CHEMISTRY 474/674
STRUCTURAL AND PHYSICAL BIOCHEMISTRY
Fall 2009

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Course information available on, Blackboard.syr.edu

The Course: CHE 474/674 covers basic physical chemistry for the undergraduate biochemistry majors and graduate students with interests in biochemistry. Part I of the course discusses the interactions between biological molecules in solution, acid/base equilibria, chemical equilibrium and the application of the 1st and 2nd laws of thermodynamics to biochemical systems. Part II of the course addresses important physical and structural properties of DNA and RNA. In this part of the course, chemical kinetics and its application to biological systems is also presented and discussed. The last part of the course covers bonding theory using quantum mechanics and analyzes the absorption spectra of biological macromolecules.

In addition to discussing the physical and chemical properties of biological systems, students also learn how to search the biochemical literature, download structures from the Protein Data Bank, and use a molecular modeling program to build and analyze proteins, DNA and drugs. These computer exercises comprise the "homework" portion of the course.

Required Text.

Physical Chemistry. Principles and Applications in Biological Sciences, 4th. ed., I. Tinoco, K. Sauer, J. C. Wang and J. D. Puglisi, Prentice Hall, Upper Saddle River, NJ, 2002. This text, which is required for the course, has an extensive number of well designed problems covering biophysical chemistry. The text is denoted by the letter, "**T**".

Resource Texts.

General Chemistry, Ebbing, D. D. & Gammon, S. D., 8th ed., Houghton Mifflin Co., Boston. The text is a valuable resource for basic information on many topics covered in CHE 474 including, chemical equilibrium, thermodynamics, chemical kinetics, molecular forces, and chemical bonding. Use the index of this text to search for topics of interest. The text is denoted by the letter, "**E**".

Biochemistry, Berg, J. M., Tymoczko, J. L., & Stryer, L., 6th ed., W. H. Freeman and Co., New York, 2006. The text covers the structure and function of DNA, RNA, and proteins. Use the index of this text to search for topics of interest. The text is abbreviated by the letter, "**B**".

Biochemistry, Mathews, C. K., vanHolde, K. E., & Ahern, K. G., 3rd ed., Addison Wesley Longman, Inc., San Francisco, 2000. This physically oriented general biochemistry text covers many topics addressed in CHE 474. Use the index of this text to search for topics of interest. The text is abbreviated by the letter, "**M**". This book is on reserve in the Science and Technology Library.

Course Organization: Structural and Physical Biochemistry, CHE 474/674, is composed of four parts, lecture, practice problems, exams, and homework assignments.

Lecture: The lecture material in the course is collected from the texts, **T**, **E**, **B**, and **M**, selected research articles, and other publications. Since the early part of the course applies basic principles learned in general chemistry to problem solving in biochemistry, it is important to read and understand appropriate sections in **E**. As the course progresses, more

emphasis is placed on the physical and structural aspects of biological systems, as discussed mainly in **T** (some from **B**, and **M**), and detailed chemical kinetic analyses, as found in **T**. The lecture material for the final portion of the course, which covers basic quantum mechanics and absorption spectroscopy, is primarily derived from **T**.

For the lecture portion of the course, students are expected to take detailed notes and review them after each lecture. When additional information is required or if a point made in lecture is not clear, students are expected to seek information from the required and resource texts as well as from other sources.

It is University policy that cell phones or other electronic devices not be audible and disturb the lecture environment in any way.

Practice Problems: CHE 474/674 has an extensive series of "practice problems", posted on Blackboard, that are designed to prepare the student for the exams in the course. A good strategy for working out the solution to a practice problem is to read the lecture notes that apply and, if necessary, consult appropriate sections in one or more of the above texts. If after doing so, the approach to solving the problem is not obvious, consult the solution that is posted on Blackboard. Since an exam question will *not* be identical to a practice problem, understanding the scientific logic behind the setup of a solution is more important than memorizing the solution to a specific problem. *Working out the solutions to practice problems should be started early and it should be continuous and on-going throughout the course. Saving this task for the night before the exam is not a good way to obtain a high grade on the exam. No points are allotted for solving the practice problem sets in the course.*

As outlined above, the practice problems are designed to help the student prepare for the exams in the course. Consulting "hard copies" or electronic versions of the solutions to the practice problems *during* exams is academic dishonesty and is strictly forbidden.

Examinations: Three exams, each weighted 16% of the final grade, will be given on the dates and time (9:30 AM to 10:50 AM), indicated in the syllabus. These exams, referred to as "hourly" exams, cover the material for the various parts of the course, Exam I covers material for Part I, Exam II/Part II and Exam III/Part III. Typically, each hourly exam consists 7-9 questions with nearly all questions requiring a numerical solution (use of a calculator). The final exam, which is given on the date and time set by the University, is comprehensive (covers Parts I-III), and accounts for 30% of the grade in the course. The final exam generally consists of 9-11 questions with nearly all questions requiring a numerical solution (use of a calculator). Usually, all of the exams given in the course have an attached page that gives formulas, relationships, and other data that are important for answering questions on the exam. A full set of exams from the previous year along with solutions can be found on the website for the course.

During exams, cell phones and PDAs with phone and text messaging capabilities must be hidden from view and inaudible during the exam. *If a student is observed using a cell phone or PDA during the exam, even as a calculator, a grade of zero will be give for the exam.*

Homework Assignments: There are 4 homework assignments in the course which are worth 22% of the total grade. For the first three assignments, HW-1, HW-2, and HW-3, each student is given his or her own structure which must be constructed, manipulated and/or analyzed using the molecular modeling program, HyperChem. This program can be accessed from computers located in LSC 215. *Since computer files will be saved and analyzed, the student is responsible for obtaining a storage device, e.g. a flash drive, for this purpose.*

The material submitted for grading for the first three homework assignments, HW-1-3, consists of digital files of molecules built/analyzed using the molecular modeling

program, HyperChem. *Due dates for homework assignments HW-1, HW-2, and HW-3 are 9 PM EST on the indicated date in the syllabus. These assignments are submitted for grading, as HyperChem files, via Blackboard*. The final homework assignment, HW-4, the "Mini-Project", is a written report on an assigned topic. The report, which has imbedded figures/images that were created using HyperChem is submitted for grading as a Word document via Blackboard with the due date, *Thursday November 19, at 9 PM EST*.

The grading scale for "on time" submissions for all homework assignments is 0 to 100%. If the student fails to submit the homework assignment on time, or the assignment was submitted on time but it is missing critical elements required for grading, the assignment will be considered "late" and a grading scale 0-75% will be applied. *Note that since Blackboard will only allow one submission for a given assignment, it is the student's responsibility to make sure that the transmitted files contain the information required for grading*. Assignments submitted more than *one week after the due date and time* will be considered a "missed assignment" and receive a *score of zero*. A student who has missed the deadline for a homework assignment, but who has a valid medical excuse and has *promptly* provided written documentation related to the excuse, will be subject to the grading policy stated above but the 25% penalty for the "late" period will be waived. The weightings for the homework assignments in the course are, HW1-3 (4% for each), HW4, the *Mini-Project*, (10%).

CHE 674. Students enrolled in CHE 674 can expect a greater number and more challenging questions on exams as well as more demanding homework assignments than their CHE 474 counterparts. Separate grading scales will be used for CHE 474 and CHE 674.

Examination Policies: The dates and times (9:30 AM to 10:50 AM) for the three hourly exams and the final exam are as indicated in the syllabus. *Except for the final exam there is no possibility to make up an exam*. A student with a valid medical excuse or a valid student-athlete excuse, who has missed one hourly exam, and who has *promptly* provided written documentation related to the excuse, can have the averages of the other two exams used as the score for the missing exam. A student with a second or third "miss" will receive a grade of zero for the additional missed hourly exam(s). If a student has a valid medical excuse or a valid student-athlete excuse for a missed final exam, a comprehensive make up final exam, 2 hours in length, may be taken for the missing grade. The documentation pertaining to the excuse must be presented promptly after the missed final exam and reasonable time must be allotted for preparing the make up final exam.

CHE 474 (fall 2009)

Date	Day		Lecture Subject (Page numbers refer to the text, T)
Sept.	1	Tues.	1. *Noncovalent Interactions*. pp. 97-100, 497-498, 503-512. Assign Practice Problem Set 1.Assign HW-1. Getting Started/Building a Drug Molecule.
	3	Thurs.	2. *Acid/Base Equilibria*. pp 163-165.
	8	Tues.	3. *Buffers/Ionic Strength*. p.141.
	10	Thurs.	4. *1st Law of Thermodynamics/Hess's Law*. pp 22, 48-50. Assign Problem Set 2.
	15	Tues.	5. *2nd Law of Thermodynamics/Chemical Potential* pp. 122-123.
	17	Thurs.	6. *Equilibrium Dialysis/Scatchard Equation*. pp. 197-202. HW-1 due. Assign HW-2. Studying the structure of DNA and RNA.
	22	Tues.	7. *Free Energy and Biological Systems/Activity*. pp 136-137.
	24	Thurs.	8. *Exam I*.
	29	Tues.	9. *Primary Structure of Nucleic Acids*. pp. 101-106. Assign Practice Problem Set 3.
Oct.	1	Thurs.	10. *Secondary Structure of Nucleic Acids*.
	6	Tues.	11. *Supercoiled DNA Structure and Properties*. HW-2 due. Assign HW-3. Studying the structure of proteins.
	8	Thurs.	12. No class
	13	Tues.	13. *Physical Properties of Nucleic Acids Melting*. pp. 643-645, 172-175
	15	Thurs.	14. *Physical Properties of Nucleic Acids*. *Chemical Kinetics/Rate Laws*. pp. 315-331, 338-339. Assign Practice Problem Set 4.
	20	Tues.	15. *Chemical Kinetics Rate Laws*.
	22	Thurs.	16. *Chemical Kinetics*. HW-3 due. Assign HW-4. Mini Project.
	27	Tues.	17. *Chemical Kinetics*. *Equilibrium and Kinetics*. pp 349.

	29	Thurs.	18. *Chemical Kinetics/Activation Energy* pp. 354-357.
Nov.	3	Tues.	19. *Exam II*.
	5	Thurs.	20. *Schrodinger Equation/Wave Mechanics*. *Particle in a Box*. pp. 436 - 463. Assign Practice Problem Set 5.
	10	Tues.	21. *Particle in a Box/The Hydrogen Atom*. pp. 469-476.
	12	Thurs.	22. *Many Electron Atoms/Molecular Orbitals* pp. 476-484.
	17	Tues.	23. *Hybridization/Molecular Structure and Molecular Orbitals* pp. 484-491.
	19	Thurs.	24. *Absorption Spectroscopy*. *Beer-Lambert Law*. pp. 530 - 544. Assign Practice Problem Set 6. HW-4, Mini-Project Due, 9 PM
	24	Tues.	25. *Absorption Spectroscopy/Quantitative Determinations*. pp. 544-547.
	26	Thurs.	Thanksgiving. No Lecture.
Dec.	1	Tues.	26. *Absorption Spectroscopy/Equilibrium*. pp. 548-553.
	3	Thurs.	27. *Absorption Spectroscopy/Proteins and Nucleic Acids*.
	8	Tues.	28. *Exam III*.
	10	Thurs.	29. *Review for Final Exam*.
	16	Wed.	*Final Exam*, 2:45-4:45 PM

Revised, 08/23/09