

## PHYC230A/146A Biological Physics Fall 2019

Location: Donald Bren Hall 1425

Time: MWF 10am-10:50am

Course code: 48455(230A)/47800(146A)

Instructor: Jun Allard

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Office Hours: Fridays 3:30pm-5pm

Course website: <https://canvas.eee.uci.edu/courses/19559>

**Premise of the course:** “Biological physics” means many things to many people. Here, we espouse the view that basic physics, specifically,

- 1) Mechanics (especially elasticity),
- 2) statistical mechanics like diffusion and
- 3) entropy, free energy,
- 4) polymer physics and
- 5) electrostatics (especially in salty solutions),

can help us understand the behavior of biological systems. We will focus on small-scale (cell-scale and molecular-scale) biology, where these areas of physics have had their greatest impact, with an eye towards how cells function in tissues, organs and organisms.

**Learning objectives:** At the end of the course, among many other things, the student should be able to

- Quantitatively evaluate explanations of cell and molecular biology phenomena in terms of elastic, electrostatic forces, entropy and transport.
- Make order-of-magnitude calculations using sizes, timescales and energy scales to explain biological phenomena.
- Use quantitative models based on physical principles to make predictions of cellular and molecular biological behavior.

**Textbook:** There is no textbook for the course. Most material is drawn from research articles from the last 10 years. However, some excellent useful resources can be found in *Physical Biology of the Cell* by Phillips, Kondev and Theriot, 2<sup>nd</sup> edition. Most of our topics are covered in this textbook (although in a different sequence and with different motivating examples and calculation styles). It was written for a diverse audience, with soft introductions to biology, mathematical methods, and physics. We will also draw from *Random Walks in Biology* by Berg, *Biological Physics* by Nelson, *Mechanics of Motor Proteins and the Cytoskeleton* by Howard, and *Cell Biology by the Numbers* by Milo and Phillips.

**Grading, homework, final presentation:** There will be five homework assignments due throughout the quarter. You are encouraged to work in groups but must write up your solutions individually. Solutions must be typeset using LaTeX, MS Word, Mathematica or another software and must be handed in via the Canvas system. In addition, students will give a 10-minute presentation on a published paper related to course material or an extension of a class topic. Your final grade will be 50% assignments and 50% presentation. There is no final exam.

## Outline

The following preliminary weekly plan is subject to change.

| Week | Topic                             |
|------|-----------------------------------|
| 0    | Scales and estimates              |
| 1    | Force-balance                     |
| 2    | Elasticity                        |
| 3    | Biophysics guest lectures         |
| 4    | Diffusion                         |
| 5    | Entropy and enthalpy              |
| 6    | Polymers at $k_B T$               |
| 7    | Electrostatics in salty solutions |
| 8    | The action potential              |
| 9    | Student presentations             |
| 10   | Student presentations             |

**Academic integrity:** Students are responsible for informing themselves of UCI's policies regarding academic dishonesty. Students found in violation of the code are subject to penalties ranging from loss of credit for work involved to a grade of F in the course, and possible risk of suspension or probation. The academic dishonesty policy will be enforced in all areas of the course, including homework, quizzes, and exams. For more information about the academic dishonesty policy and procedures, including information about your rights and responsibilities as a student, see: <http://www.editor.uci.edu/catalogue/appx/appx.2.htm>

**Adding and Dropping the Course:** During the first two weeks of class, all add/drop changes are made online. There is also an online waitlist for the course if it is full. For more information please see the official guidelines at: <http://www.math.uci.edu/courses/policy.php>

**Special Needs Students:** Contact me privately or the UCI Disability Services Center.

**Student Wellness:** Your professors want you to thrive at UCI, and we believe that your physical and emotional well-being are the pathways to getting there. We encourage you to do your best to maintain a healthy lifestyle this quarter by eating well, exercising, getting educated about the effects of illicit drugs and alcohol, getting enough sleep, and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. If you are interested in what you can do to promote wellness in yourself and others, visit the Center for Student Wellness & Health Promotion ([studentwellness.uci.edu](http://studentwellness.uci.edu); 949-824-9355). This office, along with many other offices at UCI, can point you to campus resources that promote physical activity, good nutrition, and stress management. For other issues, consider reaching out to the Counseling Center ([counseling.uci.edu](http://counseling.uci.edu); 949-824-6457). There are professionals there who can help with feelings of anxiety and depression, and who can provide guidance and support on a variety of concerns. Last, if you are concerned about a life threatening situation, we encourage you to contact the UCI Police Department at 9-1-1.