Fall 2017

BC411 – Physical Biochemistry

Instructors: Dr. Olve Peersen — Dr. P. Shing Ho

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Course Description

BC411 is delivered as a face-to-face course, and covers fundamental concepts of physical chemistry and their application to understanding the behavior of biological systems. It is aimed at providing the student with an appreciation for the basic laws of thermodynamics, biochemical equilibria, reaction rates and kinetics in biological reactions, introductory quantum theory, and molecular spectroscopy.

Learning Outcomes and Assessment

Students are expected to learn the applications of quantitative and experimental methods to study and understand biochemical processes. Students are expected to enter the course with a background in chemistry, physics, biology, mathematics (up to and including calculus II), and one full year of comprehensive biochemistry. Thus, students enrolled in BC411 will demonstrate the ability to understand the foundational principles from which fundamental biochemical processes are derived; understand how to interpret equations, formulas, and concepts that underlie these principles; and apply these equations, formulas, and concepts to conceptually understand various biochemical processes and solve problems based on experimental observations and quantitative data.

Class hours: BC411 Lectures Mon–Tue–Wed 9:00–9:50 AM in Biology 136
BC411 Recitation Thu 9:00–9:50 AM in Clark A202

Office hours:

Dr. Ho:	Friday, 1:00 – 1:50 PM in MRB 375
Dr. Peersen:	Friday, 1:00 – 1:50 PM in MRB 341
Rhea Rowe:	Tuesday, 2:30 – 5:30 PM in MRB 250

Pre/Co-requisites: Biochemistry (BC401, or BC351 with instructor approval)
CHEM113, MATH161 or MATH255.

Text: *The Molecules of Life* (2012) by Kuryan, Konforti & Wemmer; Garland Science
NOTE: E-book versions are available for purchase or rental from both Amazon and Garland Science: http://www.garlandscience.com/product/isbn/9780815341888

Recommended: *Physical Chemistry for the Biosciences* (2005) by Raymond Chang

ChemWiki QM:
https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Quantum_Mechanics

X-ray Crystallography: Chapter 6, van Holde, Johnson, and Ho (CANVAS)

Grading: The traditional grading (A, B, C…) system will be used. Grades in BC411 will be based on four exams (15% each), a two-hour comprehensive final (25%), and weekly problem sets (15%). Students are expected to devote 6 hours each week to complete the assigned homework. A portion of the homework grade will come from in-recitation presentations of answers to the problem sets.

CSU Student Honor Code: This course will adhere to the Academic Integrity Policy of the Colorado State University General Catalog {Page 7} and the Student Conduct Code.

BC411 Syllabus – Fall 2017

Date	Subject	Reading	Inst
Aug. 21	Introduction to Course & Thermodynamics	Syllabus – Ch 1	SH
23	Systems, Ideal gas equations	Ch 6A	SH
Wk1 24	*Recitation (Math concepts)*		RR
25	Thermodynamic Laws	Ch 6.3, 7, & 8	SH
Aug. 28	Free energy and solutions/Standard State	Ch 7 & 8	SH
30	Intro macromolecular structure/Protein Folding	Ch 8 & 9	SH
Wk2 31	*Recitation*		RR
Sept. 1	Non-covalent interactions	Ch 10A & 10B	SH
Sep. 4	**Labor day – no class**		SH
6	Ramachandran Diagram	Ch 9.10 & 9.11	SH
Wk3 7	*Recitation*		RR
8	Experimental Thermodynamics *End for Exam I*	Ch 10D	SH
Wk4 11	Quantum chemistry: Introduction/QM Math	*ChemWiki QM1 & 2*	SH
13	Quantum chemistry: Light/ Particle in 1-D box	*ChemWiki QM 3*	SH
14	**Exam I**		SH
15	Quantum chemistry: Particle in 1-D box	*ChemWiki QM5.5*	SH
Sep. 18	Quantum: Quantum tunneling/Harmonic oscillator	*ChemWiki QM 5.5, 2*	SH
20	Quantum: Hydrogen atom **BC463 EXAM**	*ChemWiki QM 6*	SH
Wk5 21	*Recitation*		SH
22	Quantum: Hydrogen atom/Atomic Orbitals	*ChemWiki QM 9*	SH
Sep. 25	Molecular Orbital theory	*ChemWiki QM 11*	SH
27	Electronic spectroscopy (absorption & emission)	*ChemWiki Spec*	SH
Wk6 28	*Recitation*		SH
29	Selection rules	*ChemWiki Spec*	SH
Oct. 2	Polarization/CD Spectroscopy *End for Exam II*	*ChemWiki Spec*	SH
4	X-ray crystallography: Crystals	Supplem (*vJH Ch 6*)	SH
Wk7 5	**Exam II**		SH
6	X-ray crystallography: Diffraction	Supplem (*vJH Ch 6*)	SH
Oct. 9	X-ray crystallography: The Phase Problem	Supplem (*vJH Ch 6*)	SH
11	Nuclear Magnetic Resonance (NMR) of proteins	Supplemental	OP
Wk8 12	*Recitation*		RR
13	Protein structure by multidimensional NMR	Supplemental	OP
Oct. 16	Mass spectrometry	Supplemental	OP
18	Mass spectrometry **BC463 EXAM**	Supp + Ch 18.8–.9	OP
Wk9 19	*Recitation*		RR
20	Molecular Recognition – Ligand binding *End for Exam III*	Ch 12A (12.1–.11)	OP
Oct. 23	Fine tuning molecular recognition – affinity & specificity	Ch 13A (13.1–.9)	OP
25	*Recitation*	Ch 15A (15.1–.10)	RR
Wk10 26	**Exam III**		OP
27	Kinetics – General principles for rates of processes	Ch 15B (15.11–18)	SH
Oct. 30	Reversibility, equilibrium, and steady states	Ch 15C (15.19–.24)	OP
Nov. 1	Rate constants	Ch 15C (15.25–.30)	OP
Wk11 2	Catalysis and activation energy		OP
3	Enzyme catalysis – Michaelis-Menten Kinetics	Ch 16A (16.1–.8)	OP
Nov. 6	Complex enzymatic reactions and inhibition	Ch 16B (16.9–.17)	OP
8	Protein and RNA Enzyme mechanisms	Ch 16CD (16.18–36)	OP
Wk12 9	*Recitation*		RR
10	Allostery and biological responses *End for Exam IV*	Ch 14A (14.1–.9)	OP
Nov. 13	**Exam IV**		OP
15	Protein-Protein Interactions **BC463 EXAM**	Ch 13B (13.10–.21)	OP
Wk13 16	Protein-Nucleic Acid Interactions	Ch 13C (13.22–33)	OP
17	Molecular Recognition – Drug binding	Ch 12B (12.12–.23)	OP

Nov 20-26	**Fall Break week – no classes**		
Nov. 27	Molecular movements – random walks and diffusion	Ch 17.1–.23	OP
29	Membranes: Composition and Structure I	Ch 3B (3.13–.23)	OP
Wk14 30	*Recitation*		RR
Dec. 1	Membranes: Composition and Structure II	Ch 3B (3.13–.23)	OP
Dec. 5	Membrane Proteins	Ch 4D (4.31–.44)	OP
6	Membrane proteins, Enzyme mechanisms	Ch 16C (16.18–.21)	OP
Wk15 7	*Recitation*		RR
8	Protein structure conservation & Evolutionary Variation	Ch 5CD (5.12–.27)	OP
Dec. 11 ***Monday***	**Final Exam** **7:30 – 9:30 AM in Biology 136** **OR** **9:40 – 11:40 AM in Clark A202** Approximately half of the final exam will be on material since Exam IV and the other half will be comprehensive over the full semester		

Additional useful resources for the course (<u>not required</u>):

Principles of Physical Biochemistry, 2nd Ed., by van Holde, Johnson, and Ho (2006) (vJH).

Principles and Problems in Physical Chemistry for Biochemists
by Price, Dwek, Ratcliffe & Wormald (2002)