

BEH.410, 2.798J, 6.524J, 10.537
MOLECULAR, CELLULAR, & TISSUE BIOMECHANICS

SPRING 2002

GENERAL COURSE INFORMATION

Instructors:

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Course Secretary:

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Teaching Assistants:

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Lectures:

MW 11:00-12:30, Rm. 4-231

Course Objectives:

This course develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena over a range of length scales, from molecular to cellular to tissue or organ level. It is intended for beginning and intermediate graduate students who have been exposed to vectors and tensors, differential equations, undergraduate course(s) in either fluids or fields or transport, and certain aspects of modern biology. Topics include:

Molecular mechanics:

Mechanics at the nanoscale: intermolecular forces and their origins; single molecules; thermodynamics and statistical mechanics; Formation and dissolution of bonds; mechanochemistry; Motion at the molecular and macromolecular level; Muscle mechanics; Experimental methods at the single molecule level – optical and magnetic traps, force spectroscopy, light scattering.

Cellular mechanics:

Static and dynamic cell processes; Cell adhesion, migration and aggregation; Mechanics of biomembranes; The cytoskeleton and cortex; microrheological properties and their implications; Mechanotransduction; Experimental methods – passive and active rheology, motility and adhesion assays.

Tissue mechanics:

Elastic (time independent), Viscoelastic and Poroelastic (time-dependent) Behavior of Tissues; Electromechanical and physicochemical properties of tissues; Physical Regulation of Cellular Metabolism; Contribution of molecular level electrical interactions to tissue properties; Experimental methods – macroscopic rheology, electrokinetics.

Textbooks and Reference Materials:

Most of the material will come from journal articles and notes to be handed out by the instructors.

Texts in the library that are useful as general references:

- (a) Y. C. Fung, **Biomechanics: Mechanical Properties of Living Tissues**, 2nd Edition, Springer-Verlag, 1993
- (b) R. Nossal and L. Lecar, **Molecular and Cellular Biophysics**, Wiley, 1990.
- (c) H. Lodish, D. Baltimore, L. Zipurksy, P. Matsudaira, **Molecular Cell Biology**, 1996.
- (d) P. C. Nelson, **Biological Physics: Energy, Information, Life** (draft Notes, Dec. 2001)

Course structure and assignments:

BEH.410/2.798J/6.524J/10.537J will be taught in lecture format, but with liberal use of class examples and demonstrations to link the course material with various biological issues. Readings will be drawn from a variety of primary and text sources as indicated in the attached lecture schedule. Problems will be assigned each week to be handed in and graded. There will be one in-class exam, a take home final, and a term paper due at the end of the term (details to be described in class).

Term Paper (due Friday May 10):

A term paper will be assigned that will require you to delve more deeply into one of the topics of the course. The paper will utilize the format of a mock NIH research proposal. Additional information concerning the term paper will be provided at a later date.

Grading

The term grade will be a weighted average of exams, term paper and homework grades. The weighting distribution will be 20% for Quiz 1, 35% for the final, 25% for the term paper, and 20% for homework.

Homework grading is intended to show you how well you are progressing in learning the course material. You are encouraged to seek advice or help from other students and/or to work in study groups. However, the work that is turned in must be your own. The homework exercise should be viewed as a learning experience, not a competition.

Term Paper: This is also meant to be an individual effort. However, you should feel free to discuss your project with fellow students. The report is to be written entirely by you. You should acknowledge other sources with proper citations.