Spring Quarter 2012

Physics 187: Senior Year Seminar on Biophysics
Syllabus

Instructor: Alex Levine

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Time and Location
Lecture:
MW 3-4:20pm
PAB 2434

Office Hours:
Knudsen 3-144
MW 4:30pm- 5:30pm

Textbook
Molecular and Cellular Biophysics, M. B. Jackson (Cambridge University Press, Cambridge, 2006).

Grading:
Homework: 50% One assignment per week. Generally these will be assigned on Monday and due the following Monday.
Final Report: 50% You will turn in a paper by Monday of Finals week on one or perhaps a few research articles in biological physics. A list of suggested papers will be provided to you by the three week of class. In addition, you may discuss alternative articles with me.

General Description:

In this class we will survey some of the key physical concepts useful in the study of living systems and learn to apply these ideas to a few classic areas of study in biological physics. Certainly theoretical efforts in this field differ from fundamental theory in physics in that we will not attempt to develop an overarching theory of living systems from first principles. The role of historical contingency, which is inherent in evolution, precludes this approach. Nevertheless we will be able to apply fundamental principles that you have already studied in mechanics, electricity and magnetism, and statistical physics to elucidate the underlying mechanisms of life processes. Wherever possible, we will neglect biochemical specifics to concentrate on the more general physics principles. No background in chemistry/biochemistry will be assumed nor is required.

We will explore:

1) Key force and energy scales in biology and we can understand them. There is a modular approach to building biological structures and we will study the hierarchy of energy scales holding them together.

2) Proteins and allosteric transitions: How do proteins catalyze reactions and how they can act like simple computers? How can one encode a specific algorithm into the mechanics of a single molecule?
3) Fluctuations, diffusion, and Brownian motion: How randomness controls the shapes of some polymers and even determines the foraging behavior of bacteria. What are the implications of living in a high temperature and thus noisy environment?
4) Electrostatics in salty water: How do neurons work? How one can build a system of complex electrical signaling using leaky conductors immersed in salty water? Brains do it, but not computers. In other words, don't drop your iphone in the bathtub!