Physiological Biophysics (PSL 425, 3 credits)
Spring Semester, 2023
https://d2l.msu.edu/d2l/home/1844153

Section 001 - Tuesdays and Thursdays 8:30am - 9:50am Eastern Time (ET)
Room 19 Natural Resources Building

Section 002 - Tuesdays and Thursdays 1:00pm - 2:20pm Eastern Time (ET)
Room 228 Erickson Hall

Instructor:
Joseph A. Beatty, Ph.D.
Assistant Professor
Department of Physiology
Office: 5007 Interdisciplinary Science and Technology Building (ISTB)
Office phone: 517-884-5046
Email: beattyj7@msu.edu (Best contact method, please include PSL 425 in subject)
Office hours: By email appointment (either in person at ISTB or via Zoom)

Course Description:

This is an advanced undergraduate course that will examine the quantitative aspects of human biophysics with an emphasis on membrane biophysics and electrophysiology. Course instruction could change at any time given changes in public health guidance or changes in MSU operations.

Course Prerequisites: PSL 250, or PSL 310, or PSL 431 & PSL 432

Course Competencies: At the end of this course, you should be able to answer the following questions in short essay form:

1.1) What influences passive, noncoupled transport of a solute across a permeable membrane?
2.1) What is the ionic basis of the membrane potential?
2.2) How does the cell membrane behave like an electrical circuit?
2.2.1) How does voltage clamping deduce properties of ion channels?
2.3) What is the molecular physiology of ion channels?
3.1) What are the mechanisms/components of an action potential?
3.1.1) What are the properties of the ionic conductances responsible for an action potential?
4.1) What is the physiology of voltage-gated sodium and calcium channels?
4.2) What is the physiology of voltage-gated potassium channels?
4.3) How does the action potential propagate?
5.1) What are the mechanisms of synaptic transmission?
5.1.1) What are the basic electrophysiological principles of synaptic transmission at the neuromuscular junction?
5.1.2) What are the principles of neurotransmitter release?
5.1.3) How do toxins and drugs affect synaptic transmission?

Required Resources:

- ✓ Free Online Textbook - Boron, Walter F and Emile L. Boulpaep. *Medical Physiology*, 2017.
- ✓ Calculator w/logarithmic capability
- ✓ PubMed
- ✓ Laptop Computer with Respondus LockDown Browser in D2L (see end of syllabus for download instructions)

Attendance Expectations:

It is expected that you attend class ready to participate during your scheduled class time. Ready to participate entails reading the required readings and completing the required assignments prior to class. You will need to be prepared for each class so that you can contribute to the class discussion. This course involves active discussion among the entire class and within small groups on the readings. The ideal student will contribute to discussions in class but will also let others participate. You are expected to bring a laptop computer on scheduled days to access D2L for completion of research paper questions (RP?s) assignments, quizzes, and the final exam. There will also be a group oral presentation/discussion of a student chosen research paper with the whole class. Your attendance and participation in class discussions is critical for your success in this course. Please contact me via email prior to any absences to arrange for completion of missing assignments.

Academic Integrity:

Please make all assignments in your own words. Quizzes and the Final Exam will be administered via the D2L website with Respondus Lockdown Browser enabled to minimize the possibility of academic dishonesty. Please adhere to the restriction of only a calculator, blank paper, and a writing utensil being allowed during these assessments.

- ❖ MSU Academic Integrity website

Tentative Course Schedule:

This schedule is tentative and subject to change.

Date	Covered Readings		Activities	Assignments	Covered Competencies
Tues. 1/10	**NO CLASS**				
Thurs. 1/12	-	Syllabus and What is Biophysics Pamphlet	Review Syllabus and class expectations, Intro to biophysics lecture	Week 2 Guided Reading Questions (GR?s) **Due 1/17**	-
Tues. 1/17	Chapter 5 - "Solute transport across cell membrane" up to "In simple diffusion..."	-	Discuss GR?s and Lecture clarification	-	1.1

Date	Covered Readings		Activities	Assignments	Covered Competencies
Thurs. 1/19	-	Instructor chosen Research Paper	Discuss Research Paper and **Week 2 Research Paper Questions (RP?s)**	Week 3 GR?s **Due 1/24**	1.1
Tues. 1/24	Chapter 6 - "Electrophysiology of the Cell Membrane" up to "Electrical Model of a Cell Membrane"	-	Discuss GR?s and Lecture clarification	-	2.1
Thurs. 1/26	-	Instructor chosen Research Paper	**Quiz 1**, Discuss Research Paper, and **Week 3 RP?s**	Week 4 GR?s **Due 1/31**	2.1
Tues. 1/31	Chapter 6 - "Electrical Model of a Cell Membrane" up to "A voltage clamp measures..."	-	Quiz review, Discuss GR?s, and Lecture clarification	-	2.2
Thurs. 2/2	-	Group organization	Group organization and Presentation expectations	Week 5 GR?s, **Due 2/7**	2.2
Tues. 2/7	Chapter 6 - "A voltage clamp measures..." up to "Molecular Physiology of Ion Channels"	-	Discuss GR?s and Lecture clarification	-	2.2.1
Thurs. 2/9	-	Instructor chosen Research Paper	Discuss Research Paper and **Week 5 RP?s**	Week 6 GR?s, **Due 2/14**	2.2.1
Tues. 2/14	Chapter 6 - "Molecular Physiology of Ion Channels" up to End of Chapter	-	Discuss GR?s and Lecture clarification	-	2.3
Thurs. 2/16	-	Instructor chosen Research Paper	**Quiz 2**, Discuss Research Paper, and **Week 6 RP?s**	Week 7 GR?s, **Due 2/21**	2.3
Tues. 2/21	Chapter 7 - "Electrical Excitability and Action Potentials" up to "The Na+ and K+ currents..."	-	Quiz review, Discuss GR?s, and Lecture clarification	-	3.1
Thurs. 2/23	-	Instructor chosen Research Paper	Discuss Research Paper and **Week 7 RP?s**	Week 8 GR?s, **Due 2/28**	3.1
Tues. 2/28	Chapter 7 - "The Na+ and K+ currents..." up to "Physiology of Voltage-Gated Channels and Their Relatives"	-	Discuss GR?s, and Lecture clarification	-	3.1.1
Thurs. 3/2	-	**Group 1** chosen Research Paper	**Quiz 3**, Discuss Research Paper and **Week 8 RP?s**	Week 9 GR?s, **Due 3/14**	3.1.1
Tues. 3/7	**SPRING BREAK**				
Thurs. 3/9	**SPRING BREAK**				

Date	Covered Readings		Activities	Assignments	Covered Competencies
Tue. 3/14	Chapter 7 - "Physiology of Voltage-Gated Channels and Their Relatives" up to "K+ channels determine..."	-	Discuss GR?s, and Lecture clarification	-	4.1
Thurs. 3/16	-	**Group 2** chosen Research Paper	Discuss Research Paper and **Week 9 RP?s**	Week 10 GR?s, **Due 3/21**	4.1
Tues. 3/21	Chapter 7 - "K+ channels determine..." up to "Propagation of Action Potentials"	-	Discuss GR?s and Lecture clarification	-	4.2
Thurs. 3/23	-	**Group 3** chosen Research Paper	Discuss Research Paper and **Week 10 RP?s**	Week 11 GR?s, **Due 3/28**	4.2
Tues. 3/28	Chapter 7 - "Propagation of Action Potentials" up to End of Chapter	-	Discuss GR?s and Lecture clarification	-	4.3
Thurs. 3/30	-	**Group 4** chosen Research Paper	**Quiz 4**, Discuss Research Paper, and **Week 11 RP?s**	Week 12 GR?s, **Due 4/4**	4.3
Tues. 4/4	Chapter 8 - "Synaptic Transmission and the Neuromuscular Junction" up to "Synaptic Transmission at the Neuromuscular Junction"	-	Quiz review, Discuss GR?s, and Lecture clarification	-	5.1
Thurs. 4/6	-	**Group 5** chosen Research Paper	Discuss Research Paper and **Week 12 RP?s**	Week 13 GR?s, **Due 4/11**	5.1
Tues. 4/11	Chapter 8 - "Synaptic Transmission at the Neuromuscular Junction" up to "Miniature end-plate potentials..."	-	Discuss GR?s and Lecture clarification	-	5.1.1
Thurs. 4/13	-	**Group 6** chosen Research Paper	Discuss Research Paper and **Week 13 RP?s**	Week 14 GR?s, **Due 4/18**	5.1.1
Tues. 4/18	Chapter 8 - "Miniature end-plate potentials..." up to "Toxins and Drugs Affecting Synaptic Transmission"	-	Discuss GR?s and Lecture clarification	-	5.1.2
Thurs. 4/20	-	**Group 7** chosen Research Paper	Discuss Research Paper, and **Week 14 RP?s**	Week 15 GR?s, **Due 4/25**	5.1.2
Tues. 4/25	Chapter 8 - "Toxins and Drugs Affecting Synaptic Transmission" up to End of Chapter	-	Discuss GR?s, and Lecture clarification	-	5.1.3
Thurs. 4/27	-	**Group 8** chosen Research Paper	**Quiz 5**, Discuss Research Paper and **Week 15 RP?s**	-	5.1.3

Grading plan:

Final grades will be determined based on the scores from the assignments noted below.

Points Received	%Points Received	Grade
477-530	90-100	4.0
451-476	85-89.99	3.5
424-450	80-84.99	3.0
398-423	75-79.99	2.5
371-397	70-74.99	2.0
345-370	65-69.99	1.5
318-344	60-64.99	1.0
<317	<59.99	0.0

1) Guided Reading Questions (14 assignments worth 4 points each, 56 total points, ~10%)

Guided reading questions (GR?s) are approximately 6 questions to guide you in your weekly textbook reading. These weekly questions will help highlight text sections I find particularly interesting/important. Please do not skip reading sections of text that are not highlighted with GR?s. These portions of the text are still testable. Think of the GR?s answers as notes you would take while reading. *It is best if you make these in your own words.* We will devote approximately 20 minutes of Tuesdays' class time to discuss the GR?s and any questions from the readings, first in small groups, then as a class. It is your responsibility to understand what you completed wrong. *These assignments will be scored based on completion only. Assignments turned in after the due date will receive half credit.*

GR?s for the next week will be available on D2L by Thursday 4pm ET.

GR?s will be due on D2L by the following Tuesday at 8am ET

2) Research Paper Questions (13 assignments worth 9 points each, 117 total points, ~22%)

We will have one research paper a week to read. The goals of these research papers are for you to see how biophysics concepts we learn from the text are applied in practice or papers meant to further clarify concepts learned. *The emphasis should be on **all the biophysics content present in the paper that we have covered in the semester** with less emphasis on the true science being conducted.* I will choose the first 5 research papers and lead the discussions on them. The remaining 8 research papers will be chosen by student groups.

Either before or after each research paper presentation (instructor and group), research paper questions (RP?s) will be answered in class on D2L. RP?s will consist of questions worth a total of 9 points. RP?s are questions are designed to help highlight concepts in the paper and/or to ensure students have read the research paper. *These assignments are only available during the scheduled presentation class time.* The week of your group discussion the group will need to provide me with at least 3 research paper questions with answers to assign to the class. These questions can be true or false, multiple choice, fill in the blank, or matching questions. The presenting group members will not be required to answer the RP?s for that week (see **Research Paper**

Presentation). They will receive their points based on the submission of their RP?s to me.
RP?s will be completed on D2L during most scheduled Thursday class meetings.

3) Quizzes (5 quizzes worth 50 points each, drop lowest quiz score for 200 total points, ~38%)

There will be 5 (on 1/26, 2/16, 3/2, 3/30, and 4/27) 30-minute quizzes on the material covered since the last quiz. You will be allowed to drop your lowest quiz score. However, these quizzes still make up a significant portion of your grade. The quizzes will be administered in class via D2L with Respondus Lockdown Browser enabled to minimize the possibility of academic dishonesty. The quizzes will be multiple-choice questions. You will be allowed a calculator, blank paper, and a writing utensil. The Tuesday following a quiz, we will spend the first 20 minutes of class reviewing the quiz. *Make up quizzes for excused absences need to be done either prior to the quiz Thursday or prior to the following Tuesday class when the quiz is reviewed in class.* No quiz make ups will occur after the following Tuesday class. *Proctoring arrangements will be decided at the discretion of the instructor and are subject to change in the event of an unanticipated circumstance.*

4) Research Paper Presentations (25 points group, ~5%; 25 points individual, ~5%: 50 total points, ~10%)

The remaining 8 research papers will be chosen by student groups and the groups will lead the discussion that day (see table below). We will spend a Thursday early in the semester to organize groups (2/2), there will be no research paper or RP?s assignment that week. Groups should use my research papers and discussions as examples of how to prepare for their presentation. Assigned groups of students will choose a research paper that highlights biophysics topics we have covered, or we will cover in class (I can help guide the groups on topics that we have not covered yet). *This paper should **NOT** be a review article.* Groups should have their suggested research paper and research paper questions with answers chosen and given to me based on the table below.

Group	Competency Covered That Week	Research Paper Chosen	RP?s Chosen	Disc. Day
Group 1	3.1.1) What are the properties of the ionic conductances responsible for an action potential?	**2/16**	**2/28**	**3/2**
Group 2	4.1) What is the physiology of voltage-gated sodium and calcium channels?	**3/2**	**3/14**	**3/16**
Group 3	4.2) What is the physiology of voltage-gated potassium channels?	**3/3***	**3/21**	**3/23**
Group 4	4.3) How does the action potential propagate?	**3/16**	**3/28**	**3/30**
Group 5	5.1) What are the mechanisms of synaptic transmission?	**3/23**	**4/4**	**4/6**

Group 6	5.1.1) What are the basic electrophysiological principles of synaptic transmission at the neuromuscular junction?	**3/30**	**4/11**	**4/13**
Group 7	5.1.2) What are the principles of neurotransmitter release?	**4/6**	**4/18**	**4/20**
Group 8	5.1.3) How do toxins and drugs affect synaptic transmission?	**4/13**	**4/25**	**4/27**

The discussion is an oral presentation and leading of class discussion based on your research paper. ***By 12pm ET the Wednesday before your group discussion*** *each group should email me the file of their presentation.* The presentation should follow the examples I have given in the first half of the semester. Groups should plan on this discussion lasting ~30-40 minutes of class time. **Do not have one person present the results section of the paper.** The results should be a major focus of your presentation and should be divided amongst the group.

You will be evaluated both as a group and as an individual, each consisting 5% of your final grade. You will be evaluated on your **preparation** (quality of slide show and knowledge of the content), **oral presentation** (logic, delivery, and timing), **discussion period** (leading the class in discussion of the material, asking questions to class), and **clarity** of presentation and discussion.

5) Final Exam (107 points, ~20%)

Date	Section	Time	Location
Tues. 5/2	**Section 001**	**7:45am-9:45am ET**	**Room 19 Natural Resources Building**
Wed. 5/3	**Section 002**	**10:00am-12:00pm ET**	**Room 228 Erickson Hall**

The final exam will be cumulative over all material covered during the semester. The final will consist of multiple-choice questions. You will be allowed a calculator, blank paper, and a writing utensil. The final exam will occur via D2L similar to the quizzes. Students will be required to use Respondus Lockdown Browser for the final exam.

Proctoring arrangements will be decided at the discretion of the instructor and are subject to change in the event of an unanticipated circumstance.

"A student absent from a final examination without a satisfactory explanation will receive a grade of 0.0 on the numerical system, NC on the CR-NC system, or N in the case of a course authorized for grading on the P-N system. Students unable to take a final examination because of illness or other reason over which they have no control should notify the associate deans of their colleges immediately." From the Office of the Registrar website: Academic Programs

– General Information, Policies, Procedures and Regulations found at http://www.reg.msu.edu/AcademicPrograms/Text.asp?Section=112#s499

Accommodations for Students with Disabilities:

Michigan State University is committed to providing equal opportunity for participation in all programs, services, and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at rcpd.msu.edu. Once your eligibility for an accommodation has been determined, you will be issued a verified individual services accommodation ("VISA") form. *Please present this form to me at the start of the term* and/or two weeks prior to the accommodation date (test, project, etc.). Requests received after this date will be honored whenever possible.

Internet accessibility and help:

All students will need some form of connectivity for this semester. In the United States, hotspots are available for a low price and often carry one month of free internet connection. Some assistance might be available through the Office of Financial Aid or Student Services because connectivity will effectively become a requirement for the course. A map of free hotspots in Michigan is available here:

http://cngis.maps.arcgis.com/apps/webappviewer/index.html?id=0d69accbb5ff422a82eccc2c9101b69d

If you need technical assistance at any time during the course or to report a problem, you can:

- Visit the Online and Distance Learning Services Support Site
- Visit the Desire2Learn Help Site
- Or call Distance Learning Services (24x7 with the exception of University Holidays): 1-800-500-1554 or 517-355-2345

Respondus LockDown Browser:

This course requires the use of LockDown Browser for online exams (Exams and Final Exam). Watch this video to get a basic understanding of LockDown Browser:
https://www.respondus.com/products/lockdown-browser/student-movie.shtml

Download Instructions

- Select the quiz in the course
- Under Quiz Requirements you will see "To take this quiz you must use the Respondus LockDown Browser"
- Below this will appear: "You can use the button below if you have not already downloaded LockDown Browser". Click the button to go to the download page and then follow the instructions
- Use the link to download Respondus LockDown Browser to your computer; follow the installation instructions
- Return to the Quiz page in Brightspace (it may still be open in another tab) and select the quiz
- Select "Launch LockDown Browser"
- The exam will now start

Note: *LockDown Browser only needs to be installed once to a computer or device. It will start automatically from that point forward when a quiz requires it.*

Emergency Procedures:

In the event of an emergency arising within the classroom, I will notify you of what actions that may be required to ensure your safety. It is the responsibility of each student to understand the evacuation, "shelter-in-place," and "secure-in-place" guidelines posted in each facility and to act in a safe manner. You are allowed to maintain cellular devices in a silent mode during this course, in order to receive emergency SMS text, phone or email messages distributed by the university. When anyone receives such a notification or observes an emergency situation, they should immediately bring it to the attention of me in a way that causes the least disruption. If an evacuation is ordered, please ensure that you do it in a safe manner and facilitate those around you that may not otherwise be able to safely leave. When these orders are given, you do have the right as a member of this community to follow that order. Also, if a shelter-in-place or secure-in-place is ordered, please seek areas of refuge that are safe depending on the emergency encountered and provide assistance if it is advisable to do so.

Honors Option Credit:

Students must earn a 3.0 or greater in this course to be eligible for Honors Option credit. An agreement between instructor and student to undertake an Honors Option project should be reached no later than the end of the first month of the term. An honors option project in this course consists of reading a research paper on membrane biophysics (topic of your choice, with my approval) and giving a short (~30-40 minutes) presentation to me where we discuss the paper and how it relates to the concepts learned throughout the course. This assignment is similar to the group presentation in the class, but solo and outside of class time. Students should wait until approximately halfway through the semester or later to choose an honors paper. By waiting you are better prepared to choose a worthy paper and discuss the biophysics content.