

Chemistry 341 (01:160:341)

Physical Chemistry: Biochemical Systems, Spring 2024

Synopsis:

This course is the first part of a two-semester physical chemistry course designed for students with a biology-oriented interest. We will revisit many of the concepts that were introduced in General Chemistry (CHEM 161/163;162/164), focusing on understanding the **physical principles** and the **biological applications** of these concepts. The goal of the class is (1) to learn to think quantitatively about biological measurements and (2) to understand how quantitative biophysical and biochemical measurements are made.

Hours and Location:

Lectures: Tuesday & Thursday 2:00 pm – 3:20 pm, ARC-204 (Allison Road Classroom)
First class will meet on Tuesday, Jan. 16th.

Instructors:

Lecture: Dr. Zheng Shi, zheng.shi@rutgers.edu

Office hours: Tuesday & Thursday, 3:30 pm – 4:30 pm, CCB-4220

Materials:

(Required) **Physical Chemistry for the Life Sciences**, 3rd Edition (2023), by Peter Atkins, Julio de Paula, George Ratcliffe, and Mark Wormald

(Optional) *Physical Biology of the Cell*, 2nd Edition (2012), by Rob Phillips, Jané Kondev, Julie Theriot, Hernan Garcia, Jane Kondev

Course website:

Via Canvas: <https://rutgers.instructure.com/courses/261927>. Course materials will be posted the day before each lecture to weekly Modules. Please be aware that you are expected to review all any information published through this course site, even if it has not been formally announced during class time.

Course Format:

This course will have two lectures on Tuesday and Thursday afternoons, including (occasional) poll questions and experimental demonstrations related to course materials. There will be 7 homework assignments throughout the course. Homework assignments will generally be released before the beginning of a new chapter and will be due every other Tuesday according to the schedule below. You may collaborate with each other on the homework problems, but each student must independently complete and turn in their own assignment.

This course will have **one midterm exam** (80 minutes duration, held during class time) and **one cumulative final exam** (3 hours duration). There will also be **a final project** focusing on *how a physical chemistry approach can be applied to study a problem in biology*. Students will extensively and critically review a topic related to this course, or propose a new experiment, or develop a new physical chemistry model for a known biological phenomenon. Each student will give a ~15 min presentation to the class followed by 5~10 min in-class discussion. The presenter is expected to address questions that arose during the discussion.

The exam and project presentation dates are provided in the schedule below. Students are responsible for making it to the exams on-time – there will be no make-up exams. The class period before each exam will be set aside for additional review of the relevant material. Remember to

bring the scientific calculator that you know how to use for all exams! Calculators with QWERT keyboard are not allowed.

Grading:

The grading for this course will be based on your performance on homework assignments, course project, and exams as the following:

Homework (7 total)	100* pts
Midterm	100** pts
Project	100 pts
Final Exam	200 pts
Total	500 pts

* Bonus points may be given in homework throughout the semester. Details will be announced during class time.

** Topics tested in the midterm will compose 1/2 of the final exam. One may choose to overwrite their midterm grades with their grades in the corresponding section of the final exam.

No grading curves will be used in this course. Your final grade will be based on percentages of total points accumulated (the exact cutoff between letter grades will be determined later in the semester). Participations in lecture and project presentation will be used to decide on borderline final grade assignments. Any questions or concerns about a graded assignment or assessment should be brought to the attention of the instructor within one week of receiving the grade.

Attendance:

Students are expected to attend, participate and remain engaged during class. Exams must be taken at the scheduled times. Only excusable reasons will be considered.

To be excused from an exam, you must provide a letter of excuse within 3 days of the exam from your Academic Dean. Unexcused missed exams will result in a score of zero for that exam. For excused exams, the score will be temporarily assigned as zero and will be replaced by the grade in the corresponding section of the final exam.

Special Needs:

Any student requiring extra time and/or other unusual testing accommodations must provide documentation supporting their circumstances and **MUST** notify the course Instructor. Please do this during the first week of classes or immediately after these needs are documented. ALL requests for extend time and/or other special accommodations for exams must be handled through the Office of Disability Services (<http://disabilityservices.rutgers.edu/>). The office of Disability Services will be responsible for all necessary proctoring arrangements.

Academic Integrity

Students must adhere to the university policies on academic integrity and student conduct in all assignments, assessments and other matters regarding this course. These policies can be found online: <http://studentconduct.rutgers.edu/academic-integrity/>. The faculty and staff at Rutgers are committed to your success. Students who are successful tend to seek out resources that enable them to excel academically, maintain their health and wellness, prepare for future careers, navigate college life and finances, and connect with the RU community. Resources that can help you succeed and connect with the Rutgers community can be found at success.rutgers.edu, and nearly all services and resources that are typically provided in-person are now also available remotely.

Course Schedule: (updated 1/5/24, subject to change)

Week #	Date	Topics	Book Sections	Activity
1	T · 01/16	Introduction. Role of physical chemistry in biology. Biomolecules; membranes. Characteristic sizes, times, and energies in biology.	Class notes. <i>PBoC Chapter 1- 4</i>	PS#0 Assigned
	Th · 01/18			
2	T · 01/23	The First Law. Conservation of energy; heat and work; heat capacity; Boltzmann distribution; two state systems; internal energy; equipartition theorem; enthalpy; phase transition.	PCfLS: FOCUS 1	PS #0 Due; PS#1 Assigned
	Th · 01/25			
3	T · 01/30	The Second Law. Entropy; the Third Law; spontaneous change; hydrophobic effect; biomolecular assembly; Gibbs energy.	PCfLS: FOCUS 2	PS#2 Assigned
	Th · 02/01			
4	T · 02/06	Aqueous solutions. Water; surface tension; chemical potential; Raoult's law; Henry's law; activity; colligative properties; osmosis.	PCfLS: FOCUS 3	PS #1 Due
	Th · 02/08			
5	T · 02/13	Chemical Equilibrium. Equilibrium constants; standard conditions; coupled reactions; K_a , K_b , pH; buffer; ligand binding; cooperative binding; avidity; mechanical equilibrium.	PCfLS: FOCUS 4	PS#3 Assigned
	Th · 02/15			
6	T · 02/20	Review		PS #2 Due
	Th · 02/22			PS#4 Assigned
7	T · 02/27	Midterm		
	Th · 02/29			
8	T · 03/05	Spring Break		PS #3 Due
	Th · 03/07			decide on project topic
9	T · 03/12			
	Th · 03/14			
9	T · 03/19	Ion and Electron transport. Debye-Huckel; membrane voltage; Goldman; action potential; galvanic cell; Nernst; electron transport chain.	PCfLS: FOCUS 5	PS #4 Due; PS#5 Assigned
	Th · 03/21			
10	T · 03/26	Reaction Rates. Rate laws; reaction order and mechanism; binding kinetics; protein folding; half time; kinetics and equilibrium; Arrhenius equation; transition state; enzyme; diffusion vs. activation.	PCfLS: FOCUS 6	PS#6 Assigned
	Th · 03/28			
11	T · 04/02			PS #5 Due

	Th · 04/04	Biochemical Kinetics. Michaelis-Menten; enzymatic reactions; random walk and diffusion; Fick's law; Stokes-Einstein; diffusion-limited reaction rate; chemotaxis; size of organisms/tumor; diffusion and flow.	PCfLS: FOCUS 7	
12	T · 04/09			PS #6 Due; PS#7 Assigned
	Th · 04/11			
13	T · 04/16	Project presentations		
	Th · 04/18			
14	T · 04/23		PS #7 Due	
	Th · 04/25	Final Review		
Tuesday 05/07		Final Exam: Tuesday May 7th, 12:00 – 3:00 pm		