Syllabus

Biophysics, Fall 2020

PHY642 CRN 47193
Online course over Zoom
Class Hours: Tue.,Thur. 9:50 - 11:05 AM

Instructor: Dr. Jaan Mannik
Office: 406B Nielsen Physics Bldg.
Office Hours: Tue., Thur. 11:05 - noon
Phone: 974-6018
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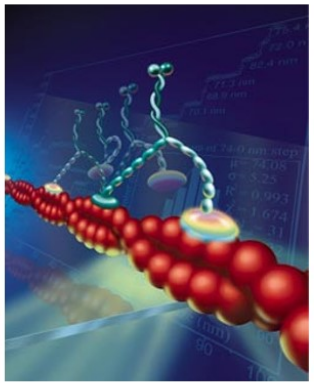

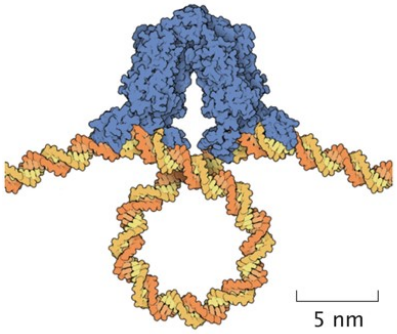

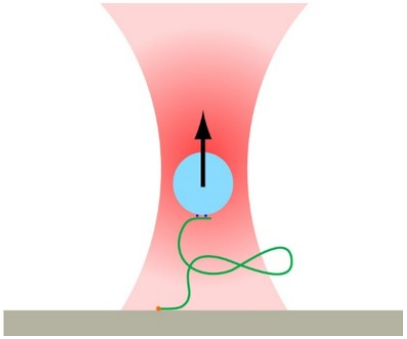

Overview:

This interdisciplinary course bridges biology and physics covering contemporary topics of polymer physics, membrane mechanics, electrical phenomena in cells, osmosis and crowding, molecular motors, self-assembly processes and pattern formation in nature. As a new topic the course will also cover viral biophysics; specifically formation of packing of DNA and RNA to viral particles, endocytosis and viral capsid assembly.

In addition to theoretical overview, the course also describes state-of the-art experimental techniques including super-resolution imaging, single molecule tracking, magnetic and optical tweezers, various scanning probe techniques and lab-on-a-chip devices.

This course is intended for wide range of students from physics and engineering to life sciences.

Learning Objectives of the Course

The main objective is to learn the underlying concepts and experimental techniques that form a foundation for contemporary biophysics.

The aim of the course is also to bring the students to the level where they will be able critically read and analyze biophysics related scientific literature.

Course textbook:

Rob Phillips, Jane Kondev, Julie Theriot and Hernan G. Garcia, Physical Biology of the Cell, 2nd Edition, Garland Science.

ISBN: 9780815344506

Other relevant books:

1. Philip Nelson, Biological Physics, 1st Edition, W. H. Freeman and Company
2. M. Rubinstein, R. H. Colby, Polymer Physics, Oxford University Press
3. B. Alberts, A. Johnson, J. Lewis et al, Molecular Biology of the Cell, 5th Edition, Garland Science

Grading policy:

40% homework, 30% attendance/participation in discussions, 30% final project.

Homework

The homework will be typically due on a weekly bases every Thursday at 9:50 am (before class begins). You can submit the homework via Canvas. Alternatively, you can scan your homework and send it to me as a pdf. Scanned handwritten document is OK as far as it is readable.

The lowest scoring homework will not count on your final score. For those of you, who have a limited background in biology, the deadline for the first homework can be extended to allow you to catch up.

Final Presentation

Final project is a seminar-style presentation of a paper. The presentation will be 15 min + 5 min for discussions. Presentations will be discussed by everybody in the class; participation in this discussion contributes to the grade.

Some of you are already involved in biophysics related research. In this case you are welcome to present a broader review of your research topic rather than a research paper as your final presentation. If you choose this option then you should prepare a 30 min presentation. There will be 5-10 min for questions after your presentation. Please contact me if you decide to choose this option. These

presentations will be arranged at the times when we cover the related material rather than in the end of the semester.

I will help to identify research presentations for those of you who are not yet involved in research or prefer to do the presentation on a new topic.

Preliminary Schedule

Lecture	Date	Topic
1	Aug. 20	Biological foundations
2	Aug. 25	Biological foundations
3	Aug. 27	Recap on statistical mechanics
4	Sept. 1	Recap on statistical mechanics
5	Sept. 3	Recap on statistical mechanics
6	Sept. 8	Osmotic pressure
7	Sept. 10	Reaction equilibrium & binding; Isothermal calorimetry
8	Sept. 15	Reaction kinetics; Measurements of reaction kinetics
9	Sept. 17	Diffusion; FSC, FRAP; Single molecule tracking
10	Sept. 22	Molecular crowding
11	Sept. 24	Molecular crowding; subdiffusion
12	Sept. 29	Polymer physics - ideal chains, optical tweezers, AFM
13	Oct. 1	Polymer physics - real chains, packing of viral DNA & RNA
14	Oct. 6	Polymer physics - twist & supercoiling, DNA looping, magnetic tweezers
15	Oct. 8	Polymer physics - polymerization kinetics in cytoskeleton, critical concentration, treadmilling
16	Oct. 13	Membranes – mechanics
17	Oct. 20	Membranes – mechanics

18	Oct. 22	Membranes - self assembly, energetics of viral endo and exocytosis
19	Oct. 27	Membranes – potentials
20	Oct. 29	Membranes – potentials
21	Nov. 3	Molecular motors – energetics and energy transduction
22	Nov. 5	Molecular motors, single molecule tracking
23	Nov. 10	Liquid-liquid phase transition
24	Nov. 12	Pattern formation in biology
25	Nov. 17	Pattern formation in biology
26	Nov. 24	Presentations