Course Syllabus – STBIO 511

Course Information

Course Number: STBIO 511 WI24
Course Name: Structural Biology and Biophysics II
Term: WI 2024
Start Date: 01/03/2024
End Date: 03/22/2024
Credits: 3.0

Meeting Days / Times

Mondays, Wednesdays, and Fridays, 9:30-11:00am PT / 12:30-2:00pm ET
(See Calendar in Canvas for the most up-to-date schedule.)

Location

CA: Graduate Office Large Conference Room (Hazen Theory Building)
FL: C212

Case studies / Journal clubs will be on Zoom

Course Managers

Role	Last Name	First Name	Email Address
Course Director	Lander	Gabriel	glander@scripps.edu
Course Director	Lasker	Keren	klasker@scripps.edu
Course Director	Wilson	Ian	wilson@scripps.edu
TA	Brust	Christina	cbrust@scripps.edu

Course Description

This course focuses on the current state-of-the-art biophysical methods that are being applied to study the structure and function of biological macromolecules and biological systems at the atomic level. Topics covered include mass spectrometry, proteomics, chemical biology approaches, single molecule techniques, spectroscopy, molecular dynamics and modeling. There is also a focus on post-translational modifications and their impact on protein structure and function. Finally, we will discuss the use of combinations of methods, so called hybrid methods, including the combined use of computational tools with experimental data, to further structural elucidation of challenging macromolecular complexes and biological systems. In each section of the course, the theoretical underpinnings and the practical applications are covered. Each technique section will contain journal club, in which the students will present and discuss current research articles in class in the presence of experts in the field. The course is designed to provide a basic familiarity with the most common techniques used in biophysics and their applications to challenging problems in biology.

Program Learning Outcomes

By the end of the program, students will have accomplished these objectives:
PLO1: Original Research – graduate students are expected to develop the skills critical for generating high-quality research output. This would include absorbing, recalling, and contextualizing scientific knowledge, evaluating scientific information and data, creating testable hypotheses and investigating hypotheses, mastering scientific tools and techniques, displaying ethical behavior, and receiving and giving feedback.
PLO2: Communication – graduate students are expected to demonstrate the oral, written, and media skills to effectively communicate the impact of a study or a body of work to the greater scientific community and to the public at large using a number of methods.
PLO3: Critical Thinking – graduate students are expected to develop a self-directed process to analyze information, form opinions or judgments, and use this process to improve the quality of their scientific thoughts, navigate problems, and make informed decisions.
PLO4: Intellectual Curiosity – graduate students are expected to acquire the capacity to build their intellectual curiosity and demonstrate problem solving approaches that serve their professional growth and ability to impact a field.
PLO5: Career and Professional Development – graduate students are expected to develop a variety of transferable skillsets throughout their graduate experience, including management and leadership, inclusiveness, resilience, scientific rigor, collaboration, accountability, time management, teamwork, networking, and career planning.

Course Learning Outcomes

Upon completion of this course students will be able to:
CLO1: Understand the strengths and limitations of various experimental and computational approaches for studying macromolecular structure and function.
CLO2: Judge when the stated scientific conclusions derived from original experimental data are justified, and when they are not justified.
CLO3: Devise alternative scientific approaches to allow more robust conclusions on specific structural biology questions.
CLO4: Identify and formulate important new questions and experiments using examples from recent papers.
CLO5: Develop and present succinct oral presentations describing specific structural biology and biophysics methods papers and their relationship to other work in the field.
CLO6: Develop peer-review skills during critical and constructive assessment of recent papers.
CLO7: Be exposed to the practical use of biophysical approaches for the study of macromolecular structure and function.

Background Preparation

This course assumes some basic knowledge of protein/nucleic acid structure and chemistry. These topics are covered in the *Structural Biology & Biophysics I* course, but it is not a prerequisite for taking this course. Some background can be found in *Introduction to Protein Structure*, Second Edition, by Carl Branden and John Tooze.

Course Materials

Useful to consult: Campbell, I.D. (2012). *Biophysical Techniques*. ISBN: 978-0199642144
Useful to consult: Compilation of articles describing structural and biophysical tools: http://onlinelibrary.wiley.com/doi/10.1002/pro.v27.1/issuetoc
Useful to consult: Robinson, C.V., Sali, A., Baumeister, W. (2007). *The Molecular Sociology of the Cell*. Nature 450: 973-982.

Instructor Policies

Case studies

One recent original research paper in the relevant area of biophysics will be required reading for each case study class, and will be the basis for the class discussion. One short, topical review to accompany each research paper may also be provided, if appropriate. The required reading list will be posted on the course website.

Expectations and Logistics for Case Studies

1. **Student teams:** Teams of two or three students each will volunteer to present specific papers. These teams will rotate over the duration of the course, such that every team will lead 1-2 classes. The student team assigned to each paper will meet with or contact the relevant faculty discussant around 1 week before the paper is presented to get help and suggestions in identifying and understanding the literature that will be used to prepare the separate Introductions and Conclusions and to discuss potential next experiments. Teams will also prepare necessary PowerPoint slides of each figure and table for discussion by the class (see below). Each of the students in the team should plan to send their PowerPoint presentation to the faculty discussant at least 2 days before their presentation, so the faculty can give some feedback for modifying it, if necessary.

   All students will submit a document to the TA(s) prior to the beginning of class that describes two strengths and two weaknesses of the case study, as well as one future experiment. This document can be referred to during the final discussion regarding strengths, weaknesses, and next experiments.

2. **Written assignment (non-presenting students).** All students must read the assigned research paper(s) prior to class, and submit a document describing two strengths and two weaknesses of the case study, as well as one future experiment. Scripps Florida students should send their written assignments to the Course TA(s) by e-mail prior to the start of each case studies class. The two strengths and two weaknesses should provide clear reasoning and justification for the decision. In doing so, the student should demonstrate understanding of the experimental approaches in the paper and analytical reasoning justifying the conclusions. "Weaknesses" sections need not merely focus on, e.g., errors in experimental analysis, insufficient data supporting the claims, etc. The students are encouraged to explore deeper implications, or lack thereof, of the assigned paper. The "strengths" and "weaknesses" sections should each be less than half a page of single-spaced printed text (12 pt Times New Roman or 11 pt Arial). Each "next experiment" should produce an amount of data that would be expected to fit into one figure. The short description of each "next experiment" should include (1) a rationale for doing the experiment, (2) a brief description of the experiment, including experimental methods, and (3) the expected outcome(s) and a rationale of why they are expected. The description of the two "next experiments" should be short (e.g. ~4-6 sentences each), and together, the text for both "next experiments" should also be less than half a page of single-spaced printed text. Concise, focused descriptions that cover the points above will be rewarded. No more than 1.5 pages total should be submitted for the whole assignment. A short review(s) related to the topic of the discussion paper may be provided for papers on the reading list. *No late submission of these "written assignments" will be allowed, except under extenuating circumstances previously approved by the course director or TA. If you do not submit the "written assignment" for a particular class, no score will be awarded and your grade will be diminished proportionately.*

3. **Class format:**

   Student Team presentation: At the beginning of each journal club type class, the student team will give an introduction of the paper including (1) biological background and (2) experimental background and setup. Then (3), the students will cover the main figures from the paper. If necessary, figures from supplementary information can also be used. Presenters are encouraged to pose questions to the class during their presentation to promote engagement and participation. After the student team presents the (4) discussion and conclusions, the student team will lead a conversation about (5) strengths, weaknesses, and future experiments, with non-presenting students discussing their discussion points prior to the team's. All presentation should be in PowerPoint or equivalent format, and all 5 numbered points above should be covered by the team. The members of the team should divide the presentation equally between them.

   All students in the class are expected to participate in the discussion during the whole presentation. Each student will be graded based on his/her contribution to the overall discussion. Time required for the class discussion should be considered when the student team prepares the presentation. Asking help from the faculty moderator during the presentation preparation is strongly recommended.

The faculty moderator will help the student team to prepare for the presentation and guide the students through the class discussion. The student team can ask for help from the moderator when answering some of the questions, but the team is expected to lead the discussion and address the majority of the questions.

Selection of Papers/Student Teams: The discussion paper for each class (together with a related short review) will be posted on the Structural Biology course website in early September. Students are asked to review this list, and send an email to the Course TA indicating 1st, 2nd, and 3rd choices. Every effort will be made to assign students to the paper(s) of their choice; however, decisions will generally be made on a first come/first served basis. Students may submit choices as individuals (and end up with a second team member arbitrarily) or as a team with a second person with whom they would like to work. Everyone will have the chance to present at least 2 times, including the final presentation. *If students do not sign up for specific papers, they will be assigned to paper(s) randomly by the course directors.*

Additional Help in Understanding Papers: Students who would like additional help for understanding any paper prior to the designated class meeting are asked to directly contact the Course TA.

Expected Outcome

The course is intended to provide a fundamental understanding of the main techniques used in the biophysics to study biological macromolecules, complexes and systems at various levels of resolution. This is not intended to be a course covering any one method or field in detail. The expectation is that students will be able to use the knowledge gained in this course to accurately evaluate structures deposited in structural databases, and research articles published in the biophysics field. The course is designed to help students use published biophysics work to effectively further their own research, regardless of their field of research whether in biology, immunology, biophysics or chemical biology. The course is suitable for biologists, biophysicists, and chemists, or anyone interested in gaining a good understanding of biophysics methodologies as applied to biological problems. The course is updated each year to reflect any new developments in the methods used to determine macromolecular structures. The intent is to emerge with a clear understanding of the major techniques used in biophysics, and when and how to best use these techniques. Students are expected to actively participate in the course by asking questions and engaging with the lecturers and TA to probe deeper into the topics so as to gain the maximum benefit. A question and answer session at the end of each lecture is recommended. The TA will attend all the lectures, practicals and discussion sessions, and will assist the lecturers, provide guidance on the course to the students in the class, address questions as they arise, and organize review sessions on request.

Lectures are intended to provide the students with familiarity to the method. The lecturer will focus on basic concepts, practical aspects, advantages and disadvantages of the technique. The lectures will lay the groundwork and background and will equip the course participants to understand and evaluate current research articles in the field. Lecturers will generally assign an appropriate review article for their section, if the course books do not cover the material, and it will be helpful to read this material prior to the lecture. Students are encouraged to ask questions during the lecture. Concepts taught in the lectures will form the basis for further discussion in the papers assigned as case studies. Faculty discussants are expected to choose the paper for discussion, aid the students in their presentations, lead the discussion of the paper and evaluate and grade the written assignments, oral presentations and class participation.

Attendance Statement

Attendance is mandatory for all classes and a portion of the grade is based upon class participation. Failure to participate will result in a reduction in credit for that portion of the course. Students who are unable to attend class must seek permission for an excused absence from the course director or teaching assistant. Unapproved absences or late attendance for three or more classes may result in a lower grade or an "incomplete" for the course.

The "written assignments" must be submitted immediately prior to the presentation of the class to which they pertain. No late submission of written assignments will be allowed except under extenuating circumstances that are approved by the course director. If a student does not submit a written assignment for a particular class, no credit for that portion of the material will be awarded.

All students will be required to make at least two PowerPoint presentations during the course.

Scientific and Professional Ethics

The work you do in this course must be your own. Feel free to build on, react to, criticize, and analyze the ideas of others but, when you do, make it known whose ideas you are working with. You must explicitly acknowledge when your work builds on someone else's ideas, including ideas of classmates, professors, and authors you read. If you ever have questions about drawing the line between others' work and your own, ask the course professor who will give you clear guidance. Exams must be completed independently. Any collaboration on answers to exams, unless expressly permitted, may result in an automatic failing grade and possible expulsion from the Graduate Program.

Technology Requirements and Support

For issues related to Canvas, please contact the Graduate Office by email at: gradprgm@scripps.edu or by phone at: 858-784-8469.

Course Grading

Grading is in accordance with the academic policies of the Skaggs Graduate School. The breakdown of grading is as follows:

- Case Studies: 50%
- Midterm: 20%
- Final Presentation: 20%
- Class Participation: 10%

Grading

Letter Grade	Percent	GPA	Description
A	93-100	4.00	Outstanding achievement. Student performance demonstrates full command of the course subject matter and evinces a high level of originality and/or creativity that far surpasses course expectations.
A-	90-92	3.67	Excellent achievement. Student performance demonstrates thorough knowledge of the course subject matter and exceeds course expectations by completing all requirements in a superior manner.
B+	87-89	3.33	Very good work. Student performance demonstrates above-average comprehension of the course subject matter and exceeds course expectations on all tasks as defined in the course syllabus. There is notable insight and originality.
B	83-86	3.00	Satisfactory work. Student performance meets designated course expectations and demonstrates understanding of the course subject matter at an acceptable level.
B-	80-82	2.67	Marginal work. Student performance demonstrates incomplete understanding of course subject matter. There is limited perception and originality.
C+	77-79	2.33	Unsatisfactory work. Student performance demonstrates incomplete and inadequate understanding of course subject matter. There is severely limited or no perception or originality. Course will not count toward degree.
C	73-76	2.00	Unsatisfactory work. Student performance demonstrates incomplete and inadequate understanding of course subject

			matter. There is severely limited or no perception or originality. Course will not count toward degree.
P	73-100	0.00	Satisfactory work. Student performance demonstrated complete and adequate understanding of course subject matter. Course will count toward degree.
F	0-72	0.00	Unacceptable work/Failure. Student performance is unacceptably low level of knowledge and understanding of course subject matter. Course will not count toward degree. Student may continue in program only with permission of the Dean.
I		0.00	Incomplete is assigned when work is of passing quality but is incomplete for a pre-approved reason. Once an incomplete grade is assigned, it remains on student's permanent record until a grade is awarded.
W		0.00	Withdrew from the course with Dean's permission beyond the second week of the term.

- All courses will be recorded and maintained in the student's permanent academic record; only courses that apply towards the degree will appear on the academic transcript. Non-credit or audited courses will not appear on the transcript.
- 4 core courses taken for a letter grade (pass = B- or higher for a core course)
- 2 elective courses taken pass/fail (pass = C or higher for an elective)

Grades will be assigned for:

- Case Studies (written assignment, presentation, participation) - 50% of final grade
- Midterm Exam problem set - 20% of final grade
- Final Presentation (presentation, participation, peer evaluation) – 20% of final grade
- Class participation (TA(s) will keep track of each student's level of participation during the course) - 10% of final grade

Points will be awarded for all above categories on the same scoring system and proportionately rated to give the final grade as indicated below:

4 points = outstanding, 3 points = very good, 2 points = average, 1 point = poor, 0 points = unsatisfactory (including late submission), that approximately reflect A, B, C, D, and F grades, respectively.

Case Studies (50% of overall grade)

60% of case studies grade will be derived from your **'strengths, weaknesses, and next experiments'** assessment, which must be submitted for every case study class. For each case study, the students must submit a written assignment describing two strengths, two weaknesses of the assigned paper and one next experiment, which will normally be graded by the faculty discussant of the day or occasionally by the TA. Excellent weaknesses will point out any flaws or caveats in the interpretations, if there are any, and/or suggest better, less ambiguous, or alternate ways to demonstrate the findings. Next experiments will test your understanding of the paper and its results and show whether you can use the knowledge acquired in the course, or from your reading, to propose two next experiments that would follow on from the results presented in the assigned paper in the case study.

Learning Purpose: Supports points 1-6 of learning outcomes, and allows assessment of mastery of course material.

20% of case studies grade will be determined by the **PowerPoint presentation** that each student will give at least once in the case studies section of the course. Presentations will be graded on a 5-point scale – one point assigned for addressing each of five sections: (1) biological background; (2) experimental background and setup; (3) figures; (4) discussion and conclusions; (5) weaknesses and future experiments. Because students will present in groups of 2 or 3, each group as a team must make sure that the relevant sections are covered (example 1: presenter 1 provides the biological background, experimental background, and first figures, while presenter 2 provides the second set of figures, discussion and conclusions, and weaknesses and future experiments; example 2: both presenters split the 5 sections).

Learning Purpose: Supports points 1-6 of learning outcomes, involves active learning and allows assessment of mastery of course material.

20% of case studies grade will be based on **"Participation in class discussion"** of each case study paper. All students, not just the presenters, will be expected to contribute to interpretation and assessment of the figures, tables and results in the assigned paper, to discuss alternative experimental approaches and to consider any still unanswered questions related to the study. Students will receive a score for each presentation: 0 – no contribution to discussion; 1 – some contribution to discussion; or 2 – outstanding contribution to discussion.

Learning Purpose: Supports points 1-7 of learning outcomes, involves active learning, and allows assessment of mastery of course material.

Final Presentation (20% of overall grade)

During the course, we will review many biophysical methodologies involved in studying the function and dynamics of macromolecules in vitro and in cells. For the final assignment, each student will describe how one or more biophysical techniques that were discussed during class could be integrated into their current rotation or thesis project. These biophysical approaches cannot already be in use for the student's ongoing studies, as the goal is for the student to consider new biophysical avenues of study for their project.

Ten minutes will be allocated for each presentation, followed by five minutes for discussion. The student will (1) describe their current project, including a brief introduction to the biological background, and (2) describe existing knowledge gaps and significance of the study. The student will then (3) describe how one or more additional biophysical methods could be used to address important questions to help close existing knowledge gaps, and discuss the expected outcomes. Finally, the student will (4) discuss a potential limitation of the method(s) and (5) propose a possible way to overcome this limitation.

60% of final presentation grade. **Power point presentation (15mins including questions)**
Grading will assess the quality of each of the 5 sections described above on a 0-4 scale. Therefore, students should use prior oral presentations as "practice" for the final paper presentation.

Learning Purpose: Supports points 1-7 of learning outcomes, and allows assessment of mastery of course material.

20% of final presentation grade. **Participation in class discussions** of each project presented – graded as class participation in case studies.

Learning Purpose: Supports points 1-6 of learning outcomes, and allows assessment of mastery of course material.

20% of final presentation grade. **Grading and evaluation** by each student of every presentation other than own presentation.

Learning Purpose: Supports point 2 and 6 in particular of learning outcomes, and allows assessment of the ability to critique others and develop peer-review skills.

Class Participation (10% of the overall grade)

Students will receive a score for their level of participation during each class lecture. This includes asking questions during class, answering questions posed by the lecturers, or contributing to discussion. These scores will be averaged at the end of the semester and curved for 10% of the final grade. Scoring is as follows:

- 0 – no contribution to discussion
- 1 – minimal or forced contribution to discussion, such as responding to a question with a one word answer, participating in a Zoom poll, or being called upon by the lecturer when no one has volunteered an answer.
- 2 – answering or asking one or more questions unprompted during class.

Course Summary:

Date	**Details**
Mon Jan 1, 2024	No Class (New Year's Day day off)
Wed Jan 3, 2024	syllabus, course requirements. Introduction to Biophysical Methods
	01.03.2024 Participation
Fri Jan 5, 2024	Post-translational Modifications (Dawson)
	01.05.2024 Participation
Mon Jan 8, 2024	Glycans I (Paulson)
	01.08.2024 Participation
Wed Jan 10, 2024	Glycans II (Paulson)
	01.10.2024 Participation
Fri Jan 12, 2024	Journal Club #1 (Mia Huang)
	Journal Club #1
	01.12.2024 Participation
Mon Jan 15, 2024	No Class (Martin Luther King Jr. Day)
Wed Jan 17, 2024	Introduction to Mass Spectrometry (Siuzdak)
	01.17.2024 Participation
Fri Jan 19, 2024	Mass Spectrometry and Proteomics (Yates)
	01.19.2024 Participation
Mon Jan 22, 2024	Lipidomics I (Ed Dennis, UCSD)
Wed Jan 24, 2024	Lipidomics II (Ed Dennis, UCSD)
Fri Jan 26, 2024	HDX-MS (Griffin)
Mon Jan 29, 2024	Chemical Biology Tools in Biophysics (Hang)
Wed Jan 31, 2024	Applying Chemical Biology to study protein function and dynamics (Badran)
Fri Feb 2, 2024	Journal Club #2 (Ahmed Badran)
	Journal Club #2
Mon Feb 5, 2024	Spectroscopy I: Methods in Biology (Sander)
Wed Feb 7, 2024	Fluorescent Proteins (Nathan Shaner, UCSD)
Fri Feb 9, 2024	Single Molecule and Fluorescence Techniques (Deniz)
Mon Feb 12, 2024	Super Resolution Microscopy (Henderson)
Wed Feb 14, 2024	Core Day: Microscopy (Henderson)
Fri Feb 16, 2024	FRET and ensemble methods (Millar)

	Take-Home Midterm Exam
Mon Feb 19, 2024	No Class (President's Day)
Wed Feb 21, 2024	Journal Club #3 (Ashok Deniz)
	Journal Club #3
Fri Feb 23, 2024	Conformational heterogeneity in single particle EM (Lander)
Mon Feb 26, 2024	Advanced CryoEM for dynamic systems: correlative microscopy (Grotjahn)
Wed Feb 28, 2024	Introduction and Application of Atomic Force Microscopy (Gavin King, Univ of Missouri-Columbia)
Fri Mar 1, 2024	Intrinsically Disordered Proteins (Wright)
Mon Mar 4, 2024	Biophysics of phase separation (Lasker)
Wed Mar 6, 2024	Integrative methods to characterize chromatin structure and dynamics from molecular to cellular scales (Racki)
Fri Mar 8, 2024	Journal Club #4 (Keren Lasker)
	Journal Club #4
Mon Mar 11, 2024	Computational Biology & Modeling (Rommie Amaro, UCSD)
Wed Mar 13, 2024	Hybrid Modeling and Kinematics (Olson)
Fri Mar 15, 2024	Cellular imaging and modeling (Graham Johnson, Allen Institute)
Mon Mar 18, 2024	Student Presentations I
	Final Presentation