Course Syllabus – STBIO 511

Course Information

Course Number: STBIO 511 WI23
Course Name: Structural Biology and Biophysics II
Term: WI 2023
Start Date: 01/04/2023
End Date: 03/24/2023
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 Dining Room (Hazen Theory Building)
FL: C212
Online via 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	Swanson	Olivia	oswanson@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.

2) Class format: 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 important figures. Not all figures are needed to be discussed, and if necessary, figures from supplementary information can also be used. Finally, the student team will present (4) discussion and conclusions and (5) weaknesses and future experiments. All presentation should be in PowerPoint or equivalent format, while 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 answer the majority of the questions.

3) Written assignment. We will assign at least one discussion paper for each class (to be read by all class members beforehand). All students will be required to submit their two weaknesses assessment, as well as two next experiments, prior to the start of class. Scripps Florida students should send their written assignments to the Course TA by e-mail prior to the start of each case studies class. The 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 "weaknesses" section should be less than half a page of single-spaced printed text (12 point, Times New Roman). 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 a) a rationale for doing the experiment, b) a brief description of the experiment, including experimental methods, and c) 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 (12 point, Times New Roman). Concise, focused descriptions that cover the points above will be rewarded. No more than one page 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.*

Selection of Papers/Student Teams: The discussion paper for each class (together with a related short review) will be posted on the Biophysics course website in early January. 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 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: 25%
- Final Presentation: 25%

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 - 25% of final grade
- Final Presentation (presentation, participation, peer evaluation) – 25% 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 **'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 weaknesses of the assigned paper and two next experiments, 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 (~25% of overall grade)

60% of final presentation grade. **Power point presentation of a paper (15mins including questions)** to be selected and given by each student that includes background, introduction, discussion of results, conclusions, strengths and weaknesses, and next experiments. 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 paper 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.

Course Summary:

Date	Details
Mon Jan 2, 2023	**No Class (New Year's Day day off)**
Wed Jan 4, 2023	**Post-translational Modifications (Dawson)**
Fri Jan 6, 2023	**HDX/MS (Griffin)**
Mon Jan 9, 2023	**Metabolomics (Siuzdak)**
Wed Jan 11, 2023	**Mass Spectrometry & Proteomics (Yates)**
Fri Jan 13, 2023	**Mass Spectrometry & Proteomics Journal Club (Yates)**
	Journal Club #1 paper
Mon Jan 16, 2023	**No Class (Martin Luther King Jr. Day)**
Wed Jan 18, 2023	**Spectroscopy I: Methods in Biology (Sander)**
Fri Jan 20, 2023	**Spectroscopy II: CD Vibrational UV (Sander)**
Mon Jan 23, 2023	**Single Molecule & Fluorescence Techniques I (Deniz)**
Wed Jan 25, 2023	**Single Molecule & Fluorescence Techniques II (Deniz)**
Fri Jan 27, 2023	**Single Molecule & Fluorescence Techniques Journal Club (Deniz)**
	Journal Club #2 paper
Mon Jan 30, 2023	**FRET (Millar)**
Wed Feb 1, 2023	**NMR Applications (Berlow)**
Fri Feb 3, 2023	**Optical Traps (Carlos Bustamante, UC Berkeley)**
Mon Feb 6, 2023	**Chemical Biology Tools in Biophysics I: Applying Chemical Biology to Study Protein Function and Dynamics in Vitro and in Vivo (Hang)**

Wed Feb 8, 2023	**Chemical Biology Tools in Biophysics II: Applying Chemical Biology to Study Protein Function and Dynamics in Vitro and in Vivo (Badran)**
Fri Feb 10, 2023	**Chemical Biology Tools & Biophysics Journal Club (Hang)**
	Journal Club #3 paper
Mon Feb 13, 2023	**Glycans I (Paulson)**
Wed Feb 15, 2023	**Glycans II (Paulson)**
	Take-Home Midterm Exam
Fri Feb 17, 2023	**Glycans Journal Club (Paulson)**
	Journal Club #4 paper
Mon Feb 20, 2023	**No Class (President's Day)**
Wed Feb 22, 2023	**Lipidomics I (Ed Dennis, UCSD)**
Fri Feb 24, 2023	**Lipidomics II (Ed Dennis, UCSD)**
Mon Feb 27, 2023	**Super Resolution Microscopy (Henderson)**
Wed Mar 1, 2023	**Biophysics of Phase Separation I (Keren Lasker)**
Fri Mar 3, 2023	**Biophysics of Phase Separation II (Keren Lasker)**
	Journal Club #5 paper
Wed Mar 8, 2023	**Integrative methods to model the structure of chromatin (Racki)**
Fri Mar 10, 2023	**Journal Club #6 paper**
Mon Mar 13, 2023	**Integrative Structure Determination (Andrej Sali, UCSF)**
Wed Mar 15, 2023	**Computational Biology & Modeling (Rommie Amaro, UCSD)**
Fri Mar 17, 2023	**Integrative Structure Determination Journal Club (Andrej Sali, UCSF)**
Mon Mar 20, 2023	**Cellular Modeling (Graham Johnson, Allen Institute)**
Wed Mar 22, 2023	**Student Presentations**