Physiological Biophysics (PSL 425, 3 credits)
Spring Semester, 2021
https://d2l.msu.edu/d2l/home/1170857

Section 001 - Tuesdays and Thursdays 8:30am - 9:50am Eastern Time (ET)
Synchronous Online via Zoom
Meeting ID: 994 3386 4225
https://msu.zoom.us/j/99433864225

Section 002 - Tuesdays and Thursdays 1:00pm – 2:20pm Eastern Time (ET)
Synchronous Online via Zoom
Meeting ID: 944 9956 5160
https://msu.zoom.us/j/94499565160

Instructor:
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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, include PSL 425 in subject)
Office hours: Via Zoom by email appointment, Meeting ID: 565 508 9955
(https://msu.zoom.us/j/5655089955)

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 University operations.

Course Prerequisites: PSL 250 or PSL 310 or (PSL 431 and 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 the 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:

- ✓ Textbook - Boron, Walter F, and Emile L. Boulpaep. Medical Physiology. 2017.
- ✓ Calculator w/logarithmic capability
- ✓ PubMed
- ✓ Zoom
- ✓ Respondus LockDown Browser in D2L (see end of syllabus for download instructions)
- ✓ V=IR (password)

Attendance Expectations:

It is expected that you attend class via Zoom with your *video enabled* and ready to participate during your scheduled class time (Eastern Time). This entails reading the required textbook reading and answering the guided reading questions prior to class on Tuesdays. While on Thursdays, having the assigned research paper read and being prepared to answer the research paper questions during 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 (Zoom breakout rooms) on the readings. The ideal student will contribute to discussions each class but will also let others participate. There will also be a group oral presentation/discussion of a student chosen research paper with the whole class. Your attendance on Zoom 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:

Exams 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 being allowed during these online assessments.

- ❖ MSU Academic Integrity website

Tentative Course Schedule:

This schedule is tentative and subject to change.

Date	Covered Readings		Activities	Assignments	Covered Competencies
Tues. 1/12	**NO CLASS** Reading, Reviewing, and Reflection	Syllabus	Review Syllabus	Syllabus Review Check **Due 1/19**	-
Thurs. 1/14	**NO CLASS** Reading, Reviewing, and Reflection	Syllabus	Review Syllabus	Week 2 Guided Reading Questions (GR?s) **Due 1/19**	-

Date	Covered Readings		Activities	Assignments	Covered Competencies
Tues. 1/19	Chapter 5 - "Solute transport across cell membrane" up to "In simple diffusion..."	-	Discuss Guided Reading Questions (GR?s) and Lecture clarification	-	1.1
Thurs. 1/21	-	Instructor chosen Research Paper	Discuss Research Paper and **Week 2 Research Paper Questions (RP?s)**	Week 3 GR?s **Due 1/26**	1.1
Tues. 1/26	Chapter 6 - "Electrophysiology of the Cell Membrane" up to "Electrical Model of a Cell Membrane"	-	Discuss GR?s and Lecture clarification	-	2.1
Thurs. 1/28	-	Instructor chosen Research Paper	**Exam 1**, Discuss Research Paper, and **Week 3 RP?s**	Week 4 GR?s **Due 2/2**	2.1
Tues. 2/2	Chapter 6 - "Electrical Model of a Cell Membrane" up to "A voltage clamp measures..."	-	Exam review, Discuss GR?s, and Lecture clarification	-	2.2
Thurs. 2/4	-	Group organization	Group organization and Presentation expectations	Week 5 GR?s, **Due 2/9**	2.2
Tues. 2/9	Chapter 6 - "A voltage clamp measures..." up to "Molecular Physiology of Ion Channels"	-	Discuss GR?s and Lecture clarification	-	2.2.1
Thurs. 2/11	-	Instructor chosen Research Paper	Discuss Research Paper and **Week 5 RP?s**	Week 6 GR?s, **Due 2/16**	2.2.1
Tues. 2/16	Chapter 6 - "Molecular Physiology of Ion Channels" up to End of Chapter	-	Discuss GR?s and Lecture clarification	-	2.3
Thurs. 2/18	-	**Group 1** chosen Research Paper	**Exam 2**, Discuss Research Paper, and **Week 6 RP?s**	Week 7 GR?s, **Due 2/23**	2.3
Tues. 2/23	Chapter 7 - "Electrical Excitability and Action Potentials" up to "The Na+ and K+ currents..."	-	Exam review, Discuss GR?s, and Lecture clarification	-	3.1
Thurs. 2/25	-	**Group 2** chosen Research Paper	Discuss Research Paper and **Week 7 RP?s**	Week 8 GR?s, **Due 3/4***	3.1
Tues. 3/2	**BREAK DAY**	**BREAK DAY**	**BREAK DAY**	**BREAK DAY**	**BREAK DAY**
Thurs. 3/4	Chapter 7 - "The Na+ and K+ currents..." up to "Physiology of Voltage-Gated Channels and Their Relatives"	-	**Exam 3**, Discuss GR?s, and Lecture clarification	Week 9 GR?s, **Due 3/9**	3.1.1

Date	Covered Readings		Activities	Assignments	Covered Competencies
Tues. 3/9	Chapter 7 - "Physiology of Voltage-Gated Channels and Their Relatives" up to "K+ channels determine..."	-	Exam review, Discuss GR?s and Lecture clarification	-	4.1
Thurs. 3/11	-	**Group 3** chosen Research Paper	Discuss Research Paper and **Week 9 RP?s**	Week 10 GR?s, **Due 3/16**	4.1
Tues. 3/16	Chapter 7 - "K+ channels determine..." up to "Propagation of Action Potentials"	-	Discuss GR?s and Lecture clarification	-	4.2
Thurs. 3/18	-	**Group 4** chosen Research Paper	Discuss Research Paper and RP?s	Week 11 GR?s, **Due 3/23**	4.2
Tues. 3/23	Chapter 7 - "Propagation of Action Potentials" up to End of Chapter	-	Discuss GR?s and Lecture clarification	-	4.3
Thurs. 3/25	-	**Group 5** chosen Research Paper	**Exam 4**, Discuss Research Paper, and RP?s	Week 12 GR?s, **Due 3/30**	4.3
Tues. 3/30	Chapter 8 - "Synaptic Transmission and the Neuromuscular Junction" up to "Synaptic Transmission at the Neuromuscular Junction"	-	Exam review, Discuss GR?s, and Lecture clarification	-	5.1
Thurs. 4/1	-	**Group 6** chosen Research Paper	Discuss Research Paper and RP?s	Week 13 GR?s, **Due 4/6**	5.1
Tues. 4/6	Chapter 8 - "Synaptic Transmission at the Neuromuscular Junction" up to "Miniature end-plate potentials..."	-	Discuss GR?s and Lecture clarification	-	5.1.1
Thurs. 4/8	-	**Group 7** chosen Research Paper	Discuss Research Paper and RP?s	Week 14 GR?s **Due 4/13**	5.1.1
Tues. 4/13	Chapter 8 - "Miniature end-plate potentials..." up to "Toxins and Drugs Affecting Synaptic Transmission"	-	Discuss GR?s and Lecture clarification	-	5.1.2
Thurs. 4/15		**Group 8** chosen Research Paper	**Exam 5**, Discuss Research Paper, and **Week 14 RP?s**	Week 15 GR?s, **Due 4/20**	5.1.2
Tues. 4/20	Chapter 8 - "Toxins and Drugs Affecting Synaptic Transmission" up to End of Chapter	-	Exam review, Discuss GR?s, and Lecture clarification	-	5.1.3
Thurs. 4/22	**STUDY DAY**	**STUDY DAY**	**STUDY DAY**	**STUDY DAY**	**STUDY DAY**

Guided reading questions (GR?s) and research papers 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 (*exception on 3/4). RP?s will be completed during scheduled class meetings on D2L.

Grading plan:

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

Points Received	%Points Received	Grade
540-600	90-100	4.0
510-539	85-89.99	3.5
480-509	80-84.99	3.0
450-479	75-79.99	2.5
420-449	70-74.99	2.0
390-419	65-69.99	1.5
360-389	60-64.99	1.0
<359	<59.99	0.0

1) Syllabus Review Check (1 assignment worth 6 points, 6 total points, 1%)

Please review this course syllabus and email me with any questions or concerns. When completed, please submit a statement in the text submission of the Syllabus Review Check assignment that you have read and understand the course syllabus prior to 8am ET Tuesday 1/19. This will serve as completion of the assignment and I will award the 6 points.

Syllabus Review Check will be due on D2L Tuesday 1/19 at 8am ET

2) Guided Reading Questions (14 assignments worth 5 points each, 70 total points, ~12%)

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 (Zoom breakout rooms), 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 (*exception on 3/4).

3) Research Paper Questions (11 assignments worth 9 points each, 99 total points, ~16%)

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 3 research papers and lead the discussions on them. The remaining 8 research papers will be chosen by student groups.

During each research paper presentation (instructor and group), research paper questions (RP?s) will be answered in class. 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 Discussion**). They will receive their points based on the submission of their RP?s to me.
RP?s will be completed during scheduled class meetings on D2L.

4) Exams (5 exams worth 48 points each, 240 total points, 40%)

There will be 5 (on 1/28, 2/18, 3/4, 3/25, and 4/15) 30-minute exams on the material covered since the last exam. These exams make up a significant portion of your grade. The exams will be administered via D2L with Respondus Lockdown Browser enabled to minimize the possibility of academic dishonesty. Exams will not be completed during class time. Instead, exams will be available to complete on your own between 8am ET Thursday and 8am ET Friday. The exams will be multiple choice questions. You will be allowed a calculator but no other material. The Tuesday following an exam, we will spend the first 20 minutes of class reviewing the exam. *Make up exams for excused absences need to be done either prior to the exam Thursday or prior to the following Tuesday class when the exam is reviewed in class.* No exam 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.*
Exams must be completed by Friday at 8am ET.

5) Research Paper Presentations (30 points group, 5%; 30 points individual, 5%: 60 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 (2/4), 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. Assigned groups of 4-5 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 8am ET	Discussion Day
Group 1	2.3) What is the molecular physiology of ion channels?	**2/5**	**2/10**	**2/18**
Group 2	3.1) What are the mechanisms/components of an action potential?	**2/11**	**2/17**	**2/25**
Group 3	4.1) What is the physiology of voltage-gated sodium and calcium channels?	**2/25**	**3/4**	**3/11**

Group 4	4.2) What is the physiology of voltage-gated potassium channels?	**3/4**	**3/10**	**3/18**
Group 5	4.3) How does the action potential propagate?	**3/11**	**3/17**	**3/25**
Group 6	5.1) What are the mechanisms of synaptic transmission?	**3/18**	**3/24**	**4/1**
Group 7	5.1.1) What are the basic electrophysiological principles of the synaptic transmission at the neuromuscular junction?	**3/25**	**4/31**	**4/8**
Group 8	5.1.2) What are the principles of neurotransmitter release?	**4/1**	**4/7**	**4/15**

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 ~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), and **clarity** of presentation and discussion.

6) Final Exam (125 points, ~21%)

Date	Section	Time	Location
***Tues. 4/27**	**Section 001**	***7:45am-9:45am ET**	**Online via D2L**
***Wed. 4/28**	**Section 002**	***10:00am-12:00pm ET**	**Online via D2L**

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, but no other material. The final exam will occur via D2L similar to the other exams. Students will be required to use Respondus Lockdown Browser for the final exam. **The exact window of dates and times for the online final exam will be determined later and stated in class meetings closer to the final exam dates.*

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 exam 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.*