Syllabus for BINF740: *Introduction to Biophysics*

Course title: Introduction to Biophysics
Course number: BINF740
Instructor name: Dmitri Klimov
Semester and year: Spring 2025
Course credits: 3
Class meeting day/time/modality: Thursdays, 4:30 pm - 7:10 pm, online via zoom
Class website: Blackboard 202510.18980 BINF-740-DL1 (Spring 2025)
Class zoom invitation: Provided via email
Instructor email address: dklimov@gmu.edu (preferred way of communication)
Instructor telephone number: 703-993-8395
Instructor office location: Colgan Hall, Rm 328B, Science and Technology Campus
Instructor office hours: By appointment (email to arrange zoom meeting or to speak over the telephone)

Course Description and Goals

This graduate course is designed as a broad introduction into the field of biophysics for graduate students with the background in chemistry, physics, computer science, or biology. The goal of the course is to present the concepts of physical chemistry and map their application on a rapidly expanding interdisciplinary interface, combining biology, chemistry, and physics. The course aims to balance the need for rigorous mathematical treatment with the simplicity of presentation.

The course consists of three parts. The first part introduces students to the fundamental concepts in physical chemistry, which are commonly used in the description of biological systems. Two other parts demonstrate a multiscale nature of biophysics by exploring *macroscopic* and *microscopic* applications. The use of computational approaches is emphasized.

Part I introduces the basic notions of thermodynamics, statistical mechanics, and physical kinetics. Molecular interactions, ranging from covalent bonding to electrostatic and van-der-Waals interactions, are thoroughly discussed. The course then shows how these interactions are combined to produce a complex array of biomolecular structures found in DNA, RNA, and proteins.
Part II describes several important *macroscopic* aspects of biophysics. The energetics of living systems is studied, including energy consumption, photosynthesis, and ATP production. The fundamental role of biomembranes is investigated in detail. Other important topics, such as nerve signals, memory function, and biomechanics, are introduced.
Part III focuses on several important *microscopic* aspects of biophysics. This part reveals the mystery of protein folding and the function of cellular chaperone systems assisting proteins to fold. The phenomenon of protein misfolding and aggregation is

discussed and linked to a new class of diseases. The unfolding of proteins implicated in a variety of biological processes is investigated.

Prerequisites: Students are expected to be familiar with basic concepts of physics, calculus, and biology on undergraduate level.

Required Reading

Required textbooks:

1. Rodney Cotterill "Biophysics: An Introduction" (for parts I and II of the course).
2. Roland Glaser "Biophysics: An Introduction", 1st or 2nd editions (for parts I and II of the course).

Online lecture notes will be distributed for part III of the course.

Course Policies

Grading schema (percentage): A+ (>100), A (90-100), B (80-89), C (≤79). Percentages are not rounded to the closest whole number.

Grade weights and grading policy: Students will be graded on the basis of homework (30%), final take-home exam (40%), and class participation (30%). Class participation implies asking questions during lectures. For each problem a student will earn up to one point. Homeworks are weighted equally independent of the number of problems in the homework.

Campus Closure: If the campus closes or class is canceled due to weather or other concern, students should check Blackboard and/or contact instructor for updates on how to continue learning and information about any changes to events or assignments.

Participation and make-up work: In case of illness or quarantine, please contact the instructor to set up a plan for make-up work. Late assignments will not be accepted unless due to emergency, illness, quarantine, work-related or other documented reasons.

Course Recordings: All synchronous meetings in this class will be recorded to provide necessary information for students in this class. Recordings will be stored on Zoom cloud and will only be accessible to students taking this course during this semester.

Other considerations: If there are any schedule issues related to religious holidays, please inform the instructor the first week of class. Completion of regular weekly homework is expected to take several hours.

Learning Outcomes

By the end of this course, students will be able to

1. Apply fundamental physical principles and concepts to biological phenomena.

2. Recognize multiscale nature of biophysics, from molecular to cellular and organism levels.
3. Appraise recent nanoscale advances in biophysics.
4. Apprehend synergistic contributions of theory, experiment, and computer simulation to the field of biophysics.

Course Logistics

The course uses Blackboard for distributing lecture materials, submission of homework, and grading. To access Blackboard

1. Go to https://mymasonportal.gmu.edu.
2. Login using your NETID and password.
3. Click on the 'Courses" tab.
4. Click on **"202510.18980 BINF-740-DL1 (Spring 2025)"** in the Course List.

The course uses Zoom for online meetings. The Zoom invitation information is provided via email.

Technology Requirements for the Course

Software and Hardware: This course uses Blackboard as a learning management system available at https://mymasonportal.gmu.edu. This course uses web-conferencing Zoom software for online meetings. Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or 11 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent 1.5 Mbps [megabits per second] download speed or higher). In addition to the requirements above, students are required to have a device with a functional camera and microphone. A larger screen is recommended for better visibility of course material. In an emergency, students can connect through a telephone call, but video connection is the expected norm.

Note: If you are using an employer-provided computer or corporate office for class attendance, please verify with your systems administrators that you will be able to install the necessary applications, and that system or corporate firewalls do not block access to any sites or media types.

Technical Help: If you have difficulty with accessing Blackboard or Zoom, please contact the ITS Support Center at 703.993.8870 or support@gmu.edu. If you have trouble with using the features in Blackboard, email courses@gmu.edu.

Common Polices Addendum

The course follows Common Policies Addendum available at https://stearnscenter.gmu.edu/home/gmu-common-course-policies/. Further information on policies is provided below.

Student Responsibilities

MasonLive/Email: Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communications from the university, college, school, and program will be sent to students solely through their Mason email account.

Students with disabilities: Students with disabilities who seek accommodations in a course must be registered with the George Mason University Disability Services and inform their instructor, in writing, at the beginning of the semester [See Disability Services website: https://ds.gmu.edu/].

Academic integrity: Students must be responsible for their own work, and students and faculty must take on the responsibility of dealing explicitly with violations. The tenet must be a foundation of our university culture [See Academic Standards website: https://academicstandards.gmu.edu/].

Academic Standards Code and Virtual Classroom Conduct: Students must adhere to the guidelines of the George Mason University Academic Standards Code [See Academic Standards Code website: https://academicstandards.gmu.edu/academic-standards-code/].

Academic Honesty Policy of the course: Students are expected to follow the Academic Standards Code. Academic dishonesty will not be tolerated in this class. Exams, projects, and homework must reflect individual work. If you have difficulty with the assignments, discuss it with the instructor.

University policies: Students must follow the university policies [See University Policies website: https://universitypolicy.gmu.edu].

Responsible use of computing: Students must follow the university policy for Responsible Use of Computing [See University Policies website: https://universitypolicy.gmu.edu/policies/responsible-use-of-computing].

University calendar: Students should consult the current Academic Calendar [See University Calendar website: https://www2.gmu.edu/academics/academic-calendar].

University catalog: Students should use the current university catalog [See University Catalog website: http://catalog.gmu.edu].

Student Services

Writing center: The George Mason University Writing Center staff provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing. (See Writing Center website: http://writingcenter.gmu.edu). ESL Help: The program was designed specifically for students whose first language is not English who feel they might benefit from additional, targeted support over the course of an entire semester.

University libraries: University Libraries provide resources for distance learning students [See Library website: http://library.gmu.edu/for/online].

Counseling and Psychological Services: The George Mason University Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance [See Counseling and Psychological Services website: https://caps.gmu.edu].

Family Educational Rights and Privacy Act (FERPA): The Family Educational Rights and Privacy Act of 1974 (FERPA), also known as the "Buckley Amendment," is a federal law that gives protection to student educational records and provides students with certain rights. [See Registrar's Office website: https://registrar.gmu.edu/privacy].

Course Materials and Student Privacy

Video recordings of class meetings that are shared only with the instructors and students officially enrolled in a class do not violate FERPA or any other privacy expectation. Video recordings that only include the instructor (no student names, images, voices, or identifiable texts) may be shared without violating FERPA (but see University Policies: Privacy for some qualifications and recommendations). All course materials posted to Blackboard or other course site are private to this class; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class.

Video conferencing or recordings: Video recordings - whether made by instructors or students - of class meetings that include audio, visual, or textual information from other students are private and must not be shared outside the class. Live video conference meetings that include audio, textual, or visual information from other students must be viewed privately and not shared with others in your household or recorded and shared outside the class.

Course schedule for Spring 2025*

Lecture 1, Jan 23
Introduction to thermodynamics and statistical mechanics.
Lecture 2, Jan 30
Reaction kinetics and transport processes. Connecting thermodynamics and kinetics.
Lecture 3, Feb 6
Biomolecular energies, forces, and bonds.
Lecture 4, Feb 13
Biomolecular structure: DNA, RNA, polypeptides.

Lecture 5, Feb 20
Biological energy: Energy consumption, photosynthesis, ATP.
Lecture 6, Feb 27
Biological membranes.
Lecture 7, Mar 6
Nerve signals.
Lecture 8, Mar 20
Memory
Lecture 9, Mar 27
Biomechanics

Lecture 10, Apr 3
Protein folding.
Lecture 11, Apr 10
Molecular chaperones.
Lecture 12, Apr 17
Protein aggregation.
Lecture 13, Apr 24
Mechanical unfolding.
Lecture 14, May 1
1. Molecular crowding.
2. Transition state in protein folding.

*****Complete schedule with assignments can be found on Blackboard class website.

Notes:
1. Each lecture is a 2 hour 40 minutes presentation with a 5 minute break.
2. Final exam will be held during the exam week.