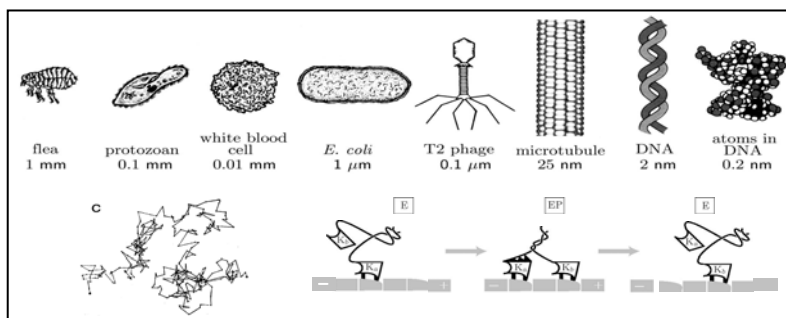


**PH 475/575-2C\* Introduction to Biophysics**

Fall, 2006

**Time:** 11:00-12:15 Tu/Th**Location:** CH 394 ("Del Square" at UAB); H.323 internet**Professor:** Tom Nordlund, UAB.**Office Hrs:** 1-2:30 PM, M/Th**Texts:** Required: Philip Nelson, *Biological Physics* (2004), WH Freeman. Recommended - Voet & Voet, *Biochemistry* (1995 or more recent; any recent Biochemistry textbook will likely be fine. Contact instructor.)**Course web site:** [www.phy.uab.edu/~nordlund](http://www.phy.uab.edu/~nordlund) . Click link to Biophysics course. Password needed.**Start Date:** Aug 22, class orientation (UAB); Aug 24 , 1<sup>st</sup> class (UAB/UA).**Prerequisites:** Permission of instructor.

All students should have had a year of *calculus-based* Physics. (More calculus is better.) The main problem physics students will encounter is the large variety of subjects and methods that must be employed; the bio/chem student may encounter challenging math. None of the physics, chemistry, biology or math<sup>†</sup> needed is terribly advanced, but knowing a



little of everything is valuable. Students should also have knowledge of college-level chemistry and thermodynamics, and should recognize the meaning of differential equations. The course is primarily directed toward mid- to upper-level undergraduate students, but graduate students may also register for PH 575, with modified expectations. PH 475 is one of the primary electives for Biophysics Track Physics majors.

**Approach and Goals.** The goals of this course are (i) to learn the multidisciplinary science needed to understand biological, as well as nonliving, systems on a microscopic scale; (ii) to prepare students to quantitatively understand and apply the physical laws governing the nanometer to micrometer scale in cells and subcellular structures. We will observe the overall structure of cells, learn the principles underlying macromolecular structure, interactions and reactions, and discover the molecular and supramolecular devices that make a living cell "living". Focusing on energetics, statistics and mechanics, we will learn how behavior changes when diffusion and friction overwhelm the familiar inertial effects of the macroscopic world. We will also merge concepts of free energy in chemistry with energy, entropy and elasticity from physics, in order to understand how unexpected driving and resistive forces develop on the nanoscale. *The central focus of this course, indeed, is on the structures and dynamics of biosystems on the micro- to nanoscale.*

Understanding the physics of biological systems demands an understanding of some biochemistry. In addition to the Nelson text, a standard biochemistry text such as Voet & Voet, *Biochemistry*, will provide a background and further reading for topics we cannot cover. This biochemistry text (and others) provides diskette-based, computer-animated color images of proteins and nucleic acids to aid in visualization of molecular structure. We will add additional material from literature articles and from web-based texts.

Besides providing the tools for quantitative understanding of biosystems, PH 475/575 prepares students to apply this knowledge to molecular motors and to an open-ended investigative project in the subsequent course, PH 476/576.

<b>Basis for grading.</b>	Homework (weekly)	40%
	Midterm	25%
	Final Exam	35%

PH 575 students will be expected to solve additional, more mathematically-sophisticated homework problems. Higher math performance will likewise be expected from PH 575 students on exams, which will be graded separately for 475 and 575.

**Homework.** Homework will consist of weekly problem sets from the text, supplemented by problems given out in class. Some assignments will involve computer work. Homework must be submitted via email.

\* UAB course numbers. UA numbers differ.

† Some of the math may look intimidating, but the same math is found in most physical chemistry texts.

**Midterm and Final Exam.** The exams will consist of (a) problems similar to homework problems (generally short), (b) extended problems, generally demanding calculation and written explanation, and (c) descriptive questions. The final will be comprehensive and will be take-home. Exams will be posted on the web and must be submitted via email as attached pdf files (scanned, if from original handwork).

**Course Format and H.323.** Classes will be held in Campbell Hall, room 394, which is furnished with H.323 Internet2 interactive broadcast equipment. Broadcasts to students at the University of Alabama, Tuscaloosa, (UA) will be made. At least two persons in the UA class must be capable of controlling internet cameras and signals (to be arranged by UA personnel). DVD recordings of each class will also be made available. In necessary cases, students may arrange to view the video record, rather than attend class.‡

**Tentative Schedule of Topics:**

Week	Topic	Reading <sup>§</sup>	Suppl. reading **	Notes
Aug 22, 24	Orientation (UAB), Introduction	N1		
Aug 29,31	Biological structures	N2, VV4:1	VV1	
Sept. 5,7	Biological Structures (cont'd)	VV5.1-5.4; 8.1-8.3; 12.1-12.3C		
Sept. 12,14	Diffusion, thermodynamics, reactions	N3.1-3.2	VV3	
Sept. 19,21	Random walks, conformation, diffusion	N4.1-4.4		
Sept. 26,28	Membrane permeability, Nernst eq.	N4.5-4.6	VV16-5	
Oct. 3,5	Fluids and friction, swimming	N5.1-5.3	VV35-3 (web)	<b>Midterm assigned/due Oct. 5/6 via email.</b>
Oct. 10,12	Entropy, Boltzmann.	N6.1-6.4		
Oct. 17,19	Forces and free energy in biology	N6.5-6.7		
Oct. 24,26	Entropic forces	N7.1-7.4	W deadline: Oct 23 (UAB)	
Oct. 31, Nov2	Water	N7.5	VV2	W deadline: Nov 1 (UA)
Nov. 7,9	Pause: catchup or photosynthesis		VV24	
Nov 14,16	Chemical forces	N8.1-8.3	VV13,14	
Nov. 21	Self assembly	N8.4-8.6		
Nov. 28,30	Selected Topic: nucleosomes	tba		
Dec. 5	Prelude to PH 476: molecular machines	N10.1		
Dec 7	Review session			
Dec 8-13	<b>Take-home exam period opens Dec 8, noon; due Dec 13, 11:59 PM via email.</b>			

‡ A live exchange of questions and ideas is important for learning in this course.

§ Abbreviations: N 1.1-1.5 = Nelson text, chapter 1, sections 1-5; VV 1= Voet & Voet, Chapter 1. Additional suggested reading from Voet & Voet may be added, based on student need.

\*\* Or comparable sections of another recent biochemistry book.