Introduction to Biophysical Chemistry
CHEM 4150/6150 (3.0 credits)
Department of Chemistry, Georgia State University
2019 Fall semester

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Time and location: Tuesdays and Thursdays, 5:30 to 6:45 pm, **PSC 171**

Office Hours: Wednesdays 1 to 2 pm in NSC 416 or by appointment

Prerequisite: Math 2212 or equivalent with grade of C or higher

Course Objective:

A complete understanding of biological systems includes a quantitative description of the physicochemical properties that define their molecular structure and function. This course introduces students to how principles of physical chemistry apply to understanding biological systems and biotechnological advances in food science and pharmaceutics.

Expected Learning Outcomes:

1. Understand how physical chemistry governs the interactions of biological macromolecules with small molecules (including drugs and nutrients) and other macromolecules;
2. Develop and articulate a physically intuitive view of biological systems at the molecular level;
3. Rationalize food science and pharmaceutics in terms of fundamental chemistry;
4. Develop skills needed to critically analyze experimental data.

Recommended textbooks:

Given the diverse nature of the materials and interests of the students taking this course, we do not impose a required text. However, one or more of the following texts is recommended depending on your interests:

Physical Biology of the Cell by Phillips, Kondev, Theriot, and Garcia, 2nd edition (2012), Garland Science, New York, NY. (This book is recommended for students from a biology background but are mathematically inclined.)

Atkins' Physical Chemistry by Atkins, de Paula, and Keeler, 11th edition (2018), Oxford University Press, Oxford, UK. (This book is recommended for chemistry and physics majors.)

Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco, Sauer, Wang, Puglisi, Harbison, and Rovnyak, 5th edition (2014), Pearson, Upper Saddle River, NJ.

Course materials:
Course content consists primarily of lecture slides, which will be supplied on iCollege, class discussions (i.e. notes that you take in class), and problem sets (more below). They are supplemented by textbook reading as indicated in the course schedule on p.3.

Problem sets:

A problem set will be provided approximately every two weeks. They are aimed at applying the concepts presented in class and **preparing you for the questions on the tests.** We will work on part of the problem sets in groups during class; the rest is for you to complete outside of class. They will not be marked, but you may submit them on the due dates for extra credits.

Policy regarding calculators:

For problem solving, you will need a scientific calculator and learn how to use it. Any standalone scientific calculator will suffice; programming or graphing capabilities are not required, though permitted. If you would like suggestions, units such as the Casio fx-260 or fx-300 are reasonably equipped, widely available, easy to use, and inexpensive (<$10). **N.B. Sharing or substitution of standalone calculators with phones, tablets, or laptop computers during tests is not allowed.**

Attendance:

The vast majority of the concepts taught in this course cannot be adequately learnt outside of class. Attendance is therefore a major component of this course and will be assessed accordingly for credit (see next section). Attendance means presence in the classroom and giving consideration to yourself and others, not electronic devices. Please put your phones away. I will politely remind you if you do not.

Assessments:

Assessment is based on attendance (**25%**) and four in-class tests, the last of which will be held during Finals week. The tests are not specifically cumulative in content. The best 3 out of the 4 written tests will be used for calculating your final score (**3 x 25%**). **Skipped tests that are not made up will count and will not be dropped.** In addition, you can recover up to 10% of your final grade with extra credit earned by scores on problem sets which you choose to submit**.** Tests are composed of a mixture of multiple choices and short written questions. Graduate students enrolled in CHEM 6150 will answer extra questions, which are optional (bonus) for undergraduate students, aimed at probing a more advanced level of understanding.

Grading Scale:

Students can be assured of the following grades by attaining the indicated scores:

90%	**A+**	77%	**B+**	67%	**C+**	50%	**D**
85%	**A**	74%	**B**	64%	**C**	Below 50%	**F**
80%	**A-**	70%	**B-**	60%	**C-**		

Academic integrity:

Students are reminded of the University's academic honesty policy, which can be found here: http://deanofstudents.gsu.edu/faculty-staff-resources/academic-honesty/. Specifically, all tests taken must represent individual, unaided efforts. Receiving or offering information on a test is cheating, as is the use of unauthorized supplementary materials or devices. The consequences of cheating are potentially severe and permanent: don't do it!

Course Schedule

Week	Session	Date	Topic		Phillips*	Tinoco*
1	1	8/28	Introduction	Conventions and measurements		
	2	8/30	Mathematics review	Algebra		
2	3	9/4		Differential calculus	5.3	
	4	9/6		Integral calculus		
3	5	9/11	**Test 1 (Sessions 1 to 4)**			
	6	9/13	Thermodynamics	Introduction	5,6	2
4	7	9/18		Work, energy and enthalpy		
	8	9/20		Entropy and free energy		3
5	9	9/25		Chemical potential and equilibrium		4
	10	9/27		Applications of the equilibrium constant		
6	11	10/2	Kinetics	Chemical kinetics	15.2	
	12	10/4	Review for Test 2			
7	13	10/9	**Test 2 (Sessions 6 to 12)**			
	14	10/11	Thermodynamics and kinetics in biology	Biomolecular thermodynamics I	6.3,6.4	2,3,4
8	15	10/16		Biomolecular thermodynamics II		
	16	10/18	Biotech applications of biophysical chemistry	Introduction		
9	17	10/23		Sterilization and food preservation		
	18	10/25		High pressure in biotechnology I		
10	19	10/30		High pressure in biotechnology II		
	20	11/1	Review for Test 3			
11	21	11/6	**Test 3 (Sessions 14 to 20)**			
	22	11/8	Interpreting biomolecular interactions at equilibrium	Introduction and independent site binding	7	5,6
12	23	11/13		Heterogeneity in site binding		
	24	11/15		Statistical features of multi-site binding		
13	25	11/20		Cooperativity and allostery		
	26	11/22	Enzyme kinetics	Michaelis-menton formulation	15.2	10
14	27	12/4		Enzyme inhibition		
	28	12/6	Review for Test 4			
Finals			**Test 4 (Sessions 22 to 28)**			

*These chapters refer to *Physical Biology of the Cell*, 2nd ed (Phillips) or *Physical Chemistry: Principles and Applications in Biological Sciences* (Tinoco) that complements the lectures.