Syllabus for BINF740: *Introduction to Biophysics*

Name of course: BINF740 Introduction to Biophysics
Meeting place: Bull Run Hall, Room 249, Science and Technology Campus (PWC)
Meeting time: Thursdays, 4:30 pm - 7:10 pm
Instructor Name: Dmitri Klimov
Credits: 3
Class website: http://binf.gmu.edu/dklimov/biophysics.html and on Blackboard (201710 - Master - BINF-740-001 / BINF-740-DL1)
Office location: Occoquan Bldg, Rm 328B, Science and Technology Campus (PWC)
Office hours: By appointment (email to set up an in-person appointment or to speak over the telephone/Skype)
Email address: dklimov@gmu.edu (preferred way of communication)
Telephone number: 703-993-8395

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, and 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, biomechanics, hearing, 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 system 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 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" (for parts I and II of the course)

Online lecture notes will be distributed during the course as needed.

Course Policies

Grading scale (points): A+ (>100), A (90-100), B (80-89), C (≤79)

Grading policy: Students will be graded on the basis of homework (30%), final course paper or final take-home exam (40%), and class participation (30%). For each problem a student will earn up to one point.

Late assignments: Late assignments will not be accepted unless due to emergency, work-related or other documented reasons.

Other considerations: If there are any 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 synergetic 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, grading, and, for distance learning students, for accessing online sessions.

To Access Blackboard

1. Go to http://mymason.gmu.edu.

2. Login using your NETID and password.
3. Click on the 'Courses" tab.
4. Click on **201710 - Master - BINF-740-001 / BINF-740-DL1** under the "Course List" heading.

Technology Requirements for the Course

Hardware: You will need access to a Windows, Macintosh or Linux computer with at least 2 GB of RAM and to a fast and reliable broadband internet connection (e.g., cable, DSL). A larger screen is recommended for better visibility of course material. Students will need speakers or headphones to hear recorded content and a headset with a microphone is highly recommended for best experience.

Software: This course uses Blackboard as a learning management system. You will need a browser and operating system that are listed compatible or certified with the Blackboard version available on the myMason Portal. Log in to myMason to access BINF740. You may need Acrobat Reader, Flash, Java (Windows), and Windows Media Player, QuickTime and/or Real Media Player. Your computer should be capable of running current versions of those applications. Also, make sure your computer is protected from viruses by downloading the latest version of Symantec Endpoint Protection/Anti-Virus software for free at http://antivirus.gmu.edu.

Students owning Macs or Linux should be aware that some courses may use software that only runs on Windows. You can set up a Mac computer with Boot Camp or virtualization software so Windows will also run on it. Computers running Linux can also be configured with virtualization software or configured to dual boot with Windows.

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, please contact the ITU Support Center at 703.993.8870 or support@gmu.edu. If you have trouble with using the features in Blackboard, email courses@gmu.edu.

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 communication 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 Office of Disability Services (ODS) and inform their instructor, in writing, at the beginning of the semester [See Office of Disability Services website: http://ods.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 Integrity website: http://masononline.gmu.edu/student-resources/academicintegrity/].

Honor Code and Virtual Classroom Conduct: Students must adhere to the guidelines of the George Mason University Honor Code [See Honor Code website: http://oai.gmu.edu/the-mason-honor-code-2]. 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: http://universitypolicy.gmu.edu].

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

University calendar: Students should consult the current Academic Calendar [See University Calendar website: http://calendar.gmu.edu].

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 students [See Library website: http://library.gmu.edu/distance].

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: http://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: http://registrar.gmu.edu/privacy].

Course schedule for Spring 2017*

Lecture 1, Jan 26
Introduction to thermodynamics and statistical mechanics (Lecture notes, Chapter 4 (RC), Chapter 3 (RG)). *Biological examples.*

Lecture 2, Feb 2
Reaction kinetics and transport processes (Chapters 4 and 5 (RC), Sections 2.3.5, 2.3.6, 3.1.5 (RG 1st ed) or 2.1.5, 2.1.6, 3.1.6 (RG 2nd ed)). Connecting thermodynamics and kinetics.

Lecture 3, Feb 9
Biomolecular energies, forces, and bonds (Chapters 2 and 3 (RC))

Lecture 4, Feb 16
Biomolecular structure: DNA, RNA, polypeptides (Chapter 7 (RC)). Hydration (section 2.4.2 (RG 1st ed) or 2.2.2 (2nd ed))

Lecture 5, Feb 23
Biological energy: energy consumption, photosynthesis, ATP (Chapter 9 (RC))

Lecture 6, Mar 2
Biological membranes (Chapter 8 and 11 (RC), section 2.5 (RG 1st ed) or 2.3 (2nd ed))

Lecture 7, Mar 9
Nerve signals and memory (Chapters 12 and 13 (RC))

Lecture 8, Mar 23
Movements of organisms (Chapter 10 (RC))
(i) Biomechanics (Section 3.6(RG)); (ii) Blood circulation (Section 3.7(RG))

Lecture 9, Mar 30
Physics of environmental impacts (Section 4 (RG))
(i) Hearing; (ii) Electromagnetic field.

Lecture 10, Apr 6
Protein folding (online lecture notes)

Lecture 11, Apr 13
Molecular chaperones (online lecture notes)

Lecture 12, Apr 20
Protein aggregation (online lecture notes)

Lecture 13, Apr 27
Mechanical unfolding (online lecture notes)

Lecture 14, May 4
1. Molecular crowding
2. Transition state in protein folding

*****complete schedule with assignments can be also found at
http://binf.gmu.edu/dklimov/biophysics.html

Notes:
1. Each lecture is a 2 ½ hour presentation with a 10 minutes break
2. RC and RG are the abbreviations for the textbooks by Rodney Cotterill and Ronal Glaser, respectively.