PSL 425: Physiological Biophysics Fall 2018 Section 1 Honors Section
3 credits
Prerequisite: PSL 250 or PSL 310 or both PSL 431 and PSL 432
TT 8:30-9:50 1425 Biomedical and Physical Sciences
Dr. Patrick Dillon, 2178 BPS, 884-5040, dillon@msu.edu, Office Hours, W 11-12, 1-3; M,F by appointment
TA: Thomas Turkette, Office Hours TBA
Textbook: Biophysics: A Physiological Approach, Patrick F. Dillon, Cambridge University Press, 2012

Please note that in an emergency you should use the double doors at the back of the room to exit and gather at the nearest rally point outside, east of the building near the trellises.

This course will explore in detail the quantitative physical phenomena underlying kinetics and equilibria of physiological processes. The topics covered will include bonds, molecular excitation and energy transfer, molecular and ionic interactions, diffusion and directed transport, thermodynamics, muscle mechanics, connective tissue, physiological flows, membrane phenomena and control systems. Analytical and critical thinking skills are emphasized in this class which requires a thorough background in the fundamentals of physiology so that the understanding of complex issues can be achieved. This is an Honors sections and will cover more material and at a higher level than a regular 425 section.

This class will have both classroom lectures based on the textbook and student presentations of biophysical research papers. The first day will include discussion of the course goals and an introductory lecture which covers aspects from several different parts of the course. We will start on the material in Chapter 1 of the book on the second day of class and will move sequentially through the book. It is expected that you will have read the parts of the book before we cover tham in class. We will cover slightly more than half a chapter per lecture.

The course will have short answer quizzes, a critical thinking mid-term, two 12 minute presentations by each student and a final exam There will be 3 in-class quizzes in this class. The quizzes will be given at the start of class on the dates below. The short answer quizzes will cover the material covered since the previous quiz. For the first quiz, the questions will be posted on Monday, the day before the quiz. For quiz 1, you will get all the questions in advance, but you will not know which ones will be asked. For quiz 2, you will not know the questions in advance, but you will get to choose which questions you want to answer. For quiz 3, you will neither know the questions in advance nor have a choice of questions. The quizzes total 20 points of your final grade.

The critical thinking test (CTT) will cover all the material up to that point and will be open book, non-electronic: you may bring any book or papers you choose for the essays, but you cannot access any electronic resources, computer, tablet, phone, internet, etc.. For the critical thinking test, Thursday October 25, you will have to discuss the logic of

an experiment leading to its conclusions. Your answers will be in essay form. For some questions you will have seen the material during the semester, but for other questions the experimental scenario will be new. You will not get the questions in advance or have a choice of questions on the CTT. This test will take up the entire class on that day. A table summary of the quizzes and CTT is below. The CTT is worth 20 points toward your final grade

Date	Quiz#	Format	Question Choice	Q's in Advance
9/18	1	Short Answer	4 of 6, no choice	Yes
10/4	2	Short Answer	4 of 6, choice	No
10/9, 10/11, 10/16	Paper Present.	8 Slides, 12 Min		
10/25	CCT	Essay	4 of 4, no choice	No
11/6	3	Short Answer	4 of 4, no choice	No
11/20, 11/27, 11/29	Metastudies	8 Slides, 12 Min		
12/6	Half Quiz MU	Short Answer	Choice of Q1, Q2, Q3	Yes, No, No

All makeups of missed, excused quizzes can be scheduled during office hours. A valid excuse, such as a doctor's note for illness or documentation of a medical school interview, for example, is needed to take a makeup.

All students will present a two 15 minute (12 minute talk, 3 minutes for questions) power point presentations. There is a strict maximum of 8 slides, regardless of content (title, graphs, references, etc.: use your judgment). You may only include a video if it is part of the paper. A video counts as one slide. The Research Paper talk will be based on a research paper in **Biophysical Journal from 2016-present, volumes 110-115**, which can be accessed for free through the MSU library portal. Students must inform the instructor of the paper they will present and select a presentation slot by midnight on September 11 by email at dillon@msu.edu. All paper selections are on a first come first choice, whoever emails me their selection first**. Each selection email must include first author, volume, first page number, first two significant words of title, preferred date and slot.** Cut and paste the form below into your email with your information included.

First Author	
Biophysical Journal Volume 110-115	
First Page Number	
First Two Significant Words of Title	
Preferred Date	
Preferred Slot	

The paper must be a **Research Article** from Biophysical Journal: it will say research article right above the title on the BJ website. Do not choose a review, letter, commentary, stand-alone abstract, erratum, etc. Available slots can be seen in the Research Paper Presentation file on D2L. Each student must also provide an 800-1200 word summary of the research field of their paper and how their paper fits within the field. The research summary may have figures from both your selected paper and other papers if you wish. References will not count toward the summary word count. Both the power point presentation and the research area summary are due by midnight on Tuesday, September 27 in a D2L Assignments dropbox. Class presentations start on October 9. Students will fill in a question sheet during each presentation and some will ask the presenter questions following the talk. The paper presentation/research summary/questions assignment is worth 20 points.

The second presentation will be of a metastudy done by each student. Each student will select an area in which they summarize the research from some area of biophysics. It is this assignment which most separated this course from the regular course material. Each student should discuass their proposed area with Dr. Dillon so that the studey is sufficiently focussed. Two outstanding metastudies done by previous students are included in D2L, one on the optimun amount of chocolate in the diet and the other on the energy of head collisions in soccer. As with the previous presentation, each metastudy presentation will have a maximum of 8 slides and be 12 minutes long with 3 minutes for questions. Two video maximum. These presentations will begin on November 20. For these presentations you can choose your day and slot after Dr. Dillon has approved your topic.

The final will have two parts. The first part will be short answer questions similar to the short answer quiz questions. It will be closed book and will cover the technical material from the lectures and papers. The second part will be essay questions. The second part will be open book, non-electronic as in the CTT. You may bring any notes, papers or books to this part, but you can only use these during the second part of the final, after the first part has been turned in. There will be question from both the research paper and metastudy presentations. The final will be during are final exam time, 12:45-2:45 PM on Thursday, December 13. The final is worth 30 points. Some questions previous tests are below.

My office hours are on Wednesday morning and afternoon. With biophysics classes on both Tuesday and Thursday morning and afternoon, those days are out for office hours. I will meet with students on Monday and Friday by appointment, but as I also have committee work and research activities on those days, I will not always be available. We can meet then if there is a mutually convenient time. The TA office hours are TBA.

The grading scale is the standard university scale, 90% for 4.0, 85% for 3.5, 80% for a 3.0, etc. Many students do very well in this class.

Three additional points: bonus points, letters of recommendation and attendance. (1) Every question, short answer, essay, power point, summary or question, has the potential to get an additional point over and above what the value of that assignment is: bonus points are given for truly exceptional answers and while rare, on average 6-10 are given out in a semester. (2) Each year a number of students in the class ask for letters of recommendation. I will write letters for students for whom I think the letter will help their future application. If you are in the bottom half of the class for example, a letter from me would not help a medical school application. Having received a bonus point on a question makes writing a letter both easy and helpful for the application. (3) If you regularly miss class without an excused absence I won't be able to write you a good letter.

Previous students have described this course as unlike anything they have ever had at MSU. It is meant to be that way. I look forward to meeting all of you soon. I hope we will have a great semester.

Guidelines for Paper Presentations/Research Summary in Physiological Biophysics.

1. What kind of paper is it: experimental research, new method, or model? Does the presentation explain the background of the paper: what previous work was done in this area; is the paper challenging or confirming previous work; are there any technical problems that have to be overcome or new technical developments that make the current work possible? What were the major conclusions of the paper? The student should have read the key papers cited in the paper that led to this work.

2. Did the student show technical proficiency in presenting the paper? Were any slides or handouts clear and understandable? Was there logical flow from slide to slide? Did the student bring in any additional information from other sources to make the presentation better? Was the presentation timely?

3. How does the paper presented fit with other work in the field? Does it confirm where the field is going or send it in a new direction? Does the summary appropriately describe what is happening in this field?

PSL 425 Previous Short answer Questions

1. What is kT (the concept, not the numerical value)? Explain why, in a system at equilibrium, no molecules will be at kT.

2. Below is the Maxwell energy distribution equation. Which part of this equation indicates that the molecules have only kinetic energy, not potential energy?

$$\frac{dn(v)}{n_o dv} = \frac{4}{\sqrt{\pi}}\left(\frac{m}{2kT}\right)^{3/2} v^2 e^{-\frac{mv^2}{2kT}}$$

3. Show why, during the formation of a thymine dimer by UV radiation, the energy is neither released as a photon nor entirely as heat. You may wish to use a graphical explanation.

4. Why can humans detect sounds with negative decibels at 3000 Hz?

5. Give an example showing the relationship between retention time and reaction time in probabilistic systems.

6. Why is the concept of a K_e more appropriate than a K_D near a membrane?

7. Give an example of how changes in absorbance are used to infer the formation of molecular complexes.

8. What did the paper on protein stability and folding kinetics conclude about the differences in protein folding in the nucleus and the cytoplasm? [This question was from a research paper that semester.]

9. In the paper presented in class on protein unfolding, what were the major differences between molecular dynamic simulation and constraint-based modeling? [This question was from a research paper that semester.]

10. What is the major technical difficulty that must be overcome for successful MRS proton measurements?

PSL Previous Essay questions.

1. Consider a molecular system at equilibrium. We are able to rapidly annihilate every molecule with an energy greater than 2kT, before the system is allowed to return to equilibrium. Please diagram and describe the molecular energy distribution before the annihilation event, at the exact moment of annihilation, and once the system has returned to equilibrium.

2. If an activated muscle is allowed to slide down its length-tension curve until it is generating no tension, although still being activated, how would this affect the small-square/basket-weave distribution?

3. Beginning at very low temperatures and increasing through very high temperatures, please explain how the addition of heat to an enzyme system will affect the rate of the catalyzed reaction.

4. Suppose you are treating a disease with an exogenous antibody that has both a greater retention time and a greater reaction time than native antibodies. How would the system respond?

5. How might the membrane electric field affect the orientation of a molecular dipole sufficiently close to the membrane?