Chemistry 750
Biophysical Chemistry
Spring 2017
Schedule Number 20759

COURSE INFORMATION

Class Days: Tuesdays and/or Thursdays
Class Times: 6:00-7:15 pm
Class Location: GMCS 325
Office Hours Times: Monday 12:30-1:30 pm or email me to make an appointment, mswairjo@maill.sdsu.edu
Office Hours Location: My office CSL-340

INSTRUCTOR INFORMATION

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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 and cellular biophysics and major biophysical methods 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 over 16 weeks; 13 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 weekly class sessions are 2 hours long, with a 10-minute break at half time, and are constituted of a lecture combined with individual or group exercises (mini workshops) of practical skills. During each instruction week, students are expected to come to class having completed an assignment given the week before and for which the student will earn a partial grade. The assignments may include reading assigned chapters from the

primary textbook or other material from the scientific literature, solving problems, and illustrating concepts discussed in class. Additional resources must be identified by the student to complete the final exam.

- 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.
  - Draw illustrative diagrams of biophysical phenomena.
  - Infer functional details from structural information.
  - Extract relevant 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 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 biophysical tools commonly used in biomedical research. Through established examples, they will see the importance and broad applicability of biophysical principles to biological problems. The course will enhance students' experimental 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), or Advanced Physical Chemistry (Chem-510).

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).
  - Laptop with internet connection (and preferably a mouse) is needed for one or two classes.

- Recommended Materials:
  - C. R. Cantor & P. R. Schimmel, *Biophysical Chemistry pts I, II & III*, (1980) is the classic graduate level text on physical biochemistry / 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 whether or not it is used in this course.
  - Handbook of thermal analysis and calorimetry / [series editor, Patrick K. Gallagher] http://libpac.sdsu.edu:80/record=b3267047

- 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 is also available in the library. Both textbooks can be found on Amazon.

Course Structure and Mode of Delivery

- Course structure: This one semester course will be delivered over 16 weeks; 13 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). Exams will assess critical thinking, evidence-based knowledge, and application skills. The class sessions are 1 hour and 15 minutes long, and are constituted of a lecture combined with individual or group exercises (mini workshops) of practical skills. During each instruction week, students are expected to come to class having completed an assignment given the week before and for which the student will earn a partial grade. The assignments may include reading assigned chapters from the primary textbook or other material from the scientific literature, solving problems, and illustrating concepts discussed in class. To foster self-directed learning, additional resources must be identified by the student to complete the final exam.

- Technology Utilized in the Course: Blackboard, PowerPoint, laptops.

Course Assessment and Grading

- Each assignment is due on the day of the next class.
- Exams can be in class or take home exams, depending on how you are doing digesting the material.

Scoring:

Homework assignments: 40 points.
Three exams: 60 points (20 points each)

TOTAL POINTS= 100

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 weekly assignments instructions

I plan to post 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.	6
3. Spectroscopic methods.	10
4. At home weekly assignments	20

Module	Estimated hours
5. In class exams	0-2
6. Take home exam	10 hrs

Guidelines for student participation

Attending class is essential for success in this course. Homework problems will be assigned in class, and discussed and graded during the next class. Therefore, class participation is the best way to secure homework credit.

Course Schedule

Date	Activity	Assignment given out that day
Tues, Jan 17 Thurs, Jan 19	1) Introduction, pre-course survey, and review of major mathematical and physical concepts used in the course. (handouts).	
Tues, Jan 24 Thurs, Jan 26	2) Lecture: Biological Macromolecules (ch. 1).	Assignment 1. Read chapter 2.
Tues, Jan 31 Thurs, Feb 2	3) Lecture: Thermodynamics in Biochemistry. Calorimetry (ch. 2).	
Tues, Feb 7 Thurs, Feb 9	4) Students' board illustrations. Lecture: Macromolecular thermodynamics and modeling (ch. 3). (In-class demo).	Assignment 2: present subsections of chapter section 3.4.
Tues, Feb 14 Thurs, Feb 16	5) Lecture: Methods for separation and characterization of macromolecules (ch. 5).	Assignment 3: Read chapter 7. Prepare and present illustration of a concept from next week's learning objectives.
Tues, Feb 21 Thurs, Feb 23	6) Lecture: Light scattering. Rayleigh scattering, forward scattering, dynamic light scattering. (ch. 7)	Assignment 4: Read chapter 7. Prepare and present illustration of a concept from next week's learning objectives.

Date	Activity	Assignment given out that day
Tues, Feb 28 Thurs, March 2	7) Lecture: Low angle X-ray scattering, Neutron scattering, Raman scattering. (ch. 7). Mid-term exam 1 (in material covered in sessions 1-7).	Midterm 1.
Tues, March 7 Thurs, March 9	8) Students' board illustrations. Lecture: X-ray crystallography – overview, crystallization and X-ray diffraction by crystals (ch. 6).	Assignment 5: optional handout problems (PDB).
Tues, March 14 Thurs, March 16	9) Lecture: X-ray crystallography – crystal structure solution (ch. 6). Understanding the PDB.	
Tues, March 21 Thurs, March 23	10) Lecture: X-ray crystallography structure refinement and analysis. Mid-term exam 2 (in material covered in sessions 7-9).	Midterm 2: refine / analyze structure.
March 27-31	Spring Break. No class.	
Tues, April 4 Thurs, April 6	11) Lecture: Spectroscopy, a quantum view. (ch. 8)	Assignment 6: Read chapter 9. Prepare and present an illustration of a concept from next week's learning objectives on absorption spectroscopy.
Tues, April 11 Thurs, April 13	12) Students' board illustrations. Lecture: Absorption spectroscopy (ch. 9)	Assignment 7: Read chapter 10. Prepare and present an illustration of a concept from next week's learning objectives on dichroism.
Tues, April 18 Thurs, April 20	13) : Linear and circular dichroism (ch. 10)	Assignment 8: Read chapter 11. Analyze experimental data.
Tues, April 25 Thurs, April 27	14) Lecture: Emission spectroscopy (ch. 11)	Assignment 9: Read chapter 15.
Tues, May 2 Thurs, May 4	15) Lecture: Mass spectrometry (ch. 15). Take home final exam (in all material)	No assignment
Tues, May 9 Thurs, May 11	Part 1 of final exam due Part 2 of final exam due	

Suggested search keywords for further reading on applications:

- Excitation and regulation by intracellular calcium (fluorescence imaging).
- Membrane biophysics, transport and the electrical properties of cells. (Osmosis. Solute-solvent coupling. Diffusion. Facilitated transport. Ion channels and water transport. Electrophysiology: voltage clamp and patch clamp).
- 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, PET, FACS, cell fluorimetry, 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.