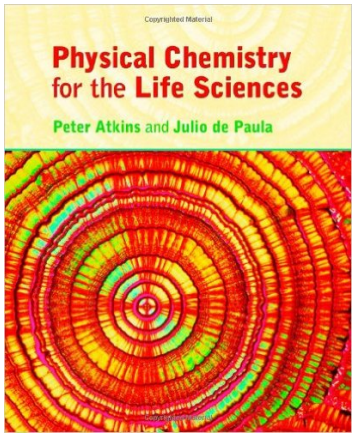
Physical Biochemistry

BIOL 4001, Fall 2019

Term: August 26 – December 7
Class times: TTh 9:00am – 10:20am
Location: 117 Tureaud Hall

Instructor: Michal Brylinski
E-mail: mbrylinski@lsu.edu
Website: www.brylinski.org
Office: 407 Choppin Hall

Office hours: Tue 3pm – 5pm
Thu 3pm – 5pm
or by appointment



Text: "Physical Chemistry for the Life Sciences" by Peter Atkins and Julio de Paula, first edition, Oxford University Press, ISBN-13: 978-0-1992-8095-7, ISBN-10: 0-1992-8095-9.

Additional recommended sources:

- "Physical Chemistry for the Chemical and Biological Sciences" by Raymond Chang, University Science Books, ISBN-13: 978-1-891389-06-1, ISBN-10: 1-891389-06-8
- "Principles and Problems in Physical Chemistry for Biochemists" by Nicolas C. Price, Raymond A. Dwek, R. George Ratcliffe and Mark R. Wormald, Oxford University Press, ISBN-10: 0198792816, ISBN-13: 978-0198792819

Course overview: The course objective is to introduce and develop physical concepts for biochemists by using ideas from physical chemistry (rather than pure mathematical formulations) to exemplify biochemically relevant phenomena. The desired outcome is for students to gain a basic understanding of how solution dynamics, thermodynamics, kinetics, and spectroscopy can be applied to biochemical problems. In addition, the course aims to provide a solid background in physical biochemistry for those students who wish to pursue further study in this field of science. Progress will be assessed through homework assignments, in-class discussions, quizzes and exams. This 3-credit hour course requires a minimum of 6 hours (on average)/week outside class work/study.

Homework: Problems will be assigned from the textbook and other sources. These will be collected and graded. You may discuss homework assignments with your classmates or use online resources for help, but you must submit your own work. Homework is due in no later than 5pm on the due date.

Equation sheets: During quizzes and exams, you will be allowed to use an equation sheet, which needs to be approved by the instructor. It can include only equations, numerical data, physicochemical constants and conversion factors. Definitions, graphs, concepts, example calculations, etc., are not allowed.

Grading policy:
Homework 20%
Quizzes 20%
Midterm 25%
Final 35%

Makeup quizzes and exams: PS-22 applies (https://www.lsu.edu/policies/ps/ps_22.pdf).

Extra points: You have the following opportunities to earn extra points that will be added to your score (on quizzes and exams):

- Solving problems on the board
- Attending classes

Presentations: The instructor welcomes volunteers willing to give a short (~20 min) presentation on a selected topic relevant to p-chem.

Tentative schedule:

Intro

- **Week 1, 2:** Fundamentals

Biochemical Thermodynamics

- **Week 3, 4:** The First Law
- **Week 5, 6:** The Second Law
- **Week 7, 8:** Phase Equilibria
- **Week 9, 10:** Chemical Equilibrium
- **Week 11, 12:** Ion and Electron Transport

The Kinetics of Life Processes

- **Week 13, 14:** The Rates of Reactions

Students with disabilities: If any student feels that he/she has a disability and needs special accommodations of any nature whatsoever, the instructor will work with you to provide reasonable accommodations to ensure that you have a fair opportunity to perform in this class. Please advise the instructor of such disability and the desired accommodations at some point before, during or immediately after the first scheduled class period.

FAQ

Why should biochemistry students study p-chem?

We may define biochemistry as the field of science comprising the knowledge of the properties of chemical reactions and physical processes also involving molecules of biological interest. Under this definition we can easily understand the importance of knowing basic physical principles, which ultimately explain the driving forces defining both the feasibility and rates of chemical and physical processes. Chemical reactions and physical interactions are responsible for the function, malfunction, or death of individual cells or multi-cellular organisms. We can see, then, that as our knowledge of the physical principles governing biological processes improves so does our ability to understand biology, physiology and even medicine.

Why do schools require a course in p-chem for students pursuing a degree in biochemistry?

An elementary class of p-chem is a key element of a plan of study designed for a degree in biochemistry and/or molecular biology. Basic elements of physical chemistry are needed to understand protein synthesis and folding, protein stability, protein-protein interaction, protein-ligand interactions, biogenesis of membranes, lipid-lipid and lipid-protein interactions, enzyme kinetics, RNA or DNA synthesis, protein-nucleic acid interactions, control of metabolic pathways, membrane potential and excitability, etc.
P-chem gives you the opportunity to understand why something happens. Without it you may know a few facts, you may have information. However, you will not have the knowledge to predict a similar occurrence under similar circumstances.

How can p-chem benefit my career?

- **Medicine:** An elementary class of physical chemistry will greatly benefit students planning on attending medical school. The greater the depth of the physical chemical perspective of a medical student the easier will be the understanding and memorization of important medical topics. The information and rationale provided by a p-chem course contribute to the global education of medical doctors increasing their knowledge and improving the common sense that cannot be achieved in a formation based only on information. For example thermodynamics is a key element in the understanding, research and practice of sports physiology; p-chem will enhance the ability to understand the complex processes of ion and water transport in kidney, or the delicate acid-base equilibrium in blood that must be carefully monitored and balanced to allow the survival of numerous intensive care patients; similarly, the students will be better prepared to understand the phenomena of gas and water exchange that takes place in lungs and the role of the composition of the breathing atmosphere in the acid-base equilibrium and oxygenation of blood.

- **Research in biosciences:** Successful experimental research in biosciences, such as that required for students pursuing a Ph.D. in biochemistry, requires the consideration of the possible

interactions and effects among the components and conditions of a reaction mixture: solvent, salts, pH, protein, lipids, RNA, DNA, substrates, temperature, etc.

- **Biotechnology:** Physics and chemistry are also essential disciplines for the advancement of biotechnology. Students pursuing a career in biotechnology will be highly benefited by a strong physical chemical background. Food processing, or food technology, is based on the physical chemical manipulation of mixtures of proteins and lipids, among other components, to achieve products of different physical properties.

- **Pharmaceutical sciences:** A successful career will be more likely for graduates with strong backgrounds in physical chemistry. Most experimental and theoretical approaches used in the pharmaceutical industry to design, discover and test potentially useful drugs require physical chemical methods.