

BME 3410 Systems Mechanobiology

Location: T, R 1:20-2:45 Philips 213
Instructor: Jonathan Butcher jtb47@cornell.edu
Office: 304 Weill Hall, 5-3575
Office Hours: TBD

Blackboard Site: www.blackboard.cornell.edu

Course Summary: This course analyzes how mechanical forces affect biological responses across biological scales, from molecular to whole body level. Theoretical, empirical, and practical foundations for engineering approaches to quantify, model, and control biological responses will be presented. Clinical applications in human health and disease pathogenesis will be emphasized throughout, including biomedical devices that affect tissue growth and remodeling. Students will also be introduced to SimBIO and CircAdapt simulation environments, as well as conduct a human body kinematics research laboratory exercise.

Prerequisites: ENGRD 2020, MATH 2930, BME 3010 or equivalent*
(equivalent biology requires permission of instructor)

Textbook: **No textbook.** Course content will derive from lecture notes, primary articles from literature/textbooks, and web based resources/tutorials. There are several texts that are excellent supports of learning for students if they are interested.

Honor Code: Students are expected to abide by the Cornell Code of Academic Integrity (<http://www.cuinfo.cornell.edu/Academic/AIC.html>). No unfair advantage will be afforded any student in the conduct of this class.

Grades: 20% Exam 1
25% Homework
20% Lab Simulation Exercises
15% Class Participation
20% Final Exam

Regrading Policy: In the event you feel I misgraded a problem, I will gladly revisit the question, but I will check the entire problem set/exam to make sure I didn't make any other mistakes.

Exams: Exams are IN CLASS. No makeup exams except for documented medical/family emergencies, which must be established/discussed ahead of the exam.

Final Exam: Final Exam period time (TBD).

- Homework: Late homework will NOT be accepted. You may discuss HW with other students, but your homework must be your own work.
- Reading: The lectures rely on course notes that are found on Blackboard. Some lectures will be supplemented by further reading.
- Attendance: Attendance will not be taken, but homework and exams will be based on class notes that may deviate significantly from text material. Also class participation is difficult if you aren't in class.

BME 3410 Course Topics

Pressure/Touch Sensation
Shear stress and blood vessel remodeling
Tissue stretch modes
Tissue stiffness and aging
Mechanotransduction mechanisms
Muscle contraction mechanics
Mechanics of growth
Actuatable biomaterials
Biomechanical Failure Criteria/Fracture healing
Kinematics
Impulse/Impact loading
Gait/balance control
Cardiac pump performance
Lumped Parameter Modeling
Cardiac shunts and reverse remodeling
Mechanobiology effects of microgravity