

Oct. 17:

- Solid mechanics, fluid mechanics, and diffusion (**Genin**)

Oct. 22:

- Nuclear Mechanics (**Discher**)

Oct. 24:

- Statistical mechanics (**Genin**)

Oct. 29: EXAM ON MODULE 2

Module 3: Integrating biology and mechanics – big questions

Oct. 31:

- Fibrotic responses to injury in plants and animals (**Wells**)

Nov. 5:

- Cell-cell communication (**Chen and Strader**)

Nov. 7:

- The nucleus and chromatin structure (include lamins/nuclear membrane, chromosome territories, etc; including connections to polymer physics and nuclear mechanics) (**Lakadamyali**)

Nov. 12:

- Discussion: cell wall polymers, mechanics, and assays (**Cosgrove**)

Nov. 14:

- Cell migration and movement (including at tissue and intercellular level) (**Pathak**)

Nov. 19:

- Integrating biology and mechanics through materials (**Burdick**)

Nov. 21:

- Memory, the nucleus and the ECM (**Mauck**)

Nov. 26:

- Mechanical deformations of membranes (**Radhakrishnan**)

(No class Nov. 28 – Thanksgiving Break)

Dec. 3: FINAL PROJECT PRESENTATIONS (Wells/Genin/local instructor – done separately at each site)

Dec. 5: FINAL PROJECT PRESENTATIONS (Wells/Genin/local instructor – done separately at each site)