Chemistry 565 / 665
BIOPHYSICAL CHEMISTRY

- Spring 2003 -

LECTURE: 9:55 – 10:45 a.m. MTRF, B383 Chemistry

LECTURER: Prof. Silvia Cavagnero
Office: 8108 New Chemistry Building
(will be 5341 Daniels Chemistry Building)
Phone: 262-5430
Email: cavagner@chem.wisc.edu

OFFICE HOURS: M, R 11:00 - 11:50 a.m. and by appointment

TEACHING ASSISTANT: Eric Fulmer
Office: 8131 New Chem. Bldg.
(will be 5365 Daniels Chemistry Building)
Phone: 265-7948
Email: fulma55@hotmail.com

TA OFFICE HOURS: M, F 2:00 – 3:00 p.m. and by appointment

COURSE WEB SITE: genchem.chem.wisc.edu/physical/cavagnero/pcourse.asp
You can either type the above or get to the course web site by following this path: www.chem.wisc.edu → Education → Course Pages → Current Courses

BIOPHYSICAL CHEMISTRY WEB SITE: http://www.library.wisc.edu/libraries/chemistry/biophysics/biophysicshome.htm

---

INTRODUCTION

Chemistry 565 / 665 is an introductory class on equilibrium thermodynamics and chemical kinetics with emphasis to biological applications. Issues of particular interest are the concept of entropy, enthalpy and free energy, the kinetics of complex reactions, the non covalent forces that determine protein and nucleic acid stability (particularly the hydrophobic effect, electrostatic interactions and the hydrogen bond) and the folding and misfolding kinetics of proteins and nucleic acids.

TEXTBOOK AND OTHER REQUIRED MATERIAL

1. Dill & Bromberg, *Molecular Driving Forces*, Garland Science, 2003.
2. An inexpensive calculator. It should have capabilities for square roots, logarithms and exponential operations. The calculator will be used on exams and homework assignments. A programmable calculator will not be allowed during exams.

ADDITIONAL USEFUL READING

Handouts distributed in class;
Tinoco, Sauer, Wang and Puglisi, *Physical Chemistry: Principles and Applications in Biological Sciences*, Pearson Education, 2001;
Van Holde, Johnson and Ho, *Principles of Physical Biochemistry*, Prentice Hall, 1998;
Hammes, *Themodynamics and Kinetics for the Biological Sciences*, Wiley& Sons, 2000;
Connors, *Chemical Kinetics, The study of Reaction Rates in Solution*, VCH, 1990;
Fersht, *Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding*, Freeman, 1999;
Daune, *Molecular Biophysics: Structures in Motion*, Oxford Un. Press, 1999;
Eisenberg and Crothers, *Physical Chemistry with Applications to the Life Sciences*, Addison-Wesley, 1979;
Cantor and Schimmel, *Biophysical Chemistry, Parts 1, 2 and 3*, Freeman, 1980;
Klotz and Rosenberg, *Chemical Thermodynamics*, Wiley & Sons, 1994;
Jencks, *Catalysis in Chemistry and Enzymology*, Wiley & Sons, 1975;
Klotz, *Ligand-Receptor Energetics*, Wiley & Sons, 1997;
Weber, *Protein Interactions*, Chapman & Hall, 1992;
Espenson, *Chemical Kinetics and Reaction Mechanisms*, Mc Graw Hill, 1995;
Creighton, *Proteins: Structures and Molecular Properties*, Freeman & Co., 1992;
Crothers, Bloomfield, Tinoco, *Nucleic Acids, Structures, Properties and Functions*, University Science Books, 2000;
Nelson and Cox, *Lehninger Principles of Biochemistry*, Worth, 2000;
Stryer, *Biochemistry*, Freeman, 1995.

COURSE INFORMATION

Lectures. During lectures we will discuss principles, and illustrate them with examples. You should take your own notes during lecture. In addition, a set of lecture notes taken by a Teaching Assistant (TA) will be available on the web (see course website above).

Lecture Schedule. The Biophysical Chemistry (Chem 565/665) lectures are on Mondays, Tuesdays, Thursdays and Fridays at 9:55 am. Please check the course outline (which follows) for a detailed schedule of the lectures.

Textbook. The textbook supplements the lectures. It provides background material for the lectures and also works out many relevant examples. In addition, at the end of each chapter are a number of problems. For an understanding of the material in this course it is important to solve as many of these problems as possible. Plan to buy your own textbook. A reference copy of the textbook is available for consultation in the Chemistry library. This library also contains a copy of the Additional Useful Reading material listed above.

Problems. For each chapter a set of especially relevant problems is assigned. The formation of study groups for working on problems is strongly encouraged. Difficulties with any problems should be discussed with your TA in the discussion sections. Your solutions to the problems are due in the TA mailbox on selected Mondays by 5 p.m. (see detailed schedule below). The problems will be graded by your TA. Answer Keys to the problems will be distributed during Discussion Sections on Wednesdays.

Discussion Section. Discussion sections are primarily for review and problem solving relevant to the recent lecture material. Your TA will go over some examples similar to the assigned problems. You should be prepared when you come to discussion section. Ask specific questions to your TA and plan to be interactive.

Exams. There will be two two-hour exams, one class presentation on a special topic in biophysical chemistry related to the course, and a two-hour final exam. Check the course outline (which follows) for the examination dates and times. The exams will primarily be based on the material presented in the lectures, and on material illustrated by the assigned problems. No make-up exams will be given. The final exam will be comprehensive, covering topics from the entire semester.

Oral Presentation. All students will independently work on a well defined special topic in biophysical chemistry of their choice. Example of possible special topics are: polymer dynamics, the hydrophobic effect, helix-coil transition theory, cooperative processes in biology, the effect of pressure on protein stability, ion pairs in biology, design of proteins with a desired fold and function, the thermodynamic effects of denaturing agents, secondary *vs* tertiary structure formation in protein folding, the diffusion-collision protein folding model, the Flory-Huggins model and its predictions on polymer behavior, the hydrophobic zipper protein folding model, the kinetics of hydrophobic collapse, water and its role in biology, protein folding landscapes: theory and experiments, mechanisms and kinetics of polypeptide aggregation, and so on. Plan to talk to Prof. Cavagnero well in advance to discuss your choice of special topic. The special topic will be presented to the class during the last two weeks of class according to the class schedule below. Either transparencies or a powerpoint presentation are recommended. A hard copy of your presentation panels is due to the teacher. Students taking the course as Chem 665 are also expected to write a short report on their special topic of choice.

Biophysical Chemistry Website. This web site contains a lot of valuable educational information on various areas of biophysical chemistry. Use it as a personal resource for learning more about this exciting field. This site also contains a collection of valuable database information for researchers involved in the biophysics field. A selected number of assigned homework problems will involve using this web site.

Grades. This course will be graded on a maximum of 100 points divided as follows:

Exam I	20 points
Exam II	20 points

Special Topic Presentation	10 points
Homework Questions	20 points
Final Exam	30 points
Total	100 points

Your course grade will be determined by the total number of points you have accumulated.

COURSE OUTLINE

DATE	TOPIC	CHAPTER	NOTES ON PROBLEM SETS
T Jan 21	Principles of Probability	1	
R Jan 23	Principles of Probability	1	
F Jan 24	Principles of Probability and Biophys. Chem. Website Presentation by Emily Wixson	1	Problem Set #1 Assigned
M Jan 27	Predicting Equilibrium in Chemistry and Biology	2	
T Jan 28	Predicting Equilibrium in Chemistry and Biology	2	
R Jan 30	Heat, Work & Energy	3	
F Jan 31	Heat, Work & Energy	3	
M Feb 3	Math Tools	4	Problem Set #1 Due
T Feb 4	Math Tools	4	
R Feb 6	TA Lecture on Problem Solving	--	
F Feb 7	TA Lecture on Problem Solving	--	Problem Set #2 Assigned
M Feb 10	Multivariate Calculus	5	
T Feb 11	Multivariate Calculus	5	
R Feb 13	Entropy & the Boltzmann Distr. Law	6	
F Feb 14	Entropy & the Boltzmann Distr. Law	6	

M Feb 17	Entropy & the Boltzmann Distr. Law	6	Problem Set #2 Due
T Feb 18	Thermodynamic Driving Forces	7	
R Feb 20	Thermodynamic Driving Forces	7	
F Feb 21	Thermodynamic Driving Forces	7	Problem Set #3 Assigned
M Feb 24	Thermodynamic Driving Forces	7	
T Feb 25	Free Energies	8	
R Feb 27	Free Energies	8	
F Feb 28	Free Energies	8	Problem Set #4 Assigned
M Mar 3	Maxwell's Relations and Mixtures	9	Problem Set #3 Due
T Mar 4	Maxwell's Relations and Mixtures	9	
R Mar 6	The Boltzmann Distribution Law	10	
F Mar 7	The Boltzmann Distribution Law	10	
M Mar 10	The Boltzmann Distribution Law	10	Problem Set #4 Due
T Mar 11	TA Lecture on Problem Solving	--	
R Mar 13	Review Lecture	--	
F Mar 14	**Exam I** (5:30 – 7:30 pm, room TBA)	--	
M Mar 17	Spring Recess - No Lecture	--	
T Mar 18	Spring Recess - No Lecture	--	
R Mar 20	Spring Recess - No Lecture	--	
F Mar 21	Spring Recess - No Lecture	--	
M Mar 24	Temperature and Heat Capacity	12	
T Mar 25	Temperature and Heat Capacity	12	
R Mar 27	Temperature and Heat Capacity	12	

F Mar 28	Chemical Equilibria	13	Problem Set #5 Assigned
M Mar 31	Chemical Equilibria	13	
T Apr 1	Heat Capacity and Protein Stability	--	
R Apr 3	Equilibria between Liquids, Solids & Gases	14	
F Apr 4	Equilibria between Liquids, Solids & Gases	14	
M Apr 7	Solutions and Mixtures	15	Problem Set #5 Due
T Apr 8	Solutions and Mixtures	15	
R Apr 10	Solvation and Phase Transfer	16	
F Apr 11	Solvation and Phase Transfer	16	Problem Set #6 Assigned
M Apr 14	Vector Calculus	17	
T Apr 15	Physical Kinetics	18	
R Apr 17	Physical Kinetics	18	
F Apr 18	Physical Kinetics	18	Problem Set #7 Assigned
M Apr 21	Chemical Kinetics & Transition States	19	Problem Set #6 Due
T Apr 22	Chemical Kinetics & Transition States	19	
R Apr 24	Chemical Kinetics & Transition States	19	
F Apr 25	Energy Landscapes & Protein Folding Kinetics	--	Problem Set #7 Due
M Apr 28	Review Lecture	--	
T Apr 29	**Exam II** (5:30 – 7:30 pm, room TBA)	--	
R May 1	Student Oral Presentations	--	

F May 2	Student Oral Presentations	--
M May 5	Student Oral Presentations	--
T May 6	Student Oral Presentations	--
R May 8	Student Oral Presentations	--
F May 9	Student Oral Presentations	--
R May 15	**FINAL EXAM** (12:25 – 2:25 pm, room TBA)	