ASU Online PHY 473/BCH 598 – Spring 2025
From Molecules to Cells
General Course Information

Course Details:

PHY 473 – From Molecules to Cells (SLN:* 31729/31853*)
BCH 598 – (SLN:* 36471*)

Instructor: Professor Dmitry Matyushov
Office: PSF-352 Phone: (480) 965-0057 email: Canvas
Office Hours: Tu W Th 12:00 PM – 2:00 PM or by Zoom/appointment.
Web page: Canvas
Zoom: https://asu.zoom.us/j/4235183033

Text: No specific text is assigned to the course. Detailed typeset lecture notes are provided. The texts by Milo, Phillips, and Orme, "Cell biology by the numbers" and by Ken A. Dill and Sarina Bromberg "Molecular Driving Forces" are closest matches to the material covered in the course. Some topics (probabilities, correlation function, thermodynamics, etc) are also covered in DM's text "Manual for Theoretical Chemistry" (the chapter on elasticity is provided in Module 7).

Additional Reading:

Nelson, *"Biological Physics"*
Sneppen and Zocchi, *"Physics in Molecular Biology"*
David Boal, *"Mechanics of the Cell"*
Phillips, Kondev, Theriot, Orme, *"Physical Biology of the Cell"*
Kuriyan, Konforti, Wemmer, *"The Molecules of Life"*
Peusner, *"Concepts in Bioenergetics"*

Focus of this class:

This class is geared toward students with either physics or biochemistry background who want to learn physical principles of biology.

The class aims at developing two sets of skills: (i) problem solving through homework assignments and (ii) conceptual understanding through in-class discussions and quizzes. The exams will test the conceptual grasp of the material.

This course is geared toward students with biophysics, biochemistry, and computational biology backgrounds. It explores the rules of biological function from the perspective of physical laws focusing on scales of energy, length, and time pertinent to molecular and cellular biology. The philosophy of the class is to arrive at intuitive reasoning, rather than formal perspective, and be able to present qualitative arguments based on understanding of order-of-magnitude estimates of energies and times involved. The philosophy of the class is to provide intuitive explanations, rather than formal perspective. It focuses on length- and time-scales that determine biological function. The class will mostly cover time-dependent phenomena, entropic origin of macromolecular elasticity, and function of biological machines and principles of energy efficiency in biology. Thermodynamics will be briefly reviewed and used only when needed.

The main subjects addressed in the class:

- random motion converging to biological order
- origin of forces in biology (entropic vs enthalpic)
- flow of energy and matter on the nanoscale
- elasticity and conformations of proteins and DNAs
- bio-machines converting chemical energy to biological energy and action

Student Success:

To be successful:

- check the course daily
- read announcements
- read and respond to course email messages as needed
- complete assignments by the due dates specified
- communicate regularly with your instructor and peers
- create a study and/or assignment schedule to stay on track

Course learning objectives:

At the completion of this course, students will be able to:

1. Understand the rules of probability and dynamics in biology
2. Learn about statistical mechanics of biomolecular conformations
3. Understand elasticity and energy required for bending and torsion of biomolecules
4. Learn manipulate biomolecular structures and solve biophysics problems with Mathematica program suite.

Course activities:

PHY 473 presents lecture videos and Mathematica laboratories screen videos each week.

The delivery of the material pursues two goals: (i) a conceptual understanding of the material and (ii) hands-on solving of biophysical problems with programmable software. Given an easy learning curve and many tutorials, this course uses Mathematica software suite for illustrating the lecture material and for homework problems.

Learning modern software packages and basics of programing will greatly enhance your chances for success in natural sciences. Most of the homework problems will be given with the use of software in mind. **No prior knowledge is expected.** Additional review sessions and office hours will be dedicated to teaching basics of *Mathematica*.

Assignments:

Non-graded quiz and one **graded** homework assignments will be given every week. The solutions of the homework problems will be posted after the due date as *Mathematica* notebooks. All assignments must be submitted to the designated area of Canvas. Do not

submit an assignment via email. **The best format for submission is the Mathematica notebook** or a PDF scan if handwritten calculations and derivations are required. Check Canvas for submission due times.

Examinations:

The goal of exams is to test conceptual understanding, no calculations or use of software is required for answering exam questions. Weekly non-graded quizzes are used to prepare you to Exams.

There will be **two take-home exams**, as indicated in the timetable posted to Canvas.

Course Grade:

Your grade will be determined by combining the scores from examinations and homework assignments.

Exam 1	50 points
Exam 2	50 points
Homework	150 points
All HWs turned in on time	10 points (no partial credit)

The maximum score for the course is 250 points. The grades scale will be posted to Canvas.

Grade Appeals

Grade disputes must first be addressed by discussing the situation with the instructor. If the dispute is not resolved with the instructor, the student may appeal to the department chair per the University Policy for Student Appeal Procedures on Grades.

Student Conduct and Academic Integrity

Academic honesty is expected of all students in all examinations, papers, laboratory work, academic transactions and records. The possible sanctions include, but are not limited to, appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification and dismissal. For more information, see http://provost.asu.edu/academicintegrity. Additionally, required behavior standards are listed in the Student Code of Conduct and Student Disciplinary Procedures, Computer, Internet, and Electronic Communications policy, and outlined by the Office of Student Rights & Responsibilities. Anyone in violation of these policies is subject to sanctions.

Students are entitled to receive instruction free from interference by other members of the class. An instructor may withdraw a student from the course when the student's behavior disrupts the educational process per Instructor Withdrawal of a Student for Disruptive Classroom Behavior.

The Office of Student Rights and Responsibilities accepts incident reports from

students, faculty, staff, or other persons who believe that a student or a student organization may have violated the Student Code of Conduct.

Prohibition of Commercial Note Taking Services

In accordance with ACD 304-06 Commercial Note Taking Services, written permission must be secured from the official instructor of the class in order to sell the instructor's oral communication in the form of notes. Notes must have the notetaker's name as well as the instructor's name, the course number, and the date.

Syllabus Disclaimer

The syllabus is a statement of intent and serves as an implicit agreement between the instructor and the student. Every effort will be made to avoid changing the course schedule but the possibility exists that unforeseen events will make syllabus changes necessary. Please remember to check your ASU email and the course site often.

Accessibility Statement

In compliance with the Rehabilitation Act of 1973, Section 504, and the Americans with Disabilities Act as amended (ADAAA) of 2008, professional disability specialists and support staff at the Student Accessibility and Inclusive Learning Services (SAILS) center facilitate a comprehensive range of academic support services and accommodations for qualified students with disabilities.
Qualified students with disabilities may be eligible to receive academic support services and accommodations. Eligibility is based on qualifying disability documentation and assessment of individual need. Students who believe they have a current and essential need for disability accommodations are responsible for requesting accommodations and providing qualifying documentation to the SAILS. Every effort is made to provide reasonable accommodations for qualified students with disabilities.
Qualified students who wish to request an accommodation for a disability should contact SAILS by going to https://eoss.asu.edu/accessibility, calling (480) 965-1234 or emailing Student.Accessibility@asu.edu. To speak with a specific office, please use the following information:

ASU Online and Downtown Phoenix Campus University Center Building, Suite 160 602-496-4321 (Voice)	**Polytechnic Campus** 480-727-1165 (Voice)
West Campus University Center Building (UCB), Room 130 602-543-8145 (Voice)	**Tempe Campus** 480-965-1234 (Voice)

Title IX

Title IX is a federal law that provides that no person be excluded on the basis of sex

from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs.

As mandated reporters, course instructors (including TAs) are obligated to report any information they become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling, is available if you wish discuss any concerns confidentially and privately.