Biochemistry 104b: Physical Chemistry of Macromolecules (Spring 2016)

Prof. Timothy Street, office Rosenstiel 648, ext 6-4961, tstreet@brandeis.edu
Meeting time: Block G: T, F 9:30 - 10:50 AM Location: Shapiro Science GL14 (0-14)
Office hours: Mondays, 10-12 AM
Prerequisites: BCHM 100a, and one of the following: BCHM 104a, CHEM 141a, or Phys 40a

OVERVIEW:

Understanding biological phenomena ultimately boils down to understanding macromolecules, their structures, and how their structures dictate their functions. This course will explore the physical principles that define the structure-function relationship of biological macromolecules, primarily focusing on proteins and nucleic acids.

The main difficulty encountered in understanding macromolecular structures and interactions is their inordinate complexity. Even a small protein has an astronomical number of possible molecular configurations. A macromolecule must perform its function while interacting with thousands of water molecules; these contacts are the most important factor in determining the macromolecule’s structure. Detailed enumeration and analysis of these possible structures and interactions at the level of individual atoms ranges from difficult to impossible.

Fortunately, such enumeration is not necessary. This course will cover a relatively small number of principles that have been highly successful at analyzing macromolecular structures and interactions. The ideas we will discuss will help you understand why biological macromolecules behave the way they do and why they have the structures that they have. When you are doing research and are confronted with a specific question about a particular macromolecule, the same ideas will help to formulate and test hypotheses about its structure, function, and interactions. The power of these concepts is that they are all based on simple physical models of the molecules and the forces that act on them. A consequence of this simplicity is that, in most cases, you can obtain a reasonable answer very quickly, using only rudimentary tools (a pencil, a piece of paper, a computer, and maybe a brain).

The course requires knowledge of basic biochemistry. This is a second-semester physical chemistry course; I will assume that you are already familiar with fundamental concepts like Gibbs free energy and chemical equilibria. The course is calculus-based; you will need to be able to differentiate and integrate with ease.

RULES FOR THE COURSE:

I welcome questions and confusions from students. My main goal as an instructor is to help you understand the quantitative material presented in the course, and I am aware that the material is complex. However, I am hard-nosed and unyielding about assigned work, so here are the rules now. You cannot credibly say later that you didn't know.

1. HOMEWORK: Along with readings, about 3 hours worth of problems per week will be assigned. All problem set answers are due in digital form (preferably a PDF). Handwritten homeworks can be scanned at the library or in the Biochemistry office copy room. Detailed answer keys will be given after each problem set is collected. You are then required to correct your own work and turn in the modified version, which will be graded.

These problems are essential for understanding the material covered in class. It is important to master these problems - they are for your benefit. These problems give you indispensable practice in doing "word problems" using high-school algebra and first-year calculus, minimal elements of mathematical literacy with which you must be comfortable in this course (and for the rest of your lives).
2. **EXAMS:** There will be three exams: a "warm-up", a midterm, and a final. The final exam is cumulative and will cover all topics treated throughout the course.

3. **QUIZZES:** There will be several in-class quizzes given throughout the semester.

4. **MISSED WORK AND MAKEUPS:** Students are expected to perform all the work, period! There will be no makeups for missed exams, which will receive a failing grade. The final exam will be held during the regularly scheduled university time slot. Please consult the University calendar before scheduling plane flights for travel at the end of the semester. PRE-PURCHASED TRAVEL ARRANGEMENTS ARE NOT A LEGITIMATE EXCUSE FOR MISSING ANY EXAMS. In exceptionally unusual circumstances in which an hour exam is missed for a very good, documented reason - e.g., death of the student - you must notify me of the demise BEFORE the exam takes place and a makeup oral exam will be given to the corpse (a Biochem department tradition). A doctor’s note or its equivalent is generally required.

5. **GRADES:** Final grades will be determined by your performance on exams (15%, 15%, and 25% each, respectively), on quizzes (15%), on homework (15%), and from class participation (15%).

6. **DISCUSSION SECTIONS:** Each week, a discussion session will be held by the course's graduate teaching assistant (time TBA). These sessions are for clarifying confusions, going over problems, and correcting my mistakes. Skip them at your peril!

7. **ATTENDANCE AND PROMPTNESS:** Lectures will begin and doors will close at 9:30 AM sharp! Late arrivals are very disruptive to me (and, I suspect, to others), so make sure you arrive by 9:25. Attendance is required and class participation is part of your grade (however, if you are sick, PLEASE STAY HOME AND GET BETTER). The course is very “lecture-heavy”, as the textbooks are used primarily as references and for providing an alternate point of view.

8. **BACKGROUND EXPECTATIONS:** This is a second-semester course in physical chemistry that requires basic knowledge of biochemistry. I expect that everyone will have familiarity with thermodynamics, especially equilibrium constants and Gibbs free energy. You must be able to differentiate and integrate with ease and have a good feeling for simple mathematical functions - polynomials, exponentials, logarithms, and trig functions.

   Success in this 4 credit hour course is based on the expectation that students will spend a minimum of 9 hours of study time per week in preparation for class (readings, papers, discussion sections, preparation for exams, etc.).

**POLICY ON ACADEMIC HONESTY:**

Academic integrity is central to the mission of educational excellence at Brandeis University. You are expected to be familiar with and to follow the University’s policies on academic integrity (see http://www.brandeis.edu/studentaffairs/srcs/ai/). I will refer any suspected instances of dishonesty to the Office of Student Development and Conduct. Violations of university policies on academic integrity may result in failure in the course and could end in suspension from the university. All homework must be your own work, except when assignments specifically authorize a collaborative effort.

**STUDENTS WITH DISABILITIES:**

If you are a student with a documented disability on record at Brandeis University and wish to have a reasonable accommodation made for you in this class, please see me immediately. Accommodations cannot be made retroactively.
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