PHY 473 – Spring 2021
From Molecules to Cells
General Course Information

Course Details:

PHY 473 – From Molecules to Cells (SLN: 20012)

Lectures: TuTh 1:30 – 2:45 PM (PSH-462)
Instructor: Professor Dmitry Matyushov
Office: PSF-352 Phone: (480) 965-0057 email: Canvas
Office Hours: TuTh 10:00 AM – 12:30 PM, or by appointment.
Web page: Canvas

Text: No specific text is assigned, the lecture notes will be posted to Canvas and scans of chapters from different sources will be provided.

Main Texts:

This course traditionally followed two texts:
Ken A. Dill and Sarina Bromberg, "*Molecular Driving Forces*"
and Milo, Phillips, and Orme, "*Cell biology by the numbers*"

Additional Texts:

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"*

ASU Sync:

This course uses Sync. ASU. You can find out more information about ASU Sync for students here, https://provost.asu.edu/sync/students and https://www.asu.edu/about/fall-2020. To access live sessions of this class go to myASU and click the Attend via Sync button next to this class on your schedule. A Zoom link will be also posted on Canvas.

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.

The focus is on understanding biological function at the molecular and cellular levels from the perspective of physical laws. The philosophy of the class is to provide intuitive explanations, rather than formal perspective, and focus on length- and time-scales that determine biological function. This approach is captured by the book by Milo, Phillips, and Orme, "*Cell biology by the numbers*". 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 (PHY-371/PHY-441/CHM-346 are classes more heavily focused on equilibrium thermodynamics). The main issues 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:

The notes and discussions during the class will be provided as PDF files on Canvas. Spend your time in class to understand the material and to ask questions. Open discussions and questions are encouraged. Little background knowledge is expected and background will be provided either in class or through review sessions. No-grade quizzes will be given in class to enhance understanding. Quiz questions form the basis for examination assignments.

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. I will use *Mathematica* in class to solve problems and to show some demos. Mastering *Mathematica* will be required for doing homework. Additional review sessions and office hours will be dedicated to teaching basics of *Mathematica* (no prior knowledge is expected).

Assignments:

Graded homework assignments will be given every 2 weeks. 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 the 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 during the exam. Non-graded quizzes discussed in class will be used as prototypes for Exam questions.

There will be three written examinations in place of lectures, as indicated in the timetable. All examinations are open-notes and will be worth 100 points.

Course Grade:

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

Exam 1		100 points
Exam 2		100 points
Exam 3	Comprehensive	100 points
Homework		150 points
All HWs turned in on time		50 points (no partial credit)

The maximum score for the course is 500 points. The grades scale will be posted to Canvas.

Examination Procedures:

1. Every effort should be made to prepare for and to take the examinations as scheduled. This implies that you should work consistently throughout the semester.
2. If you are prevented by some verifiable serious turn of events from taking any examination at the scheduled time, it is your responsibility to contact the instructor.
3. Examination assignments will be delivered through the Canvas assignments tool.

Missed Examinations:

A score of zero will be entered automatically for missed examinations. No makeups will be given except in the event of a serious, verifiable emergency.

Communicating with the Instructor:

This course uses Slack for general questions and comments about the course. The collaboration/communication shell is not policed, feel free to share anything including hints on solving HW problems (however, you are not allowed to post the entire solution/Mathematica script). Use Canvas email to send questions to the instructor. Please do not use email servers outside of ASU since those emails often end up in the spam filter and are left unanswered.

PHY 473 – Spring 2021, Tentative Timetable

Date	Study*
Jan 12 ,14	Components of the cell and their dimensions
Jan 19, 21	Basics of probability and distributions
Jan 23, 25	Random walks and Brownian motion
Feb, 2, 4	Langevin dynamics
Feb 9, 11	Biological applications of diffusion
Feb 16, 18	Hydrodynamic equations and friction
Feb 25	Process at low Reynolds numbers
Feb 23	Review session
Feb 25	**MIDTERM EXAM I**
Mar 2,4	Entropy and number of configurations
Mar 9, 11	Entropic forces and osmotic pressure

Mar 16, 18		Elasticity models of polymers and stretching of macromolecules
Mar 23, 25		Chemical potential and assembly
Mar 30,		Review session
Apr 1	**MIDTERM EXAM II**	
Apr 6, 8		Basics of bio machines
Apr 13, 15, 20		Energy transformation and efficiency of biology
Apr 22	Review session for the final exam	
Apr 23	LAST DAY OF CLASSES	
May Apr 29	12:10-2:00 PM	**FINAL EXAM**

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 Disability Resource Center (DRC) 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 DRC. 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 the DRC by going to https://eoss.asu.edu/drc, calling (480) 965-1234 or emailing DRC@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.