USC Dornsife College of Letters, Arts, and Sciences

Physical Biology: From Molecules to Cells
PHYS444

Fall 2016—Tuesday/Thursday—12 pm -1:50 pm
Location: THH 105

Instructor: James Boedicker
Office: SSC 223
Office Hours: Thursday 4-5 pm
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Course Description

The last few decades have witnessed historical advances in cell, molecular, and structural biology, driven at least partially by powerful physical approaches. As new experimental measurements and techniques continue to emerge, this has become fertile ground for physicists to explore the fundamental laws and organizational principles behind biological function.

This 4-unit course bridges the "No Man's Land" between the quantitative modeling of idealized systems that physics students are typically exposed to, and the complexity of real cell biology that biologists appreciate. This course is now the cornerstone of the undergraduate biophysics major, offered by the Department of Physics and Astronomy. In addition to biophysics and physics majors, the target audience includes quantitatively-minded biology majors, as well as students from the physical/chemical sciences and engineering interested in applying physical concepts to achieve a quantitative understanding of biological systems. The course is also appropriate for graduate students seeking an introduction to biophysics. Success will be measured by our ability to make quantitative and predictive statements about complex biological processes using simple physical tools.

Learning Objectives

1. Explore the application of the concepts of mathematics and physics to develop a quantitative understanding of how living systems function.

2. Expose students with background in the physical sciences to basic concepts and fundamentals of biology.

3. Understand the relationship between theoretical predictions made using abstract mathematical models and experimental data. We will discuss how such comparisons enable us to formulate and test hypotheses regarding the fundamental laws of biology.

4. Introduce cutting edge theoretical and experimental approaches recently developed to study biological systems.

Prerequisite(s): PHYS 152 or PHYS 162

Course Notes

Your grade will be determined according to the following distribution:

- 50% Homework
- 14% Midterm project
- 16% Final project
- 20% Class participation

Class participation is essentially about you being involved in class.

Homework

Homework assignments complement the lectures and constitute an integral part of this course. They're weighted quite heavily in this course (50% of the total grade). The solutions to the written assignments are due in class at the beginning, not the end, on the dates noted below. Late HW will receive a grade of 0%. If for a very strong reason you are unable to finish your homework on time, you need to send me an e-mail and ask for an extension before the homework is due (the reason better be good). Please do not slide your homework under my door or drop it in my mailbox without prior authorization.

Midterm Project

A short Midterm Project will allow students to learn more about a topic in biophysics and the analysis and biological systems. More details regarding the Midterm Project will be given in class.

Final Project

As part of the course, students will complete a final project consisting of an in depth analysis of a topic in biophysics. More details regarding the Final Project will be given in class.

Lectures

Lectures will be held twice a week in room THH 105.

Required Readings and Supplementary Materials

Our text will be *Physical Biology of the Cell, 2nd edition, by Phillips, Kondev, Theriot, and Garcia*. You can find it at the bookstore, or get it somewhere online.

Journal articles and supplementary reading/listening will be posted on the course blackboard page throughout the semester.

Online Course Support

The PHYS 444 home page is maintained at http://blackboard.usc.edu. Under the home page you will find a copy of this course syllabus, lecture slides, assigned reading (check it every week), solutions to problems discussed in class, current homework assignments together with some hints, solutions to completed homeworks, handouts, grades and perhaps other information.

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP:
http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *SCampus*, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Emergency Preparedness/Course Continuity in a Crisis

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.

Course Schedule: A Weekly Breakdown

Lecture	Date	Topic	Associated book chapter	Assignment due dates
1	8/23/16	What is biophysics and biological numeracy	1	
2	8/25/16	Probability in biology	2	
3	8/30/16	Time scales of biology	3 and 13	HW #1
4	9/1/16	Chemotaxis	4	
5	9/6/16	Metabolism	5	HW #2
6	9/8/16	TBD		
7	9/13/16	Neural networks		
8	9/15/16	Statistical mechanics of ion channels	6	
9	9/20/16	Cooperativity	7	HW #3
10	9/22/16	Macromolecules	8 and 9	
11	9/27/16	Cellular structures	10 and 11	HW #4
12	9/29/16	Motility	13	
13	10/4/16	Cytoskeleton	14	
14	10/6/16	Biological dynamics	15	Midterm project
15	10/11/16	Oscillations		
16	10/13/16	Molecular motors	16	HW #5
17	10/18/16	TBD		
18	10/20/16	Photosynthesis	18	
19	10/25/16	Light and vision		HW #6
20	10/27/16	TBD		
21	11/1/16	Gene regulatory networks	19	HW #7
22	11/3/16	Pattern formation	20	
23	11/8/16	Information in the genome	21	HW #8
24	11/10/16	Group behavior		
25	11/15/16	Cellular counting		HW #9
26	11/17/16	TBD		
27	11/22/16	Bioluminescence		
28	11/24/16	Be thankful for biophysics		
29	11/29/16	Cellular memory		
30	12/1/16	In class presentations		Final Project