Chemistry 761
Biophysical Chemistry
Spring 2019
Schedule Number 33711

COURSE INFORMATION

Class Days: Tue & Thur
Class Times: 7-8:15 pm
Class Location: EBA-408
Office Hours Times: TBD or email me to make an appointment, mswairjo@sdsu.edu
Office Hours Location: My office CSL-340

INSTRUCTOR INFORMATION

Manal A. Swairjo, Ph.D.
Associate Professor
Email: mswairjo@sdsu.edu
Web: http://www.chemistry.sdsu.edu/faculty/index.php?name=Swairjo
Office location: Chemical Sciences Laboratory, room 340 (SDSU map coordinates K3).

Course Overview

Course Description: The primary goal of this course is to provide graduate and advanced undergraduate students of biochemistry and related disciplines with a foundation in the basic concepts of molecular biophysics and the major biophysical methods used for studying biological phenomena. Students who have taken physical chemistry, physics, and calculus courses will learn in this course how these concepts are used in biological research. The second goal of this course is to foster student-centered learning through self-directed study and experiential activities, as well as critical thinking skills through creative and peer review activities.

- Course structure: This one semester course will be delivered in three learning modules over 15 weeks; 12 weeks of instruction, and 3 weeks of assessment. The course is structured in three learning modules, separated by a week of assessment (see course schedule below). Weeks 6, 10 and 16 will consist of an assessment of critical thinking, evidence-based knowledge, and application skills. The two weekly class sessions are 1.5 hour long and, combined, they cover one topic. The Tuesday session: Students are expected to come to class having completed an assignment given on Thursday the week before and for which the students will earn a partial grade. These assignments are constituted of assigned textbook reading and a set of theoretical and practical problems in the current week's topic. In class, students work in groups (chosen - with guidelines - by the students themselves at the beginning of the semester) to discuss and illustrate their solutions to the week's assignment and identify learning issues. The Thursday session: Instructor-led discussion of remaining learning issues followed by a lecture-style introduction of fundamental concepts in next week's topic and associated assignment. This

course fosters experiential learning, where students do most of the work before they come to class.

- Student Learning Outcomes:

  Upon completing this course, students should be able to
  - List the major biophysical methods used in studying biological function.
  - Describe the physical principles that govern the structures and conformations of biological macromolecules and their interactions.
  - Formulate macromolecular mechanics and interactions in thermodynamic terms.
  - Describe the physics of light absorption, emission, scattering, and diffraction from biological macromolecules.
  - Determine crystallographic parameters from X-ray diffraction data.
  - Solve a crystal structure.
  - Extract experimental information from structural databases.
  - Interpret biophysical data collected from macromolecular samples.
  - Identify the proper biophysical technique to answer a certain biochemical/biological question.
  - Synthesize a hypothesis-driven research proposal utilizing a major biophysical technique.
  - Critique others' ideas with respect to use and interpretation of biophysical data.

- Real Life Relevance:

  This course is designed to equip the research oriented student with a thorough understanding of the theoretical basis and application of select physical tools commonly used in biomedical research. Through established examples, they will see the importance and broad applicability of physical principles to biological problems. The course will enhance students' research skills both in their graduate careers at SDSU and in the future.

Enrollment Information

Prerequisites:

General Biochemistry (Chem-560).

Physical Chemistry (Chem-410A and B), Advanced Physical Chemistry (Chem-510), or an equivalent 500-level physics course.

Adding/Dropping Procedures: you can drop the class within the first 10 days of the semester (university policy). See Registrar's guidelines. http://arweb.sdsu.edu/es/registrar/howto.html#tools, or http://arweb.sdsu.edu/es/demos/registration/.

Course Materials

- Required Materials:
  - Principles of Physical Biochemistry, Second Edition (2006), K.E. van Holde, W.C. Johnson & P.S. Ho (Pearson).
  - C. R. Cantor & P. R. Schimmel, *Biophysical Chemistry pts I, II & III*, (1980) is the classic graduate level text on molecular biophysics. These volumes are still in print and can be found on Amazon used for $5-$25 for each part. Part II is the most useful for this course. This volume is a good reference book to have for the biophysical chemist.
  - Laptop with internet connection and a mouse are required for the X-ray crystallography unit of the course.

- Recommended Materials:
  - Handbook of thermal analysis and calorimetry / [series editor, Patrick K. Gallagher] http://libpac.sdsu.edu:80/record=b3267047
  - Any online Linux manual. E.g., http://wiki.lib.sun.ac.za/images/c/ca/TLCL-13.07.pdf

- Where to find these textbooks:

  One copy of each of the three volumes of Cantor and Schimmel can be found in the SDSU Library Course Reserves. A copy of van Holde has been ordered by the library also to be held in the reserves – check with the library to see when it will arrive. These are the only copies in the library and are held in reserve for the entire semester. 7 copies of van Holde will be available at the bookstore and some may be inexpensive used copies. I will provide additional material in class and/or on Blackboard.

Course Structure and Mode of Delivery

- Course structure: This one semester course will be delivered in three learning modules over 15 weeks; 11 weeks of instruction, and 4 weeks of assessment, see course schedule below. Thursdays: Students are expected to come to class having completed an assignment given the week before and for which they earn a partial grade. The assignments are constituted of textbook reading and a set of theoretical and practical problems in the current week's topic. In the Thursday class, students discuss and illustrate their solutions to the week's assignment and identify learning issues. Tuesdays: Lecture introducing fundamental concepts in the week's topic and associated assignment. This course fosters experiential learning, where students do most of the work before coming to class.

- Technology Utilized in the Course: Blackboard, PowerPoint, laptops, internet, free software and online servers, Linux operating system, classroom A/V equipment including white board and document camera.

Course Assessment and Grading

- Assignments are given out on Tuesdays and are due on the following Tuesday.

- Final assessment is a take-home exam focused on critical thinking.

  Scoring:

  Assignments: 40% of final grade
  Three exams: 60% of final grade (20% each)

  Grading scale:

Score	Grade
≥ 93.33	A
90 to < 93.33	A-
86.66 to < 90	B+
83.33 to < 86.66	B
80 to < 83.33	B-
76.66 to < 80	C+
73.33 to < 76.66	C
70 to < 73.33	C-
66.66 to < 70	D+
60 to < 66.66	D
< 60	F

Exams and Assignments Instructions

I plan to post the assignments and exams on blackboard, depending on how the course unravels. In case I do, I recommend that you check your access to SDSU's Blackboard server and become familiar with it https://blackboard.sdsu.edu/. Ask the IT helpdesk in the library if you need help.

REMINDER: The best browser for Blackboard is Firefox. There are known problems with using other browsers to take tests and quizzes in Blackboard. Download Firefox for free: http://www.mozilla.com/en-US/

Estimated time commitment

Modules and Estimated Hours

Module	**Estimated hours**
1. Hydrodynamic methods for the study of biological macromolecules.	8
2. Light scattering and diffraction methods.	12
3. Spectroscopic methods.	10

Module	Estimated hours
4. At home weekly assignments	40
6. Exams	13 hrs

Guidelines for student participation

I recommend not missing class.

Course Schedule (tentative)

Date	Activity	Assignment given out that day
Thursday 1/24/2019	Introductions, pre-course survey, and review of major mathematical and physical concepts used in the course (handout).	
Tuesday 1/29/2019	Lecture: Biological Macromolecules (ch. 1).	Assignment 1: assigned reading & problem set in chapter 1.
Thursday 1/31/2019	Problem solving workshop – ch. 1.	
Tuesday 2/5/2019	Learning issues discussion – ch.1. Lecture: Thermodynamics in Biochemistry. Calorimetry (ch. 2).	Assignment 2: assigned reading and problem set in chapter 2.
Thursday 2/7/2019	Problem solving workshop – ch. 2.	
Tuesday 2/12/2019	Learning issues discussion – ch. 2. Lecture: Macromolecular thermodynamics and modeling (ch. 3).	Assignment 3: reading and problems for chapter 3.
Thursday 2/14/2019	Problem solving workshop – ch. 3. In-class training in modeling tools (handouts).	
Tuesday 2/19/2019	Learning issues discussion – ch.3. Lecture: Methods for separation and characterization of macromolecules (ch. 5).	Assignment 4: reading and problems for ch. 5.
Thursday 2/21/2019	Mid-term exam 1 (in material covered in chapters 1-5).	

Date	Activity	Assignment given out that day
Tuesday 2/26/2019	Lecture: Light scattering intro (Rayleigh scattering, forward scattering, dynamic light scattering, low angle X-ray scattering, Neutron scattering, Raman scattering). (ch. 7).	Assignment 5: Read chapter 7. Prepare and present assigned illustration of a concept from this week's learning objectives.
Thursday 2/28/2019	Whiteboard illustrations – ch. 7 (no slides allowed).	
Tuesday 3/5/2019	Learning issues discussion. Lecture: X-ray crystallography - crystallization and X-ray diffraction by crystals (ch. 6).	Assignment 6: read chapter 6. Problems in symmetry, space groups, lattices, construct a virtual crystal.
Thursday 3/7/2019	Learning issues discussion. Lecture: Patterson maps. Solving the phase problem by borrowing phases (ch. 6).	
Tuesday 3/12/2019	Problem solving workshop – ch. 6 Process an experimental X-ray diffraction dataset. Molecular replacement in Phaser.	Assignment 7: read chapter 6. Problem set, interpret a Patterson map, interpret results of rotation and translation function searches.
Thursday 3/14/2019	Lecture: Heavy atom derivatives, anomalous diffraction.	
Tuesday 3/19/2019	Solving the phase problem by isomorphous replacement / anomalous dispersion method (ch. 6).	Assignment 8: read chapter 6 & assigned material from Cantor & Schimmel. Problem set for ch. 6.
Thursday 3/21/2019	Mid-term exam 2.	
Tuesday 3/26/2019 & Thursday 3/28/2019	No class. I will be at a conference.	
4/1-4/5/2019	No class. Have a nice Spring break.	
Tuesday 4/9/2019	Lecture: Spectroscopy, a quantum view. (ch. 8)	Assignment 9: Read chapter 8. Prepare and present an illustration of a concept from this week's learning objectives on absorption spectroscopy.

Date	Activity	Assignment given out that day
Thursday 4/11/2019	Student whiteboard illustrations for ch. 8 (no slides).	
Tuesday 4/16/2019	Learning issues discussion. Lecture: Linear and circular dichroism (ch. 10)	Assignment 10: Read chapter 10. Problem set for ch. 10.
Thursday 4/18/2019	Problem solving workshop.	
Tuesday 4/23/2019	Learning issues discussion. Lecture: Emission spectroscopy (ch. 11)	Assignment 11: Read ch. 11. Analyze experimental data. Problem set for ch. 11.
Thursday 4/25/2019	Problem solving workshop.	
Tuesday 4/30/2019	Learning issues discussion. Lecture: Theory of Mass spectrometry (ch. 15)	No assignment.
Thursday 5/2/2019	Final Exam – two parts	Part 1 due on 5/9/2019. Part 2 due on 5/16/2019.

Suggested search keywords for further reading on applications:

- Excitation and regulation by intracellular calcium (fluorescence imaging).
- Dynamics of muscle contraction (X-ray crystallography, EM)
- Allosteric regulation of biological activity (electrophoresis, linear and circular dichroism, ultracentrifugation, FRET).
- Phototransduction and photoreceptors (FTIR, Raman spectroscopy, NMR).
- confocal and two-photon microscopy, FRAP, calcium imaging, voltage-sensitive dye imaging, immunofluorescence, FRET-based assay to analyze the activity of a protease and local protein synthesis.
- mass spectrometry analysis of the proteome.

Students with Disabilities

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that accommodations based

upon disability cannot be provided until you have presented your instructor with an accommodation letter from Student Disability Services. Your cooperation is appreciated.

Academic Honesty

The University adheres to a strict policy regarding cheating and plagiarism. These activities will not be tolerated in this class. Become familiar with the policy (http://www.sa.sdsu.edu/srr/conduct1.html). Any cheating or plagiarism will result in failing this class and a disciplinary review by Student Affairs.

Examples of Plagiarism include but are not limited to:

- Using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work)
- Copying and pasting work from an online or offline source directly and calling it your own
- Using information you find from an online or offline source without giving the author credit
- Replacing words or phrases from another source and inserting your own words or phrases
- Submitting a piece of work you did for one class to another class.

If you have questions on what is plagiarism, please consult the policy (http://www.sa.sdsu.edu/srr/conduct1.html) and this helpful guide from the Library:(http://infodome.sdsu.edu/infolit/exploratorium/Standard_5/plagiarism.pdf)

Turnitin

Students agree that by taking this course all required papers may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. You may submit your papers in such a way that no identifying information about you is included. Another option is that you may request, in writing, that your papers not be submitted to Turnitin.com. However, if you choose this option you will be required to provide documentation to substantiate that the papers are your original work and do not include any plagiarized material.