Integrative Biology 135

THE MECHANICS OF ORGANISMS

Course Control Number:

Lecture:
TuTh 1100-1230P, 101 LSA

Discussion:
INTEGRATIVE BIOLOGY 135 S 101 DIS
Location:
Course Control Number:
INTEGRATIVE BIOLOGY 135 S 102 DIS
Location:
Course Control Number:
INTEGRATIVE BIOLOGY 135 S 103 DIS
Location:
Course Control Number:

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Material covered: The same physical principles apply to any structure, whether biological or human-made. Much can be learned about organisms by considering their structure and function in terms of basic mechanical rules. During this course some basic fluid and solid mechanics will be presented along with numerous examples of their biological consequences. We'll consider how organisms interact with their physical environments, and we'll explore how the mechanical behavior of organisms depends on their structure at various levels of organization, ranging from molecules to whole-body construction. The purpose of this course is to introduce you to the breadth of diverse topics within the field of biomechanics.

Background: This is a course in biomechanics aimed at biologists who want to learn about the physical biology of organisms and how they work mechanically, and aimed at engineers who want to learn about how their approaches are used to unravel how organisms work. Courses in introductory physics and introductory biology are recommended as background.

Homework: We will give you homework assignments each week (except weeks with exams). The homework exercises have problems to solve and questions to answer, so that you can make sure that you understand the material as we go along and can get help right away if you don't. Discussion section topics for each week will start on Tuesdays after lecture and end the following Tuesday before lecture. The homework for each week will be posted on Tuesday after lecture and a printed copy due the following Tuesday before 4:45 PM in a designated area. The answer key will be posted on Tuesday evening on the website. No late homework will be accepted.

Grading: Your grade will be determined in the following way:

10%: homework (NO late homework will be accepted)
20%: midterm #1
25%: midterm #2
45%: final exam (20% = midterm #3, and 25% = material from the entire course)

Disabled Students:
Disabled students must get a letter from the Disabled Students Program and present this letter to the instructors at least 2 weeks in advance of the exam so that appropriate accommodations can be made. See http://dsp.berkeley.edu

Textbooks and reading assignments:
There is no one book appropriate for this course, although the two texts we are using are especially useful:

Life in Moving Fluids, *Second Edition*, by S. Vogel, Princeton University Press (April 1, 1996).
Mechanical Design in Organisms, by S. Wainwright, W. Biggs, J. Currey, and J. Gosline, Princeton University Press (July 1, 1982)

We won't expect you to read these texts cover-to-cover, but rather to use them as references to help you understand the lecture material and do the homework exercises. We will assign specific pages of these books to be read, and we will also assign other readings in books and articles (provided as handouts or put on the web site or on reserve in the library). We will give you specific questions to answer based on the readings, and such questions may well show up on exams.

Web Site:
We will use a bCourses site for the syllabus, homework, reading assignments, announcements and lecture material. You may access the site by going to:
http://bCourses.berkeley.edu, login through CalNet and then to Integbi 135

Integrative Biology 135 - Fall 2013
Lecture Schedule
THE MECHANICS OF ORGANISMS

Aug 29 Introduction "Living Machines"

Sep 3 Size and scaling
Sep 5 Introduction to fluids and Biological plumbing systems

Sep 10 Laminar vs. turbulent flow, Reynolds number
Sep 12 Life at low Reynolds number (the world of small organisms)

Sep 17 Boundary layers, flow microhabitats, and mass exchange
Sep 19 Non-steady-state fluid flow in the environment

Sep 24 Features that affect form drag
Sep 26 Drag at high Reynolds number

Oct. 1 Parachuting, gliding, and other uplifting subjects
Oct 3 MIDTERM #1- ***Covering lecture Aug 29 - Sep 24, discussion through Sep 26, and homework assigned Sep 3 - Sep 24***

Oct 8 Flying and swimming – quasi-steady-state approach
Oct 10 Introduction to non-steady-state flying and swimming

Oct 15 Introduction to solids: Stress and strain
Oct 17 Viscoelasticity

Oct 22 Stress-softening, shear-thinning, resilience, and plasticity
Oct 24 Biological composite materials

Oct 29 Fracture and Evolution of safety factor
Oct 31 Hydrostatic skeletons and biological hydraulic systems

Nov 5 Bending, buckling, twisting, kinking - design of skeletal elements
Nov 7 Muscle mechanics

Nov 12 Levers: hitching up muscles, tendons, and rigid skeletal elements
Nov 14 **MIDTERM #2 -** ***Covering lecture Sep 26 - Nov 5, discussion Oct 1 through afternoon of Nov 6, and homework assigned Oct 1 - Nov 5***

Nov 19 Mechanics of walking and running
Nov 21 Efficiency of locomotion

Nov 26 Terradynamics
Nov 28 THANKSGIVING

Dec 3 Surface properties and adhesion
Dec 5 SUMMARY

FINAL EXAM Dec 18, 8 AM – 11 AM