Syllabus for PHYS/BIOL 178

S. Marzen

January 24, 2025

Contact information:

- Instructor: Sarah Marzen
- Email: smarzen@natsci.claremont.edu,
- Office: E165

- If I'm sick or if there is a new horrible variant: Meeting ID: 511 196 0913, Password: Marzen
- Lectures are MW at $9:35-10:50$ AM in E180
- OH 1-2 PM R and 3-5 PM F in my office

My aim is to foster a welcoming, inclusive environment where everyone feels emboldened to ask "stupid" questions, answer questions wrongly, and in general, just talk out of turn. My experience is that the "stupid" questions are usually the smartest, that wrong answers are more interesting than correct ones, and that random musings can lead to some really interesting ideas. The problem sets are designed to be hard– in fact, some problems are likely to be barely doable on your own. I strongly advise you to find others to work with and to come to my office hours. I am here to help you learn, not to prevent you from getting a good grade, I promise.

The goal of this course is to give you the tools you will need to model any biophysics situation you come across in the future. Of course, that is a preposterous goal. Biophysics is an ever-expanding field and no professor can hope to cover what is needed to understand even half of it in one semester. Still, I will try. You will end up learning just enough from stochastic differential equations, dynamical systems, probability theory, statistics, machine learning, information theory, and equilibrium statistical mechanics to understand the basics of some of the state-of-the-art biophysics calculations. We will not delve deeply into these fields. In a sense, we will adopt the attitude that we are "jacks of all trades and masters of none". This makes theoretical biophysics really hard. It also makes it exciting.

This course is largely synchronous, but you may wish to prepare for upcoming classes by reviewing the lecture notes. These will be posted on Canvas in advance of the lectures themselves. There is no one textbook that this class is based upon; the lecture notes and the assigned readings take the place of a textbook. I will also post pre- and maybe post-quizzes to help me gauge where you're at before the lecture and to help you figure out if you learned what you needed to learn from the lecture notes and the lecture itself.

Your grade in this class will be based on homeworks, two midterms, and your final project. I will give you free extensions on any homework. You just need to email me in advance. There is no extension allowed for the final project.

Office hours: 1-2 PM R and 3-5 PM F in my office.

Scientific computing: Make sure you have downloaded one of Python (with NumPy and SciPy packages), Matlab, Mathematica, Maple, or another that you should run by me as soon as possible. I expect you to be familiar with one of these scientific computing softwares, but lessons on Maple can be found at

gould.prof/learning-maple and lessons on Python can be found on Canvas under Files. In class, I will use Mathematica for symbolic calculations and Python for numerical calculations. I will release the code discussed in class at the end of every class on Canvas.

Make sure you bring your computer every day to class so that you can participate in in-class labs.

Homeworks: Again, you can get free extensions anytime as long as you email me requesting, for any reason. Homeworks are due on select Fridays, to be determined based on the pacing of the class. You are absolutely encouraged to consult me and others in order to complete the problem set. There is no such thing as cheating, *unless* you use someone else's words without understanding their meaning. Only you will know if you understand what you are writing down, but be warned that failure to understand the homeworks can only hurt you on the other assessments.

ChatGPT or other LLMs are allowed for background research, but not as oracles that answer the question. If I catch you using an LLM as an oracle, I will first warn you that this is against policy, and then take off points at the next clear sign of use.

Midterms: There will be two midterms scheduled tentatively for March 5 and April 7 in class, with dates potentially to change. They will be open notes, open homework, and you can use any scientific computing software that you like. You cannot consult the Internet or anyone else. If I find that you consulted the Internet or anyone else during the exam, I will give you no credit. If you have a conflict with these exam times, please tell me as soon as possible!

You will have a chance to resubmit both midterms. Your final midterm score is a weighted average of the two scores, with 70% weight for the first midterm and 30% weight for the second midterm. For the second submission, please do talk to me and work with others.

Final project: In lieu of a final exam, you will be asked to do a final project that can take one of many forms. You will both turn in your work in the form of a report and present your work to the class during the final classes, the number of which will depend on how many groups there are. You are allowed to work in groups of up to 4 students as long as it is clear what individual contributions were (to be listed in a separate turn-in).

- You can choose a paper from the literature (and a list of suggestions will be provided) and recreate the calculation in full detail, though for some papers, please consult me so that we can pare down the calculation to something reasonable.
- You can take a model from class or from the literature and modify it in any way you'd like and investigate its properties. For such final projects, the way in which you modify the model is nearly as important as the results you get. I want to know what biological question you are trying to answer and why you chose to modify the model in this way.
- You can propose an experiment and corresponding statistical analysis that you'd use to address a biophysical question. The statistical analysis must match the resolution of the equipment that you propose to use. These final projects should include at least an order of magnitude estimate proving that the statistical analysis you will use can actually answer the biological question with the experimental data you hope to gather.

For items 2 and 3, it is considered cheating to not cite sources that you have used for inspiration or more. If I find that you have improperly left sources out of your references, I will take off some number of points, to be determined.

Grades: The final grade is determined via

- Participation – 10%
- Homework – 20%

- Midterms – 20% each
- Final project – 30%.

The grade cutoff is *no harsher than*

- $A = 90\%$
- $A- = 85\%$
- $B+ = 80\%$
- $B = 75\%$
- $B- = 70\%$
- $C+ = 65\%$
- $C = 54\%$.

I may move cutoffs down (but not up) as I see fit at the end of the semester. Please do not trust Canvas' grade.

Accommodations: I have copied and pasted the following information from Deans about accommodations. If you have detailed questions about any of the following, please speak to the departments or coordinators listed.

Scripps students seeking to register for academic accommodations must contact the department of Academic Resources and Services (ARS) at ars@scrippscollege.edu or $909 - 621 - 8277$ to formalize accommodation requests. Students will be required to schedule an intake with staff, complete the Disability Support Services Request form and submit documentation for approved academic accommodations. Once ARS has received documentation supporting the need for accommodations, ARS will work with faculty to ensure that faculty are in the loop regarding a student?s request for accommodations and will consult where appropriate.

Pitzer students should contact Pitzer's Academic Support Services (PASS) in the Office of Student Affairs to inquire about accommodations and support services (https://www.pitzer.edu/student-life/academic-support-services/). It would be best for students to contact PASS early in the semester so that a collaborative plan can be developed for the academic year. PASS will work with students to identify reasonable and appropriate accommodations, and also follow up with a letter to relevant faculty members outlining specific accommodation options.

Generally, a student's home campus is responsible for establishing and providing accommodations. Below is a list of coordinators:

- Scripps: Academic Resources Services, ars@scrippscollege.edu or $909 - 621 - 8277$
- CMC: Kari Rood, kari.rood@claremontmckenna.edu
- HMC: Brandon Ice, bice@g.hmc.edu
- Pitzer: Gabriella Tempestoso, gabriella_tempestoso@pitzer.edu
- Pomona: Jan Collins-Eaglin, jan.collins-eaglin@pomona.edu
- Claremont Graduate Institute: Quamina Carter, quamina.carter@cgu.edu

Students who have conflicts with labs or exams due to religious holidays should see me in advance of the exam.

My Accommodations: I also have accommodations, and there may be a situation in which I need to reschedule class. This will happen no more than once per semester. If I reschedule class, there will be a "choose your own adventure"– you can either watch a recording in Box, or you can come to a rescheduled night class at a time TBD.

Schedule: We will go over the following topics in the following order at whatever pace makes sense.

- Philosophy (1 week)
- Polymer models (2 weeks)
- Ligand-receptor binding (2 weeks)
- Gene regulation and protein production (2 weeks)
- Evolution (2 weeks)
- Ecology (2 weeks)
- How to analyze data when you have no idea what to do, also known as most of machine learning (1 week)

The last month will be spent working on final projects in class.