# Biophysics: Physical Biology of the Cell

PHYS4251 / PHYS 8803 JC
Professor: Jennifer Curtis
Spring 2009/ Georgia Tech

## Description

It is a revolutionary time for biology and for the role of physical sciences in biology! Multiple significant advances are transforming how biology is studied and the data that can be gathered. These advances include numerous fascinating quantitative molecular biology techniques, giant leaps forward in advanced microscopy techniques, increases computing power, as well as a surge of powerful new biophysical techniques. It is an exciting time to take another look at how physical scientists can work together with biologists. The aim of this course is to study the cell and its components using whatever tools we need in order to make quantitative and predictive statements about cellular life. The main intellectual thread of the course will be the idea that the type of quantitative data which is becoming routine in biology calls for a corresponding quantitative modelling framework. The plan of the course is to elucidate general principles with exciting case studies.

## Aims

To study the cell and its components using whatever tools we need to make quantitative and predictive statements about cellular life.

Further the course should:

- Orient you in the realm of biophysics using an overview of exemplary case studies from molecular and cellular biology
- Introduce you to the fundamental physical (and chemical) principles needed to analyze most biophysical problems
- Train you to think quantitatively about biology and to create appropriate quantitative models of biological systems

## Details

**When:** MWF, 10:00-10:50am, Howey S104. We will have several makeup lectures during the term since I will miss several lectures throughout the semester.
(Missed Lectures include: 1/9/09, 3/2/09, 3/4/09)

**Where**: Howey Physics

**Who**: You, and me:

Jennifer Curtis, jennifer.curtis@physics.gatech.edu, x48839
Molecular Science and Engineering Building Rm. G024
The best way to contact me or schedule an appointment is via email.

**What**: See Course Syllabus (attached) and Course Website
**Grading and Homework**:
Weekly homeworks will be posted online. Grades will be based on homework grades (70%) and on a project with report (15%) and class presentation (15%). I do NOT accept ANY late homeworks. Showing up and participating in class will be one of the crucial ways to learn this material. There will be no exams.

*Solving and writing up the homework:*
Discussing the homework with others is encouraged, but the explanations and derivations must be your own and your logic should be carefully explained and the significance of your results should also be explained. If you turn in a sloppy (sloppy thinking or writing!) homework, you will likely lose points because it will be too difficult or time consuming to grade.

**Textbook and Reading:**
***Physical Biology of the Cell***
by R. Phillips, J. Knodev, and Julie Theriot
Garland Publishing

You will also need:
***Essential Cell Biology***
by B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter

The course website will also present required reading from the original literature.
To truly benefit from this class, you should complete the reading assignments, which will be a bit heavy due to the fact that we are in a very interdisciplinary area.

## Tentative Course Outline

**Weeks 1-2.** Introduction. Quantitative modeling of biological systems. Biology primer. Spatial, temporal and energy scales in the cell.
**Week 3**. Molecular Forces in Biological Structures
**Week 4**. Statistical Mechanics in Biology
**Week 5.** Two State Models in Molecular Biology
**Week 6.** Macromolecules and their Conformations
**Week 7.** Diffusion, Brownian Motion, the Nature of Water
**Week 8.** Life in Salty Water
**Weeks 9-10.** Molecular and Cell Mechanics
**Week 11.** Life in Crowded and Disordered Environments
**Week 12.** Rate Equations and Dynamics in the Cell
**Week 13.** Dynamics of Molecular Motors
**Week 14.** Fluctuations

This is a ***tentative*** outline. Material can and most likely will change or be reordered as the semester goes on as I deem appropriate.
Note: much of the framework of this course is inspired by R. Phillips, one of the co-author's of Physical Biology of the Cell and by the book itself.