

PHY 382. Physics of Cells

Fall 2018

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Time and Location: MWF 3:10-4:00 Lewis Lab 310

Office hours: To be determined

Description

This course focuses on the physical principles underlying the organization of living cells, which spans several orders of magnitude in length and time. It provides an introduction to biological physics and relevant concepts of soft-matter physics.

Course Contents

1. Introduction to physical biology of the cell: numbers, length and time scales in biology.
2. Mechanical and chemical equilibrium. Two state systems and cooperativity. Biopolymers and membranes. Electrostatics in solution.
3. Dynamics in the cell. Brownian motion. Rate equations and kinetics of association and dissociation.
4. Cytoskeleton and molecular motors. Polymerization kinetics. Transport and force generation.
5. Biological electricity. Pumps and channels. The Hodgkin-Huxley model.
6. Biological networks. Cell signaling. Biological pattern formation.

Initial Competences

Some exposure to thermal/statistical physics, good knowledge of multivariable calculus and stochastic processes. Prior exposure to biology or biochemistry is helpful but not required.

Final Competences

1. Perform order of magnitude estimates in cell biophysics.
2. Comprehend and develop quantitative, physics-based models that captures the essential behavior of biological systems.

3. Apply physical and mathematical principles to model how cells regulate their function, internal organization and shape, process information, sense and adapt to their environment.

Grading

The final grade will be based on:

1. **Homework (35%).** Assignments must be submitted on the assigned due date. Prior permission from the instructor is required for late submissions.
2. **Hour Exam (20%).**
3. **Final Exam (35%).**
4. **Active participation in class (10%).**

Textbook

- [1] Robert Phillips, Jane Kondev, and Julie Theriot, *Physical Biology of the Cell* (Second Edition, Garland Science, New York, 2012).

Recommended Textbooks

- [1] Philip Nelson, *Physical models of living systems* (W.H. Freeman, New York, 2015).
- [2] Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, Graham Johnson *Cell biology* 3rd edition (Saunders, Philadelphia, 2016).
- [3] Jonathon Howard, *Mechanics of motor proteins and the cytoskeleton* (Sinauer Associates, Publishers, Sunderland, Mass., 2001).
- [4] Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, *Molecular biology of the cell*, 6th ed., (Garland Science, New York, 2014).
- [5] Uri Alon, *An introduction to systems biology* (Chapman & Hall/CRC, 2006).
- [6] Howard C. Berg, *Random walks in biology*, expanded ed., (Princeton University Press, Princeton, N.J., 1993).
- [7] Philip Nelson, *Biological physics : energy, information, life* (W.H. Freeman, New York, 2007, Updated edition).

Accommodations for Students with Disabilities: If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center 212 (610-758-4152) as early as possible in the

semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

The Principles of Our Equitable Community:

Lehigh University endorses The Principles of Our Equitable Community

(http://www.lehigh.edu/inprv/initiatives/PrinciplesEquity_Sheet_v2.032212.pdf). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

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Reports or inquiries should be made to: Karen A. Salvemini, Equal Opportunity Compliance Coordinator, Alumni Memorial Building / 610.758.3535 / eocc@lehigh.edu

In the event that the conduct involves the Equal Opportunity Compliance Coordinator, reports should be made to: Judy A. Zavalydriga, Human Resources Investigator, 428 Brodhead Avenue / 610.758.3897 / jaz308@lehigh.edu

Resources for students:

Counseling office:

Counseling and Psychological Services

36 University Drive

Johnson Hall, 4th Floor

Bethlehem, PA 18015

Phone: (610) 758-3880

Fax: (610) 758-6207

Hours: M-F, 8:00 AM - 5:00 PM

<http://studentaffairs.lehigh.edu/content/counseling-psychological-services-ucps>

Gender violence:

University Center C112 and C108

Phone: 610-758-1303

Fax: 610-758-6164

E-mail: ingves@lehigh.edu

<http://studentaffairs.lehigh.edu/content/gender-violence-education-support>