PHYS 410: Introduction to Biological Physics

Syllabus (Spring 2007)

CRN 35832

Lectures: Tuesday and Thursday, 2:00 - 3:50 pm, PAC 16

Instructor: Assoc. prof. Heiner Linke
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Office hours Monday 1 - 2:30 or just stop by, or email for an appointment.

Course Description

Biological physics seeks to identify the physical concepts and principles that govern biological systems. The insights gained enable biophysicists to apply techniques and methods developed in physics to help answer biological questions. In recent years, the field of biophysics has been growing very fast, in part because of the advent of single-molecule techniques (the ability to perform physical measurements on individual macromolecules), which give access to a wealth of new information, and enable highly controlled experiments on biologically relevant structures.

Studying biophysics is special for two reasons: first, it’s a highly interdisciplinary field, drawing on chemistry, physics, molecular biology, and nanotechnology. Second, compared to other fields of physics, current biophysics research can be understood with relatively simple theoretical tools and is thus more accessible to undergraduate students.

Course Objectives

- To learn important biophysical concepts and techniques in the context of specific biological examples.
- To develop an appreciation of some areas of current biophysical research, and the ability to access and read relevant research literature.

Content

The field of biophysics is far too large to cover it in a 10-week course. We will therefore focus on one particular area, namely the mechanics of processes at the molecular level, and their physical description. Specifically:

- Random walks, diffusion, and their statistical description.
- The concepts of entropy, free energy and chemical potential.
- Entropical and chemical forces.
- Molecular machines

(Roughly chapters 1-10 in Naleon - with more emphasis on some bits than on others.)

Pre-requisites

A strict prerequisite is a one-year introduction to physics, for instance PHYS 201-3 or 251-3, and some knowledge of calculus.

In addition, the course will use basic concepts from (bio-)chemistry, molecular biology, thermodynamics, and statistical physics. Any existing knowledge in these areas will come in handy, but is not assumed or expected.
Textbook
The textbook for this class is Philip Nelson: Biological Physics (Freeman, New York, 2004), available in the UO bookstore. Most lectures will follow this book closely, and I will assume that you have full access to this book. Used copies can often be found online, for instance at amazon.com. A photocopy of the first two chapters is available from the instructor if needed.

Additional/alternative reading
The following books will be on reserve in the Science Library (CRN: 35632):

- Bruce Alberts: Molecular biology of the cell. This is the bible. It’s quite possible to read short sections, and most of what we need is in the first couple of sections. If you think of buying a molecular biology book, consider Essentials of Molecular Biology by the same authors.
- Dennis Bray: Cell Movements An accessible book on motility of cells, and within cells. The treatment of the topic is more biological rather than physical.
- Alexei Grosberg: Giant Molecules. This is an accessible, semipopular introduction to polymers and polymer physics.
- Jonathon Howard: Mechanics of motor proteins and the cytoskeleton. This book was a contender for textbook for this course. The first chapters are a very to-the-point introduction to many of the basic concepts that Nelson covers in more detail. The last chapters contain an in-detail discussion of myosin and kinesin. Worth looking at.

Additional books of interest include (also available in the Science Library):

- Peter Atkins: The 2nd law (Freeman, New York, 1984). A popular book on the second law. Few examples relate to biology, but if you want to learn more about the 2nd Law without studying theoretical physics, it’s a great book.

Grading
Reading quizzes 5 %
Homework 30 %
End-of-class surveys (attendance) 2 %
2nd Week Quiz 5 %
Midterm 20 %
Individual Project 27 %
Oral project presentation 8 %
Feedback on others’ presentations 3 %
Grading scheme (I will possibly be more generous, but will not grade harder than shown.)

| 97% or more | A+ | 75 - 79% | C+ |
| 93 - 96%     | A  | 65 - 74% | C  |
| 90 - 92%     | A- | 60 - 64% | C- |
| 87 - 89%     | B+ | 50 - 59% | D  |
| 83 - 86%     | B  | < 50%    | Fail |
| 80 - 82%     | B- |          |     |

Reading assignments and reading quizzes
Reading assignments will be announced on Blackboard in the Assignment Folder, normally on Friday for the following week. You are expected to work through the reading before coming to class, and to review your notes and the text after class.

For each assignment, a short on-line reading quiz (RQ) will be available on Blackboard for at least two days until shortly before class begins (1:45 pm).

NOTE: In rare cases a browser problem may prevent you from submitting your quiz. To be sure that your score was counted, please wait for the confirmation after submission. You can also confirm your grade online using Blackboard. If there is any problem, please send me an email immediately (linke@uoregon.edu) and check your email before coming to class. Usually I can clear your attempt online, and you can retake the quiz without problems, before class.

Homework
Homework problems will be assigned weekly on Thursdays, either on Blackboard or in the form of a handout in class. Occasionally “extra problems” will be available. Points for extra problems can replace points for core (normal) problems in this or another homework. The only thing that counts for your homework grade at the end of the term is the total number of points you achieved, relative to the total number of core-problem points that were available. In this way, you can make up for lost points, and you have some freedom to choose problems you find interesting.

- Homework is due in the week after it was assigned (due time to be decided in class).
- Please submit your homework in class or into the box outside WIL 373.
- You are strongly encouraged to collaborate on homework, and to seek help from the instructor, but each student must submit her own work.
- Some solutions will be posted on Blackboard, and graded homework will be returned in class.
- Late homework will automatically lose 20% of the points unless very compelling reasons are stated to the instructor BEFORE the deadline. Extra problems cannot be submitted late. Problems submitted after solutions are posted will not be graded.

End-of-class surveys.
At the end of most class periods you are asked to hand in a brief survey:
1. In one sentence, what was today’s class about?
2. What was the most interesting thing in class today?
3. What are you confused about?
4. Any helpful comments.

Grading is simply based on completion of the survey (assuming a good faith effort). The purposes of this survey are to stimulate you to reflect on the class period and to provide feedback to the instructor.
Individual project
You will write a term paper on a special topic related to this class. Together with an oral presentation of this paper (see below), this Project will count for 35% of your grade, and essentially replaces a final exam.

Time line:
Thu, 4/5: Info handed out in class.
Tue, 4/10: Instructions discussed in class.
Weeks of 4/16 and 4/23: Individual meetings to discuss outlines and to set time lines.
Weeks of 5/11 and 5/14: Individual meetings for feedback on drafts.
Fri 6/1, 3:00 pm Deadline for submission of the final paper (hardcopy).
Dead week (6/5 and 6/7): Oral presentations. All students are expected to attend.
Finals week: If needed, we will use our time slot for the final exam for remaining oral presentations. All students are expected to attend.

Some deadlines (outline, draft, oral presentation) will be set individually, in discussion with each student. Once deadlines are set, they are strict. For additional details, see handout.

Oral presentation
Each student will give a graded, 15-minute presentation of their project in class. All students are expected to attend all presentations and to give feedback, the quality of which will be graded. Our goal will be to perform all presentations during Dead Week.

If needed, we will use our time slot for the final exam (Thursday, 6/14, 1-3 pm) for presentations. The final schedule for presentations will be settled no later than Week 9.

Tests and exams
Quiz: Tuesday April 10, in class (Nelson, Chapters 1-2)
Midterm: Tentatively on Thursday, May 10, in class.
The week-2 quiz will essentially test your knowledge of facts. Midterm and Final will mainly focus on conceptual understanding and on your ability to use the tools learned in class and in the homework. No make-up exams will be given. In the event of an unavoidable absence you need to contact the instructor (email or voice mail) as early as reasonably possible prior to the exam.

Web resource
I will use Blackboard as the web resource. For access and information, please go to:
http://blackboard.uoregon.edu
If you experience any problems, please visit the Knight or Science Library ITC for assistance.

Going to miss a class?
If you miss class it is your responsibility to obtain from another student all information that was provided in class.

Missed a handout?
Left over handouts of handouts will be available from the PHYS 410 resource box next to the door to WIL373. Many documents will also be posted on Blackboard (in Course Documents).