**CHEMISTRY 474/674**
**STRUCTURAL AND PHYSICAL BIOCHEMISTRY**
*Fall 2014*

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**Course information**: Blackboard.syr.edu

**The Course:** CHE 474/674 covers basic physical chemistry for the undergraduate biochemistry/physical science majors and graduate students with interests in the biochemical sciences. 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 and covers chemical kinetics and its application to biological systems. Part III of the course covers bonding in chemistry using quantum mechanics and analyzes the optical properties and absorption spectra of biological macromolecules.

In addition to discussing the physical and chemical properties of biological systems, students in CHE 474/674 have an opportunity to use the state-of-the-art molecular modeling program HyperChem in a computer laboratory to build and analyze structures of drugs, proteins, and DNA. In addition to viewing and analyzing structures, the modeling program is used to make figures of biological molecules that are incorporated into a short scientific paper describing the nature and function of a small molecule-macromolecule interaction.

**Required Text.**

*Physical Chemistry. Principles and Applications in Biological Sciences*, 5th. ed., Tinoco, Sauer, Wang, Puglisi, Harbison and Rovnyak, Pearson Education, Inc., Upper Saddle River, NJ, 2014. This text is denoted by **T**.

**Resource Texts.**

*Biochemistry*, Berg, J. M., et al. W. H. Freeman and Co., New York, latest edition. This text, which is mainly descriptive, covers the structure and function of DNA, RNA, and proteins. This resource is denoted by **B**.

*Biochemistry*, Mathews, C. K., et al., Addison Wesley Longman, Inc., San Francisco, latest edition. This physically oriented general biochemistry text covers many topics addressed in CHE 474/674. This resource is denoted by **M**.

**Course Organization:** Structural and Physical Biochemistry, CHE 474/674, consists of four components: lecture, practice problems, exams, and homework assignments.

**Lecture (LSB 105):** The lecture material in the course is collected from the texts, **T**, **B**, and **M**, selected research articles, other publications and graphics obtained from websites and the published literature. The early part of the course applies basic principles learned in general chemistry to problem solving in physical biochemistry. 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.

In order to preserve the learning environment of the lecture portion of the course, it is the policy of the course and the University that cell phones, computers or other electronic devices be hidden from view, inaudible and not in any way be in use. *A student violating this rule will be asked to leave the lecture room.*

**Practice Problems:** CHE 474/674 has an extensive series of "practice problems" with solutions posted on Blackboard. These problems 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 questions will often be related to but not identical to the practice problems, 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 toward a grade in the course are allotted for solving the practice problem sets.*

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 (LSB 105):** Three exams, each weighted 17% 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 of 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 27% of the grade in the course. The final exam generally consists of 9-11 questions with the majority of questions requiring a numerical solution (use of a calculator). All of the exams given in the course have an attached section 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 given for the exam.*

**Homework Assignments (LSB 215):** There are 4 homework assignments in the course which collectively constitute 22% of the total grade in the course. 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. The description of each assignment is available on Blackboard and the HyperChem program for doing the assignment can be accessed from computers located in LSB 215. *Since computer files will be saved and analyzed, the student is responsible for obtaining a storage device, e.g. a flash drive, DVD, etc., 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 plus a brief word document both of which are uploaded to Blackboard. *Due dates/deadlines for homework assignments HW-1, HW-2, and HW-3 are 9 PM EST on the date indicated in the syllabus. If errors are discovered on an assignment after it has been submitted to Blackboard, it is possible to resubmit a corrected version of the assignment to Blackboard so long as the resubmission has ALL of the parts of the assignment (even those parts that did not require correction) and is submitted to Blackboard before the deadline.* The final homework assignment, HW-4, the "Mini-Project", is a written report on an assigned topic. HW-4, which has imbedded figures/images that were created using HyperChem, is submitted for grading as a PDF document via Blackboard by date/time specified in the syllabus.

The grading scale for "on time" submissions (as determined by the 9 PM "time stamp" on the document) for all homework assignments is 0 to 100%. If the student fails to submit the homework assignment or any part of it on time, the assignment will be considered "late" and a grading scale 0-75% will be applied. Assignments (HW1-3) submitted more than *one week after the due date and time* will be considered a "missed assignment" and receive a *score of zero*. *There is no "late" grading scale for the final homework assignment (HW4, the mini project) which is due on the date/time specified*. 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 are as indicated in the syllabus. **There is no possibility to make up an hourly exam in CHE 474/674.** A student presenting a *valid excuse* (defined below) who has missed one hourly exam, can have the averages of the remaining two hourly exams used as the score for the missed hourly exam. A student with a second or third "miss" will receive a grade of zero for the additional missed hourly exam(s). *In order to receive a passing grade in CHE 474/674, a student must take the comprehensive final exam.* A student who fails to take the comprehensive final exam at the scheduled date and time, may gain the right to take a make-up final exam (2 hours in length) provided that a valid excuse is presented.

**A valid excuse:** A valid excuse is a written and dated document that is presented to the instructor *within three days of the missed exam*. A valid medical excuse must *be signed by a physician* and it must be evident from the excuse that the student was unable to write

the exam at the specified date/time. A valid student-athlete excuse is an official document provided to the instructor by the Athletic Office stating the reason for the absence.

**Academic Integrity:** Complete academic honesty is expected of all students. Any incidence of academic dishonesty, as defined by the SU Academic Integrity Policy (see http://academicintegrity.syr.edu), will result in both course sanctions and formal notification of the College of Arts & Sciences. In this course, students are allowed and encouraged to work and study together, but all assignments turned in must be the work of the individual student and may not be copied from another student's work the text, or any other source, except for short quotations with proper attribution.

**Disability Accommodation:** If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS), http://disabilityservices.syr.edu, located in Room 309 of 804 University Avenue, or call (315) 443-4498 or TDD: (315) 443-1371 for an appointment to discuss your needs and the process for requesting accommodations. ODS is responsible for coordinating disability-related accommodations and will issue students with documented Disabilities Accommodation Authorization Letters, as appropriate. Since accommodations may require early planning and generally are not provided retroactively, please contact ODS as soon as possible.

**SU's religious observances policy**, found at http://supolicies.syr.edu/emp_ben/religious_observance.htm, recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holy days according to their tradition. *Note that travel periods before and after the actual religious observance are not considered excusable periods for missed work.*

## *CHE 474/674 (Fall 2014)*

| **Date** | | **Day** | **Lecture Subject (Page numbers refer to the text, T)** |
|---|---|---|---|
| Aug. | 26 | Tues. | 1. *Non-covalent Interactions.* pp. 80-83, 466-467, 472-480. Practice Problems 1. Assign HW-1. Getting Started/Building a Drug Molecule. |
| | 28 | Thurs. | 2. *Acid/Base Equilibria*. pp 133-135. |
| Sept. | 2 | Tues. | 3. *Buffers/Ionic Strength.* p.118-119. |
| | 4 | Thurs. | 4. *1st Law of Thermodynamics/Hess's Law.* pp 19, 40-41. Practice Problems 2. |
| | 9 | Tues. | 5. *2nd Law of Thermodynamics/Partial Molar Gibbs Energy/Chemical Potential* pp. 102-104. |
| | 11 | Thurs. | 6. *Equilibrium Dialysis/Scatchard Equation.* pp. 208-213. HW-1 due. Assign HW-2. Studying the structure of DNA and RNA. |
| | 16 | Tues. | 7. *Free Energy and Biological Systems/Activity.* pp. 105-107, 112-114. |
| | 18 | Thurs. | 8. *Problem solving.* |
| | 23 | Tues. | 9. *Exam I.* (9:30 – 10:50 AM, LSB 105) |
| | 25 | Thurs. | 10. *Primary and Secondary Structure of Nucleic Acids.* pp. 83-87-106. Practice Problems 3. |
| | 30 | Tues. | 11. *Supercoiled DNA Structure and Properties.* HW-2 due. Assign HW-3. Studying the structure of proteins. |
| Oct. | 2 | Thurs. | 12. *Physical Properties of Nucleic Acids Melting.* pp. 179-180, 172-175. |
| | 7 | Tues. | 13. *RNA Structure and Equilibrium*. |
| | 9 | Thurs. | 14. *Thermodynamics of DNA Melting*. |
| | 14 | Tues. | 15. *Chemical Kinetics/Rate Laws.* pp. 305-321, 325-326. Practice Problems 4. |

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| | 16 | Thurs. | 16. *Chemical Kinetics/Rate Laws*.<br>HW-3 due. Assign HW-4. Mini Project. |
| | 21 | Tues. | 17. *Chemical Kinetics and Equilibrium*. pp. 333-334. |
| | 23 | Thurs. | 18. *Chemical Kinetics/Temperature.* pp. 338-344. |
| | 28 | Tues. | 19. *Exam II.* (9:30 – 10:50 AM, LSB 105) |
| | 30 | Thurs. | 20. *Schrodinger Equation/Wave Mechanics. Particle in a Box.* pp. 408 - 416. General Reading pp. 416-429, 434-444. Practice Problems 5. |
| Nov. | 4 | Tues. | 21. *Particle in a Box/Hydrogen Atom/Hybridization.* |
| | 6 | Thurs. | 22. *Molecular Structure and Molecular Orbitals* pp. 453-457. |
| | 11 | Tues. | 23. *Optical Spectroscopy. Beer-Lambert Law*. pp. 489 - 502. Practice Problems 6. |
| | 13 | Thurs. | 24. *Absorption Spectroscopy/Quantitative Determinations.*<br>HW-4, Mini-Project Due, 9 PM |
| | 18 | Tues. | 25. *Absorption Spectroscopy/Equilibrium/Proteins Nucleic Acids.* Pp. 502-507. |
| | 20 | Thurs. | 26. *Exam III*. (9:30 – 10:50 AM, LSB 105) |
| | 25 | Tues. | Thanksgiving Break. No lecture. |
| | 27 | Thurs. | Thanksgiving Break. No Lecture. |
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| Dec. | 2 | Tues. | 27. *Fluorescence.* pp. 507-520. |
| | 4 | Thurs. | 28. *Fluorescence.* |
| | 12 | Fri. | *Final Exam*, 5:15-7:15 PM, LSB 105 |