## BC411 – Physical Biochemistry Fall 2019


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**Course Description**
BC411 is delivered as a face-to-face course that 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, quantum mechanics, biochemical equilibria, reaction rates and kinetics in biological reactions, 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 (including calculus), 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–Wed–Fri 9:00–9:50 AM in Biology 136
BC411 Recitation **1:** Thu 9:00–9:50 AM in Clark A202
BC411 Recitation **2:** Thu 2:00–2:50 PM in Pathology 109

**Office hours:**
Dr. Ho: Friday, 2:00 – 2:50 PM in MRB 375
Dr. Sreerama: Wednesday, 8:00 – 8:50 AM in A/Z E206F
Dr. Cohen: Friday, 2:00 – 2:50 PM in MRB 273
Tom Cast: Wednesday, 1:30 – 3:30 PM in MRB 250
Ryan Czarny: Tuesday, 1:30 – 3:30 PM in AZ E210

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

**Text:** ***Biophysical Chemistry*** (2017) by Klostermeier & Rudolph; CRC Press, Taylor & Francis Group

**Grading:** The traditional grading (A, B, C…) system will be used. Grades in BC411 will be based on six exams (15% each) and weekly problem sets (10% total); there is no cumulative final exam. 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 2019

| *Date* | *Subject* | *Reading* | *Inst* |
|---|---|---|---|
| Aug. 26 | Introduction to Course & Thermodynamics | Syllabus – Ch 1 | SH |
| 28 | Systems, Ideal gas equations | Ch 2.1 | SH |
| **Wk1** 29 | *Recitation (Math concepts)* | | GTA |
| 30 | Ideal Gases/Thermodynamic Laws 1 | Ch 2.2 | SH |
| Sept. 2 | **Labor day – no class** | Ch 2.3 | --- |
| 4 | Thermodynamic Laws 2 | Ch 2.4 | SH |
| **Wk2** 5 | *Recitation* | | GTA |
| Sept. 6 | Free Energy/Solution State Thermodynamics | Ch 2.5, 3, 4 | SH |
| Sep. 9 | Experimental Thermodynamics *End for Exam I* | Ch 5 | SH |
| 11 | Quantum Mechanics Intro/Light | Ch 19.1-19.2.2 | SH |
| **Wk3** 12 | *Review* | | GTA |
| 13 | **Exam I** | | SH |
| Sep. 16 | Quantum Mechanics: Particle in 1-D box | *ChemWiki QM1 & 2* | SH |
| 18 | Quantum Mechanics: Particle in 1-D box/QM Tunneling | *ChemWiki QM 3* | SH |
| **Wk4** 19 | *Quantum Mechanics Math* | | SH |
| 20 | Quantum chemistry: Harmonic oscillator | *ChemWiki QM5.5* | SH |
| Sep. 23 | Quantum chemistry: Hydrogen atom | *ChemWiki QM 5.5, 2* | SH |
| 25 | Quantum: Hydrogen atom/Atomic Orbitals | *ChemWiki QM 6* | SH |
| **Wk5** 26 | *Recitation* | | GTA |
| 27 | Quantum: Molecular Orbitals/QM Biology *End for Exam II* | *ChemWiki QM 9* | SH |
| Sep. 30 | **Exam II** | | NS |
| Oct. 2 | Free Energy & Intro to Macromolecular Structure | Text 223-236; | NS |
| **Wk6** 3 | *Recitation* | 251-263 | GTA |
| 4 | Noncovalent Interaction and Structure | | NS |
| Oct. 7 | Ramachandran Plot; Protein Folding | 279-296 | NS |
| 9 | Molecular Dynamics; Protein Folding | 348-357 | NS |
| **Wk7** 10 | *Recitation* | | GTA |
| 11 | Absorbance, Biological chromophores | 365-377 | NS |
| Oct. 14 | UV/VIS absorbance, Protein Quantification | 380-381;384-386 | NS |
| 16 | CD spectroscopy | 390-398 | NS |
| **Wk8** 17 | **Exam III** | | NS |
| 18 | Fluorescence Spectroscopy | 404-415; 422; TBD | NS |

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|---|---|---|---|
| Oct. 21 | NMR – Principles, chemical shifts, 2D | 461-484; 489 | NS |
| 23 | NMR – COSY, NOESY, applications | | NS |
| **Wk9** 24 | *Recitation* | | GTA |
| 25 | Crystallography – basics, symmetry | 536-556; 562-568 | NS |
| Oct. 28 | Crystallography – x-ray diffraction, Miller planes | 515-519 | NS |
| **Wk10** 30 | Crystallography – phases, Patterson and density maps | | NS |
| 31 | *Recitation* | | GTA |
| Nov. 1 | **Exam IV** | | NS |
| Nov. 4 | Kinetics – General principles for rates, reaction orders | | RC |
| 6 | Kinetics – Half-lives, sequential reactions | Ch 6, 7, & 8 | RC |
| **Wk11** 7 | *Recitation* | | GTA |
| 8 | Reversibility, equilibrium, steady state | Ch 9, 10 | RC |
| Nov. 11 | Rate constants, catalysis and activation energy | | RC |
| 13 | Enzyme catalysis – Michaelis-Menten kinetics | Ch 11, 13, 14 | RC |
| **Wk12** 14 | *Recitation* | | GTA |
| 15 | Enzymatic reactions and inhibition (I) | | RC |
| Nov. 18 | Enzymatic reactions and inhibition (II) *End for Exam V* | | RC |
| 20 | Affinity, avidity, and specificity | | RC |
| **Wk13** 21 | *Recitation* | | GTA |
| 22 | **Exam V** | | RC |
| 25 | **Thanksgiving – no class** | | RC |
| 27 | **Thanksgiving – no class** | | RC |
| **Wk14** 28 | **Thanksgiving – no class** | | ---- |
| 29 | **Thanksgiving – no class** | | ---- |
| Dec. 2 | Allostery, cooperativity, and biological responses | *Supplemental* | RC |
| 4 | Molecular recognition; drug binding | | RC |
| **Wk15** 5 | *Recitation* | | GTA |
| 6 | Membrane composition and structure | Ch 16 | RC |
| Dec. 9 | Mass spectrometry | Ch 26.1; | RC |
| 11 | Proteomics using mass spectrometry *End for Exam VI* | *supplemental* | RC |
| **Wk16** 12 | *Recitation* | | GTA |
| 13 | **Exam VI** | | RC |