

# PHY315: Biological and Medical Physics

## Spring 2022

### General Information

Course Time and Place: Tues. and Thurs. 9:30AM-10:50AM EST in PB 208 or via Zoom  
 Instructor: Professor J. M. Schwarz, aka Professor Jen  
 Office: 229a Physics Building  
 Phone: 607-342-0876  
 E-mail: phy315.spring2022@yahoo.com  
 Course webpage: jmschwarztheorygroup.org/phy315  
 Office Hours: TBD

### Professor Jen's Top 5 Reasons to Take This Course

You are biology. You are made of living matter. The term “living matter” is just code for “biology” from the viewpoint of a physicist. Physicists typically think about dead matter, i.e., the hydrogen atom, the Higgs boson, black holes. And yet, there is so much living matter around us, and in us, that we cannot look away. Biology should not be simply left to biologists. We, as physicists, must embark on the journey of trying to understand what physics biology understands. I say this because cells can learn, if you will, and have been around a lot longer than we have. So they presumably “understand” more physics than we multicellular organisms do, and exploit such physics to move faster, for example.

Just in case the above was not compelling enough to encourage physicists, and even chemists, engineers, mathematicians, and computer scientists, to study biology, here are my top 5 reasons to take this course:

- (5) So you can begin to learn about how your brain and other organs function in the context of general physics principles.
- (4) So you can learn about how viruses invade cells to stop them from doing so and help save the world.
- (3) So you can talk about the origins of life at a socially-distanced party and impress your friends (or make a TikTok video about the origins of life and impress your friends in the COVID-19 era).
- (2) So you can answer such questions as: How is it that all mammals empty their bladders in  $21 \pm 13$  seconds, regardless of size? and win an Ig Noble Prize.
- (1) So you can become the next generation Randall Monroe, creator of the XKCD comic strip, with biology as a focus to keep humor alive in all of the sciences (not just physics).

On a more serious note, we will explore such topics as the spatial and temporal organization of DNA in a cell nucleus, cells moving through confined spaces, shape change in the developing brain, and how cells uptake the SARS2 virus, and more, with the theme of discovering what general physics principles drive the observed phenomena. We will uncover such principles using our keen observation skills, given the influx of quantitative experimental data, and via simplified calculations/estimations. We hope to quantify the properties of living matter, just as physicists quantify the properties of dead matter.

To be able to achieve our goals, the class will ultimately be organized more like a journal club,

where we discuss some sections in the textbook on a Tuesday that will help set the stage for going over a classic biological physics paper on a Thursday, which may typically be the primary source of information for the textbook writers. There may be a short homework problem or two a week from the textbook pertaining to the sections in the textbook and/or the paper we read. In short, I envision a couple hours a week of reading and solving a short problem or two outside of class time. Moreover, we will have *anti-quizzes* from time to time. An anti-quiz asks for a question (as opposed to an answer) and potentially an idea as to how to answer the question. There will be no exams, only a final project involving both a written and a presentation component.

## Textbook

The guiding textbook for *our* class is *Physical Biology of the Cell, 2nd Ed. (PBOC)*, written by Phillips, Konev, Theriot, and Garcia. Since a good fraction of the homework problems will be assigned from this textbook, please obtain a copy via the internet, i.e., I did not place a campus store textbook order.

In addition, we will supplement our investigations with original papers by the authors that created the field. While sometimes the material in an original paper is presented in an outdated manner, you will get a glimpse of the inner workings of the minds of some of the best biophysicists.

There are other biophysics textbooks out there, if you are so inclined to reach out beyond *PBOC*. Examples include *Biological Physics: Energy, Information, Life* by Philip Nelson and *Biophysics: Searching for Principles* by William Bialek, with the former being more geared towards graduate students.

## Assessment of Your Work

**(1)** Class participation (25 percent): Not only are you encouraged to ask questions in class and via slack/email, I may ask each of you for a consultation when preparing some of the final lectures in terms of determining what papers to cover, etc.

**(2)** Homework (20 percent): There will be approximately 10 short homework assignments. I encourage you to talk to me about them and each other, especially if you are having problems getting started. *In the end, however, each person should write up their own solutions.* If you have used any resources other than your brain, which has been nourished by the textbooks, to complete the assignment, please cite them. (I must also remind you that the Syracuse University Academic Integrity Policy holds students accountable for the integrity of the work they submit. For the complete policy, see <http://academicintegrity.syr.edu>.) Finally, after the solutions have been posted, late homeworks will no longer be accepted.

**(3)** Anti-quizzes (15 percent): Again, you write the question. These anti-quizzes will occur probably weekly but will take no more than 5-8 minutes.

**(4)** Presenting a paper (10 percent): Somewhere after the midpoint of the course, each person will take about 15-20 minutes to present and then guide the discussion of a particular paper. The paper will be chosen by both myself and the student.

(5) Final Project (30 percent): The final project will consist of a written component and a presentation component. The biophysics topic will be chosen by the student (after discussion with me) as we approach the midpoint of the course. For the PHY690 students, the final project will have to be a little more hefty than the projects completed by the PHY315 students.

## Prerequisites

Officially, one is supposed to take PHY212 or PHY216 or do well on an AP Physics exam(s) that contains both classical mechanics and electricity and magnetism before signing up for this class. In other words, some familiarity with “basic” physics is assumed but not much more than that. We will construct as much as we can from the ground up in terms of the physics.

## Meeting Logistics

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We will be meeting in classroom PB208. However, should the university decide that we need to hold classes on-line due to COVID-19 conditions, or snow conditions make driving dangerous, we will meet on Zoom.

In the event that we hold class via Zoom, please keep your microphone muted unless you are actively talking to your fellow classmates (myself included); this is especially important if you are in a noisy place, or if you are using a built-in microphone on a laptop or cellphone. *Please introduce yourself before speaking.*

Should you have to miss class due to COVID-19, to access the homework and any additional reading material, please visit the course webpage. There will also be a weekly posting about the topics covered keep you up to date with the course. If you are feeling well enough but still need to quarantine, there is the possibility of joining the class remotely. Please let me know.

## Public Health

While we have discussed the nuts and bolts of the course, my highest priority this semester is the preservation of your health (and mine). The University has already sent you the general things we expect students to do to protect public health. While the campus mask status is red, I ask that:

(1) you to wear a face covering when indoors or when interacting with others outdoors,

(2) do not share pencils, computers, etc., with your classmates, unless they have been cleaned beforehand with sanitizer or alcohol.

Your face covering should cover both your mouth and your nose and have at least three layers of material such that you cannot blow out a candle. N95 and KN95 masks are recommended. If you have a medical reason that you cannot wear a mask, please notify me ASAP. If you forget your mask for a PB208 class meet, I will likely have one or two extras; ask me, and I may have one for you. If any student is unwilling to do their part to preserve public health in in-person classes, then I will ask them to leave and complete their work online. If they do not comply, I will have to cancel the in-person class.

The campus mask status may change during the semester to reflect changing conditions and knowledge; I will let you know if any changes in class safety guidelines are about to occur.

Given the in-person classes, if you are not feeling well, one of the most important things you can do is to stay home. All of the components of our class can be done remotely, and if you are feeling unwell – particularly if your symptoms involve nausea, cough, fever, or others common in COVID-19 – you should connect to our class remotely, and inform us that you are working remotely because you are ill. We often have a culture of trying to “push through” when we are not feeling well, saying things like “Yeah, I am sick, but I will be okay – I can still go to class”. While this sort of perseverance in general is a good thing, coming to class when you are sick puts other people’s health at risk. So, if you have any symptoms at all, stay home.

If you have an illness or injury that interferes with your ability to do work in our class, i.e. you are seriously sick, please communicate with me! The Center for Disability Resources also helps students with short-term injuries and illnesses – concussions, broken bones, etc. If you are sick or hurt, I will work with you and with CDR to do whatever I can to accommodate your condition.

If you are too sick to participate in class, even remotely, do not worry! I want you to focus on taking care of yourself rather than on classes. If you are sick and miss things, I will be flexible with deadlines to allow you to catch up. If you miss a large amount of class (two weeks or more), you may be eligible to take an “incomplete grade” in the course. This is a “grade pending” status that means that you were not able to finish all your work during the semester. Once you finish up your work in the spring, I can go back and give you your final grade. If you think you might need to use this option, it is important to talk to me as early as possible so we can discuss arrangements. In general, only students who have completed a meaningful amount of classwork with a passing grade are eligible to take an incomplete.

Should I contract COVID-19 and am too sick to teach, the department will do their best to find a substitute instructor for you as soon as possible. If I am not too sick to teach, the class will go remote for my quarantine duration.

## **Equality and Inclusiveness**

Everyone in this class is an equally-valued member of this university and our community. I expect you to treat your classmates as honored colleagues in the collective endeavor we are all involved in: to understand the natural world, both living and nonliving matter, and use that understanding to improve our society.

In particular, bias against or denigration of anyone in our class because of their gender or how they express it, their sexual orientation, their religion, their national origin, their race or ethnicity, or a disability they may have will not be tolerated. If you are the target of this sort of bias or if you witness it, please report it directly to me and I will take swift action. If you don’t feel comfortable talking to me, you may report it anonymously to the Physics Department at:

<https://docs.google.com/forms/d/e/1FAIpQLScNduLL1hc9fJu5MRaKjajJFnlTDiDio0xvqprn9kCXDpS2Cg/viewform>.

## **Syllabus Statement Regarding Disability-Related Accommodations**

Students who are in need of disability-related academic accommodations must register with the Office of Disability Services (ODS), 304 University Avenue, Room 309, 315-443-4498. Students with authorized disability-related accommodations should provide a current Accommodation Authorization Letter from ODS to the instructor and review those accommodations with the instructor.

Accommodations, such as exam administration, are not provided retroactively; therefore, planning for accommodations as early as possible is necessary. For further information, see the ODS website, Office of Disability Services <http://disabilityservices.syr.edu/>.

## SU Religious Observances Policy

The policy, found at [http://supolicies.syr.edu/emp\\_ben/religious\\_observance.htm](http://supolicies.syr.edu/emp_ben/religious_observance.htm), recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holy days according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors before the end of the second week of classes. For both fall and spring semesters, an online notification process is available through MySlice/Student Services/Enrollment/My Religious Observances from the first day of class until the end of the second week of class.

## Secret Course Objective

To have **fun** solving the mysteries of biology using physics, where **fun** means that the learning experience should be enjoyable and inspiring.