Physiological Biophysics (PSL 425, 3 credits)
Fall Semester, 2019

Section 001 - Tuesdays and Thursdays 8:30 AM - 9:50 AM
Room 019 Natural Resources Bldg

Section 002 - Tuesdays and Thursdays 1:00 PM – 2:20 PM
Room 228 Erickson Hall

Instructor:
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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 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
- ✓ PubMed

Expectations:

It is expected that you come to class ready to participate. That entails reading the required reading assignment and answering the guided reading questions and pre paper questions prior to class. You will need to be prepared for 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 each class, but will also let others participate. There will also be a group oral discussion of a student chosen research paper with the whole class. Your attendance and participation in class is critical for your success in this course.

Attendance Policy:

Attendance is very important in this class since it relies heavily on student driven discussion and there will be quizzes almost every week. If you cannot make it to class because of illness, I ask you email me *prior* to class meeting (this will be deemed an excused absence) and we can arrange a makeup of missed assignments. If repeated absences do occur I reserve the right to ask for a note from a medical professional or deem absences as unexcused. Unexcused absences will result in a loss of points for the missed assignments with no makeup possible.

- MSU Attendance Policy on the Office of the University Ombudsperson website

Tentative Course Schedule:

This schedule is tentative and subject to change.

Date	Covered Reading		Activity	Assignment	Covered Competencies
Thurs. 8/29	-	Syllabus	Syllabus and expectations, Intro to biophysics lecture	Week 2 Guided Reading Questions (GR?s), Week 2 Pre Paper Questions (PP?s) **Due 9/3**	-
Tues. 9/3	Chapter 5 - "Solute transport across cell membrane" up to "In simple diffusion..."	-	Discuss Guided Reading Questions (GR?s), Lecture clarification	-	1.1
Thurs. 9/5	-	Instructor chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 3 GR?s, Week 3 PP?s **Due 9/10**	1.1
Tues. 9/10	Chapter 6 - "Electrophysiology of the Cell Membrane" up to "Electrical Model of a Cell Membrane"	-	Quiz review, Discuss GR?s, Lecture clarification	-	2.1
Thurs. 9/12	-	Instructor chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 4 GR?s	2.1
Tues. 9/17	Chapter 6 - "Electrical Model of a Cell Membrane" up to "A voltage clamp measures..."	-	Quiz review, Discuss GR?s, Lecture clarification	-	2.2

Date	Covered Reading		Activity	Assignment	Covered Competencies
Thurs. 9/19	-	Group organization	**Quiz**, Group organization	Week 5 GR?s, Week 5 PP?s **Due 9/24**	2.2
Tues. 9/24	Chapter 6 - "A voltage clamp measures..." up to "Molecular Physiology of Ion Channels"	-	Quiz review, Discuss GR?s, Lecture clarification	-	2.2.1
Thurs. 9/26	-	Instructor chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 6 GR?s, Week 6 PP?s **Due 10/1**	2.2.1
Tues. 10/1	Chapter 6 - "Molecular Physiology of Ion Channels" up to End of Chapter	-	Quiz review, Discuss GR?s, Lecture clarification	-	2.3
Thurs. 10/3	-	Instructor chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 7 GR?s, Week 7 PP?s **Due 10/8**	2.3
Tues. 10/8	Chapter 7 - "Electrical Excitability and Action Potentials" up to "The Na+ and K+ currents..."	-	Quiz review, Discuss GR?s, Lecture clarification	-	3.1
Thurs. 10/10	-	Instructor chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 8 GR?s, Week 8 PP?s **Due 10/15**	3.1
Tues. 10/15	Chapter 7 - "The Na+ and K+ currents..." up to "Physiology of Voltage-Gated Channels and Their Relatives"	-	Quiz review, Discuss GR?s, Lecture clarification	-	3.1.1
Thurs. 10/17	-	Group 1 chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 9 GR?s, Week 9 PP?s **Due 10/22**	3.1.1
Tues. 10/22	Chapter 7 - "Physiology of Voltage-Gated Channels and Their Relatives" up to "K+ channels determine..."	-	Quiz review, Discuss GR?s, Lecture clarification	-	4.1
Thurs. 10/24	-	Group 2 chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 10 GR?s, Week 10 PP?s **Due 10/29**	4.1
Tues. 10/29	Chapter 7 - "K+ channels determine..." up to "Propagation of Action Potentials"	-	Quiz review, Discuss GR?s, Lecture clarification	-	4.2
Thurs. 10/31	-	Group 3 chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 11 GR?s, Week 11 PP?s **Due 11/5**	4.2
Tues. 11/5	Chapter 7 - "Propagation of Action Potentials" up to End of Chapter	-	Quiz review, Discuss GR?s, Lecture clarification	-	4.3
Thurs. 11/7	-	Group 4 chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 12 GR?s, Week 12 PP?s **Due 11/12**	4.3

Tues. 11/12	Chapter 8 - "Synaptic Transmission and the Neuromuscular Junction" up to "Synaptic Transmission at the Neuromuscular Junction"	-	Quiz review, Discuss GR?s, Lecture clarification	-	5.1
Thurs. 11/14	-	Group 5 chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 13 GR?s, Week 13 PP?s **Due 11/19**	5.1
Tues. 11/19	Chapter 8 - "Synaptic Transmission at the Neuromuscular Junction" up to "Miniature end-plate potentials..."	-	Quiz review, Discuss GR?s, Lecture clarification	-	5.1.1
Thurs. 11/21	-	Group 6 chosen research paper	**Quiz**, Discuss research paper and PP?s	Week 14 GR?s	5.1.1
Tues. 11/26	Chapter 8 - "Miniature end-plate potentials..." up to "Toxins and Drugs Affecting Synaptic Transmission"	-	Quiz review, Discuss GR?s, Lecture clarification	Week 15 GR?s, Week 15 PP?s **Due 12/3**	5.1.2
Thurs. 11/28	**Thanksgiving**	**Thanksgiving**	**Thanksgiving**	**Thanksgiving**	**Thanksgiving**
Tues. 12/3	Chapter 8 - "Toxins and Drugs Affecting Synaptic Transmission" up to End of Chapter	-	Discuss GR?s, Lecture clarification	-	5.1.3
Thurs. 12/5	-	Group 7 chosen research paper	**Quiz**, Discuss research paper and PP?s	-	5.1.3

Guided reading questions (GR?s), instructor chosen research papers, and pre paper questions (PP?s) for the next week will be available on D2L by Thursday 4pm.
PP?s will be due on D2L by the following Tuesday at 11pm.

Guided Reading Questions

The guided reading questions (GR?s) are approximately 6 questions to guide you in your weekly textbook reading. These 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.

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

Grading plan:

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

Points Received	%Points Received	Grade
594-660	90-100	4.0
561-593	85-89.99	3.5
528-560	80-84.99	3.0
495-527	75-79.99	2.5
462-494	70-74.99	2.0
429-461	65-69.99	1.5
396-428	60-64.99	1.0
<395	<59.99	0.0

1) **Pre Paper Questions (11 assignments worth 6 points each, 66 total points, 10%)**

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 chose the first 5 research papers and lead the discussions on them. For each research paper, pre paper questions (PP?s) will be assigned. PP?s are questions designed to help highlight concepts in the paper. You should answer these questions as you read the paper and submit them on D2L for a grade. The week of *your* group discussion the group will need to provide me with at least three pre paper questions to assign to the class. The group will not be required to turn in the PP?s for a grade that week (see **Research Paper Discussion** below). I assume you will have extensive knowledge of all figures and concepts of your chosen research paper.

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

PP?s will be due on D2L by Tuesday at 11pm.

2) **Weekly Quizzes (12 quizzes worth 22 points each, 264 total points, 40%)**

Starting on 9/5, every Thursday there will be an approximately 30 minute quiz on the material for the week. These quizzes make up a significant portion of your grade. The quizzes will have multiple choice and short answer questions (similar to the GR?s and PP?s). You will be allowed a calculator but no other material. Starting on 9/10, we will spend the first approximately 20 minutes of Tuesday's class reviewing the previous quiz. You will be allowed to drop your lowest quiz score (one) for the semester.

3) **Research Paper Discussion (65 points group, ~10%; 65 points individual, ~10%: 130 total points, ~20%)**

The remaining 7 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 (9/19), there will be no paper that week. Groups should use my research papers and discussions as examples of how to prepare. Assigned groups of 2-4 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 haven't covered*

yet). Groups should have their suggested research paper and pre paper questions chosen and given to me *one week before it is assigned* (see table below).

Group	Competency Covered That Week	Research Paper & PP?s Chosen	Discussion Day
Group 1	4.1) What is the physiology of voltage-gated sodium and calcium channels?	10/3	10/17
Group 2	4.2) What is the physiology of voltage-gated potassium channels?	10/10	10/24
Group 3	4.3) How does the action potential propagate?	10/17	10/31
Group 4	5.1) What are the mechanisms of synaptic transmission?	10/24	11/7
Group 5	5.1.1) What are the basic electrophysiological principles of the synaptic transmission at the neuromuscular junction?	10/31	11/14
Group 6	5.1.2) What are the principles of neurotransmitter release?	10/7	11/21
Group 7	5.1.3) How do toxins and drugs affect synaptic transmission?	10/14	12/5

This discussion will be an oral presentation and leading of class discussion based on your research paper. **By noon 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.

You will be evaluated both as a group and as an individual, each consisting of ~10% 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.

4) **Final Exam (200 points, ~30%)**

Date	Section	Time	Location
Tues. 12/10	**Section 001**	**7:45am-9:45am**	**019 Natural Resources Bldg**
Thurs. 12/12	**Section 002**	**12:45pm-2:45pm**	**228 Erickson Hall**

The final exam will be cumulative over all material covered during the semester. The final will consist of multiple choice questions as well as short answer questions, similar to

the weekly quizzes, GR?s, and PP?s, but longer in length and more expansive in scope. You will be allowed a calculator, but no other material.

"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.

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.