Basic Physical Chemistry: Biological Applications of Physical Chemistry
CHM 3453 Spring 2014

Do you know how much energy is required for an siRNA therapeutic to bind to the HIV genome? Have you ever wondered how the flu virus packages all eight of its RNA genome segments into one virus particle? This semester we will be learning how to use physical chemistry as a tool to answer biological questions. You will use what you have learned in your previous chemistry, biochemistry, physics, and math classes to begin answering some of these questions. There is no required text for the course. Course material, including resources for math review, will be available on the Desire2Learn (D2L) course website. So you only need to bring your enthusiasm, questions, and imagination to the first day of class.

Time: MWF 10:30-11:20 am
Place: PHSc 224
Instructor: Dr. Susan J. Schroeder
Phone: 405-325-3092
Email: susan.schroeder@ou.edu
Office: SLSRC 3590 or GLCH 28
Office Hours: by appointment
Question and Answer session: Friday 11:30-12:20 pm GLCH 28
Course Website (Desire2Learn): http://learn.ou.edu

Course Objectives:

1. Understand fundamental physical chemistry concepts in thermodynamics and spectroscopy and their applications to solving biological problems.
2. Develop problem-solving skills for answering questions in biological chemistry.

Prerequisites:
CHEM 1415 or CHEM 1425; MATH 2423; PHYS 2524 or PHYS 2424; or the equivalent with permission.

Textbooks:
No specific textbook is required for this course. Useful physical chemistry texts are suggested below.

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

Physical Chemistry for the Life Sciences by Atkins and de Paula, W.H. Freeman and Co., New York, NY, 2006.

Calculus for Biology and Medicine 3rd edition by Neuhauser, Prentice Hall, Boston, MA, 2011.

Grading:
Midterm Exam (30%)
Final Exam (30%)
Homework (25%)
Class Participation (15%)

Homework sets are required and will be evaluated on a letter grade basis. Passing marks on all homework is required. A second attempt to achieve a passing mark will be allowed within one week. Students may study together to solve homework problems, but the submitted work must demonstrate individual comprehension of the problem and target concepts. All written assignments will be submitted through the drop box on the course website, which utilizes the originality reports from turnitin.com

Participation in class activities is required. Attendance is required. More than two absences will result in a lower grade, barring extreme circumstances and discussion with the instructor. Excused absences follow university guidelines for requests prior to the date of the absence.

University Codes and Policies of Behavior: Each student should be familiar with the University's codes, policies, and procedures involving academic misconduct, grievances, sexual and ethnic harassment, and discrimination based on a physical handicap.

University Attendance Policy: Any student who is unable to submit written reports or presentations on their assigned day will receive a zero unless an excused absence is granted prior to the submission deadline.

Excused absences as defined by the Dean of the College of Arts and Sciences and outlined in the Faculty Handbook are as follows:

i. Personal illness. Please note that you will not be allowed to make up work unless you can provide a doctor's note or encounter form verifying an illness serious enough to keep you from the exam.
ii. Death in the immediate family.
iii. Jury duty, military service or university educational functions. You must provide the Professor of Record with forewarning and documentation as well as a plan for making up required work.
iv. "Unavoidable circumstances". This is considered on a case per case basis and is subject to documentation.

It is the policy of the University to excuse absences of students that results from religious observances and to provide without penalty for the rescheduling of examinations and additional required class work that may fall on religious holidays. Please notify the instructors as soon as possible to make arrangements for the observance of religious holidays.

When petitioning for an excused absence, documentation must be presented to the professor no later than the next class period. A copy of the documentation will be made, the professor will decide if the absence is excused. The student will be informed of the decision, and all original documentation will be returned.

University Academic Misconduct Policy:
Academic misconduct is an extremely serious offense and immediate action will be taken if this occurs. Academic misconduct is defined as any act that improperly affects the evaluation of a student's academic performance or achievement. The following terms illustrate but do not delimit or define academic misconduct:

1) Cheating: the use of unauthorized materials, methods, or information in any academic exercise, including improper collaboration.
2) Plagiarism: the representation of the words, images, or ideas of another as one's own.
3) Fabrication: the falsification or invention of any information or citation in an academic exercise.
4) Fraud: the falsification, forgery or misrepresentation of academic work, including the resubmission of work performed for one class for credit in another class without the informed permission of the second instructor, or the falsification, forgery or misrepresentation of other academic records or documents, including admissions material and transcripts; or the communication of false or misleading statements to obtain academic advantage or to avoid academic penalty.
5) Destruction, misappropriation, or unauthorized possession of University property or the property of another.
6) Bribery or intimidation.
7) Assisting others in any act proscribed by this Code.
8) Attempting to engage in such acts.

For complete information on the OU Academic Integrity policies see: **http://integrity.ou.edu**

Academic Integrity at OU	Protecting OU's Academic Integrity	Plagiarism
http://www.kaltura.com/tiny/ivbcf	http://www.kaltura.com/tiny/i1az1	http://www.kaltura.com/tiny/cyrr9

Any form of academic misconduct, as specified in the Student Code at OU and in the Chemistry Department's Student Handbook, will be reported to the Department and the Dean for appropriate action.

All written assignments will be submitted through the drop box in D2L with turnitin.com features enabled.

University Policy of Reasonable Accomodations for Students with Disabilities: Any student in the course who has a disability that many prevent them from fully demonstrating their abilities should contact the professor of record as soon as possible to schedule a private appointment to discuss the accommodations necessary for the student to fully participate and facilitate the student's educational opportunities.

Note: The instructor reserves the right to change by addition and/or subtraction any and/or all materials contained in this syllabus. This includes, but is not limited to, course content, assignments, due dates, and portion(s) of the grades assigned to individual items within this course.

CHEM 3453: Tentative Lecture Schedule

January 13: Topic 1 begins
Question 1: How much energy is required for an siRNA therapeutic to bind to the HIV genome?
Physical Chemistry Concepts: Introduction to nucleic optical melting experiments and biological applications of thermodynamics and spectroscopy

1. Beer's Law
2. Van't Hoff plots
3. Le Chatelier Principle
4. Complex equilibria
5. Free Energy is a State Function
6. Free Energy of a Hydrogen Bond in RNA and Calculating Free Energy of an RNA Duplex

Read: Chapter 1 Tinoco
Math Review: Exponential Functions, Logarithmic Functions, and Graphs
Sections 1.1.5, 1.2.2, 1.2.5, 1.3.2, 1.3.3 Neuhauser pp. 8-10, 19-21,24-28, 42-52

January 17: Homework 1 due

January 20 Martin Luther King Holiday no class

January 22: Topic 2 begins
Question 2: What is the force necessary to unwind phage DNA?
Physical Chemistry Concepts:

1. First Law of Thermodynamics
2. Work and Energy
3. Heat and Heat Capacity
4. Enthalpy
5. PV = nRT
6. Kinetic Theory of Gases

Read: Chapter 1 Atkins and/or Chapter 2 Tinoco
Math Review: An Integral Represents the Area Under a Curve: Sections 6.3.1, 6.3.2 Neuhauser pp. 306-312
Introduction to Integrals: Section 6.1 and 6.2 Neuhauser pp. 276-305

January 31: Homework 2 due includes Topics 1 and 2

January 29: Topic 3 begins
Question 3: How does water help a protein fold?
Physical Chemistry Concept: Entropy, Temperature, Second and Third Laws of Thermodynamics
Read: Chapter 2 Atkins and/or Chapter 3 Tinoco
Math Review: Derivatives

February 7
Question 1 (reprise): How much energy is required for an siRNA therapeutic to bind to the HIV genome?
Physical Chemistry Concept: Free Energy, Chemical Potential, Equilibria

February 12
Question 4: What is the free energy of a hydrogen bond in an RNA enzyme?
Physical Chemistry Concept: Kinetics

February 14: Homework 3 due

February 24
Question 5: What is the structure of a DNA helix?
Physical Chemistry Concept: X-ray diffraction

February 28: Homework 4 due

March 3
Question 6: How does a flu virus package all eight of its genome segments into a virus particle?
Physical Chemistry Concept: Introduction to Spectroscopy

March 7: Midterm Exam on Thermodynamics and Kinetics

March10
Question 7: (reprise) How much energy is required for an siRNA therapeutic to bind to the HIV genome?
Physical Chemistry Concept: UV spectroscopy

March 17: Spring Break

March 24
Question 8: How does a cyclic peptide drug bind TAR RNA in HIV-1?
Physical Chemistry Concept: NMR Spectroscopy

April 7
Question 9 (reprise): How does a flu virus package all eight of its genome segments into a virus particle?
Physical Chemistry Concept: Fluorescence Spectroscopy

April 21
Question 10: TBA
Physical Chemistry Concept: TBA

May 2: Last Day of Classes

May 9: Final Exam

May 9-10: Commencement

CHEM 3453: Student Survey

Post your answers to the student survey in the D2L dropbox before 5 pm on January 17. This survey provides valuable information to assist the instructors in assessing student background and skill level.

1. List previous undergraduate courses in chemistry, math, physics, biochemistry, and molecular biology and institutions attended.
2. List the other courses you are taking this semester.
3. Briefly describe any previous practical laboratory experience.
4. Briefly describe your reasons for taking this course.
5. Name your favorite scientist(s), alive or dead, and briefly explain your choice.