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

Section 001 - Tuesdays and Thursdays 8:30 AM - 9:50 AM Room 111 Biochemistry
Section 002 - Tuesdays and Thursdays 1:00 PM – 2:20 PM Room S134 South Kedzie

Instructor:

Joseph A. Beatty, Ph.D.
Assistant Professor
Department of Physiology
Office: 2193 Biomedical Physical Sciences (BPS)
Office phone: 517-884-5046
Email: beattyj7@msu.edu (best contact method, include PSL 425 in subject)
Office hours: M-F by email appointment

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 Learning Objectives: We will cover these big questions in biophysics:

- How do solutes transport across cell membranes?
- What is the ionic basis of the membrane potential?
- How does the cell membrane behave like an electrical circuit?
- What is the molecular physiology of ion channels?
- What are the mechanisms/components of an action potential?
- What is the physiology of voltage-gated channels?
- How does the action potential propagate?
- What are the mechanisms of synaptic transmission?

Required Resources:

- ✓ Textbook - Boron, Walter F, and Emile L. Boulpaep. Medical Physiology. 2017. Computer file.
- ✓ Calculator
- ✓ PubMed

Expectations:

It is expected that you come to class ready to participate. That entails reading the required reading assignment 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. 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 makeup assignments to be completed for the lost discussion points. 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 your discussion points for the day with no makeup possible (see **Grading Plan** below).

- 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
Tues. 1/8	-	Syllabus	Syllabus and expectations, Intro to biophysics lecture	Week 1 Guided Reading Questions (GR?s) **Due 1/10**
Thurs. 1/10	Chapter 5 - "Solute transport across cell membrane" up to "In simple diffusion..."	-	Discuss GR?s, Lecture clarification	Week2 GR?s **Due 1/13**, Figure Facts Worksheet (FFW) **Due 1/15**
Tues. 1/15	Chapter 6 - "Electrophysiology of the Cell Membrane" up to "For mammalian cells..."	-	Discuss GR?s, Lecture clarification	-
Thurs. 1/17	-	Instructor chosen research paper	**Quiz**, Discuss research paper	Week 3 GR?s **Due 1/20**, FFW **Due 1/22**
Tues. 1/22	Chapter 6 - "For mammalian cells..." up to "Electrical Model of a Cell Membrane"	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 1/24	-	Instructor chosen research paper	**Quiz**, Discuss research paper	Week4 GR?s **Due 1/27**, FFW **Due 1/29**
Tues. 1/29	Chapter 6 - "Electrical Model of a Cell Membrane" up to "Capacitative current is..."	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 1/31	-	Instructor chosen research paper	**Quiz**, Discuss research paper	Week 5 GR?s **Due 2/3**, FFW **Due 2/5**
Tues. 2/5	Chapter 6 - "Capacitative current is..." up to "Molecular Physiology of Ion Channels"	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 2/7	-	Instructor chosen research paper	**Quiz**, Discuss research paper	Week 6 GR?s **Due 2/10**, FFW **Due 2/12**
Tues. 2/12	Chapter 6 - "Molecular Physiology of Ion Channels" up to End of Chapter	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 2/14	-	Instructor chosen research paper	**Quiz**, Discuss research paper	Week 7 GR?s **Due 2/17**, FFW **Due 2/19**

Date	Covered Reading		Activity	Assignment
Tues. 2/19	Chapter 7 - "Electrical Excitability and Action Potentials" up to "The Na+ and K+ currents..."	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 2/21	-	Instructor chosen research paper	**Quiz**, Discuss research paper	Week 8 GR?s **Due 2/24**, FFW **Due 2/26**
Tues. 2/26	Chapter 7 - "The Na+ and K+ currents..." up to "Physiology of Voltage-Gated Channels and Their Relatives"	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 2/28	-	Instructor chosen research paper	**Quiz**, Discuss research paper	Week 9 GR?s **Due 3/10**, FFW **Due 3/12**
3/5-3/7	**SPRING BREAK**	**SPRING BREAK**	**SPRING BREAK**	**SPRING BREAK**
Tues. 3/12	Chapter 7 - "Physiology of Voltage-Gated Channels and Their Relatives" up to "K+ channels determine..."	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 3/14	-	Group 1 chosen research paper	**Quiz**, Discuss research paper	Week 10 GR?s **Due 3/17**, FFW **Due 3/19**
Tues. 3/19	Chapter 7 - "K+ channels determine..." up to "Propagation of Action Potentials"	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 3/21	-	Group 2 chosen research paper	**Quiz**, Discuss research paper	Week 11 GR?s **Due 3/24**, FFW **Due 3/26**
Tues. 3/26	Chapter 7 - "Propagation of Action Potentials" up to End of Chapter	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 3/28	-	Group 3 chosen research paper	**Quiz**, Discuss research paper	Week 12 GR?s **Due 3/31**, FFW **Due 4/2**
Tues. 4/2	Chapter 8 - "Synaptic Transmission and the Neuromuscular Junction" up to "Synaptic Transmission at the Neuromuscular Junction"	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 4/4	-	Group 4 chosen research paper	**Quiz**, Discuss research paper	Week 13 GR?s **Due 4/7**, FFW **Due 4/9**
Tues. 4/9	Chapter 8 - "Synaptic Transmission at the Neuromuscular Junction" up to "Miniature end-plate potentials..."	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 4/11	-	Group 5 chosen research paper	**Quiz**, Discuss research paper	Week 14 GR?s **Due 4/14**, FFW **Due 4/16**
Tues. 4/16	Chapter 8 - "Miniature end-plate potentials..." up to "Toxins and Drugs Affecting Synaptic Transmission"	-	Quiz review, Discuss GR?s, Lecture clarification	-
Thurs. 4/18	-	Group 6 chosen research paper	**Quiz**, Discuss research paper	Week 15 GR?s **Due 4/21**, FFW **Due 4/23**
Tues. 4/23	Chapter 8 - "Toxins and Drugs Affecting Synaptic Transmission" up to End of Chapter	-	Quiz review, Discuss GR?s, Lecture clarification	-

Date	Covered Reading		Activity	Assignment
Thurs. 4/25	-	Group 7 chosen research paper	**Quiz**, Discuss research paper, Quiz review?	

Starting on 1/10, guided reading questions (GR?s), instructor chosen research papers, and figure facts worksheets (FFW) for the next week will be available on D2L by Thursday 4pm.
GR?s will be due on D2L by the following Sunday at 11pm.
FFW will be due on D2L by the following Tuesday at 11pm.

Grading plan:

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

Points Received	%Points Received	Grade
820-911	90-100	4.0
775-819	85-89.99	3.5
729-774	80-84.99	3.0
684-728	75-79.99	2.5
638-683	70-74.99	2.0
593-637	65-69.99	1.5
547-592	60-64.99	1.0
<546	<59.99	0.0

1) **In Class Discussion (3 points per day, 90 total points, ~10%)**

You must come prepared to discuss the reading assignments in class. This applies to the textbook readings (Tuesday) as well as the research papers (Thursday). This is the best time to discuss any questions you have regarding the reading material. Unexcused absences (see **Attendance Policy** above) will result in a loss of 3 points per day missed. Typical point break down: 1 point if you are present, 1-2 points based on your role in the discussion.

2) **Guided Reading Questions (15 assignments worth 6 points each, 90 total points, ~10%)**

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. Please make these in your own words. The points from this assignment will be given based on completion and effort. We will devote 20-30 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.

Starting on 1/10, GR?s for the next week will be available on D2L by Thursday 4pm.
GR?s will be due on D2L by Sunday at 11pm.

3) **Figure Facts Worksheets (13 assignments worth 7 points each, 91 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. The emphasis should be on all the biophysics content present in the paper with less emphasis on the true science being conducted. I will chose the first 7 research papers and lead the discussions on them. For each research paper a figure facts worksheets (FFWs) will be assigned. FFWs are assignments designed to help students read primary research articles. You should fill out these worksheets as you read the paper. You will not be required to turn in the FFW for the week of *your* group discussion (see **Research Paper Discussion** below). I assume you will have extensive knowledge of all figures and concepts of your chosen research paper.

Starting on 1/10, the FFW for the next week will be available on D2L by Thursday 4pm. **FFWs will be due on D2L by Tuesday at 11pm.**

4) **Weekly Quizzes (14 quizzes worth 20 points each, 280 total points, ~30%)**

Starting on 1/17, at the beginning of every Thursday class there will be a 30-40 minute quiz on the material for the week. These quizzes make up a significant portion of your grade. The quizzes will have multiple choice (1 point each) and short answer questions (3 points each). You will be allowed a calculator but no other material. Starting on 1/15, we will spend the first 20-30 minutes of Tuesday's class reviewing the previous quiz.

5) **Research Paper Discussion (90 points group, ~10%; 90 points individual, ~10%: 180 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). Groups should use my research papers and discussions as examples of how to prepare. Assigned groups of 3-5 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 haven't covered yet*). Groups should have their suggested research paper chosen and given to me one week before it is assigned (see table below).

Group	General Topic Covered That Week	Paper Chosen	Discussion Day
Group 1	Sodium channels and calcium channels	2/21	3/14
Group 2	Potassium channels and potassium dependent channels	2/28	3/21
Group 3	Action potentials and cable theory	3/14	3/28
Group 4	Synaptic transmission	3/21	4/4
Group 5	Synaptic transmission at neuromuscular junction	3/28	4/11
Group 6	Transmitter release and synaptic vesicles	4/4	4/18
Group 7	Toxins and drugs affecting synaptic transmission	4/11	4/23

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 PowerPoint/Keynote 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.

6) **Final Exam (180 points, ~20%)**

Date	Section	Time	Location
Tues. 4/30	**Section 001**	**7:45am-9:45am**	**111 Biochemistry**
Wed. 5/1	**Section 002**	**10:00am-12:00pm**	**S134 South Kedzie**

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 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.