BI 610 (Fall 2022; 12869) Adv Cellular Neurosci

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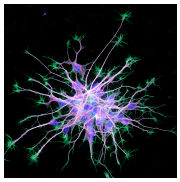

Today in Class:

- JOD
- 1FIG

[Canvas help: 541-346-1942]

Module 0: Introduction

9/27 Personal introductions. Overview of syllabus and course mechanics. Team building.
Presentation (https://canvas.uoregon.edu/courses/206804/files/14466818/download?download_frd=1) on recording techniques.

Read **Math Is the Great Secret (https://canvas.uoregon.edu/courses/206804/files/14466988/download?download_frd=1)**

Module 1: Resting Potential

9/29 Topic: Equilibrium potentials, Nernst equations, constant product rule.
Read **Hille-Chapter-1 (https://canvas.uoregon.edu/courses/206804/files/14466860/download?download_frd=1)** pp 13-17 and **Hodgkin-Horowicz-1959 (https://canvas.uoregon.edu/courses/206804/files/14466816/download?download_frd=1)** through Fig. 4.
Workshop **Worksheet 1.1 (https://canvas.uoregon.edu/courses/206804/files/14466809/download?download_frd=1)** in class. **Answers (https://canvas.uoregon.edu/courses/206804/files/14466804/download?download_frd=1)** .

10/04: Topic: Equilibrium potentials, Nernst equations, constant product rule (cont).
Read **Hodgkin-Horowicz-1959 (https://canvas.uoregon.edu/courses/206804/files/14466816/download?download_frd=1)** through Fig. 7.
Workshop **Worksheet 1.2 (https://canvas.uoregon.edu/courses/206804/files/14466803/download?download_frd=1)** in class. **Answers (https://canvas.uoregon.edu/courses/206804/files/14466805/download?download_frd=1)** .

We will complete discussion of Hodgkin-Horowicz through Fig. 7.
Problem set 1 assigned: **Problem-set-resting-potentials-V2** (https://canvas.uoregon.edu/courses/206804/files/14466822/download?download_frd=1) . **Answers** (https://canvas.uoregon.edu/courses/206804/files/14466822/download?download_frd=1) .

Module 2: Electrical Membrane models

10/6 Topic: Circuit theory.
Read **Appendix A Review of Basic Circuit Theory** (https://canvas.uoregon.edu/courses/206804/files/14466827/download?download_frd=1) through the middle of p. 7.
Read p1-4 of "**Basic Electricity and Solving Circuit Problems** (https://canvas.uoregon.edu/courses/206804/files/14466799/download?download_frd=1) ."
Complete problems 1-5 in the above reading before class.
Workshop: techniques for solving problems 1-5.

10/11 Topic: Steady-state membrane models.
Workshop **Worksheet 2.1.v2** (https://canvas.uoregon.edu/courses/206804/files/14466801/download?download_frd=1) . **Answers** (https://canvas.uoregon.edu/courses/206804/files/14466802/download?download_frd=1)
Problem set 2.1 assigned: **Problem-set-membrane-models-SS** (https://canvas.uoregon.edu/courses/206804/files/14466800/download?download_frd=1) . **Answers** (https://canvas.uoregon.edu/courses/206804/files/14466853/download?download_frd=1) .

10/13 Topic: Dynamical membrane models.
Read **Appendix A Review of Basic Circuit Theory** (https://canvas.uoregon.edu/courses/206804/files/14466827/download?download_frd=1) p. 7-10.
Read "**Neuronal Dynamics Ch1** (https://canvas.uoregon.edu/courses/206804/files/14466858/download?download_frd=1) ." Section 1.3.1 provides some functional context for dynamic membrane models.
Workshop **Worksheet 2.2** (https://canvas.uoregon.edu/courses/206804/files/14466807/download?download_frd=1) . **Answers** (https://canvas.uoregon.edu/courses/206804/files/14466875/download?download_frd=1) .
Problem set 2.2 assigned: **Problem-set-membrane-models-dynamic** (https://canvas.uoregon.edu/courses/206804/files/14466854/download?download_frd=1) . **Answers** (https://canvas.uoregon.edu/courses/206804/files/14466859/download?download_frd=1) .

Module 3: Hodgkin-Huxley Model

Topic: Current-voltage relationships.
Read Hille Chapter 1 "**Introduction**

(https://canvas.uoregon.edu/courses/206804/files/14466860/download?download_frd=1) ," pp17-22 (focus particularly on Fig. 1.6).
Workshop: Worksheet 3.1 (https://canvas.uoregon.edu/courses/206804/files/14466882/download?download_frd=1) . Answers (https://canvas.uoregon.edu/courses/206804/files/14466885/download?download_frd=1) .

Topic: Ion-substitution and ionic conductances.
Read Hille Chapter 2 "Classical Biophysics of the Squid Giant Axon (https://canvas.uoregon.edu/courses/206804/files/14466856/download?download_frd=1) ," Figs. 2.6 - 2.12.
Workshop: Worksheet 3.2 (https://canvas.uoregon.edu/courses/206804/files/14466886/download?download_frd=1) . Answers (https://canvas.uoregon.edu/courses/206804/files/14466887/download?download_frd=1) .

Topic: Rate constants, gating, and action potentials.
Read Hille chapter 2 Classical Biophysics of the Squid Giant Axon (https://canvas.uoregon.edu/courses/206804/files/14466856/download?download_frd=1) " pp47-56. We will focus on Fig. 2.16-2.18, and eq. 2.4-2.20.
Workshop: Worksheet 3.3 (https://canvas.uoregon.edu/courses/206804/files/14466812/download?download_frd=1) . The final problem requires this data file (https://canvas.uoregon.edu/courses/206804/files/14466862/download?download_frd=1) . Answers (https://canvas.uoregon.edu/courses/206804/files/14466813/download?download_frd=1) .

Further reading (optional).
The Hodgkin-Huxley Heritage: From Channels to Circuits (https://canvas.uoregon.edu/courses/206804/files/14466855/download?download_frd=1)
Neuronal Dynamics, chapter 2.2, 2.3 (https://neuronaldynamics.epfl.ch/online/Ch2.html)

Module 4: Ion Channel Gating

<date> Topic: First detection of gating current.
Read Armstrong 1973 (https://canvas.uoregon.edu/courses/206804/files/14466864/download?download_frd=1)
Workshop: Worksheet 4.1 (https://canvas.uoregon.edu/courses/206804/files/14466883/download?download_frd=1) . Answers (https://canvas.uoregon.edu/courses/206804/files/14466892/download?download_frd=1) .

<date> Topic: Molecular structure of ion channels
Read Hille Ch. 3 excerpt (https://canvas.uoregon.edu/courses/206804/files/14466895/download?download_frd=1)
Read Kuang 2015 (https://canvas.uoregon.edu/courses/206804/files/14466865/download?download_frd=1) . Focus on gating in the Kv channel family (pp3681-84). Pay special attention to the 2R9R channel which is the subject of reference 53, the next paper in the reading list.

Read **Long 2007** (https://canvas.uoregon.edu/courses/206804/files/14466868/download?download_frd=1) . This original research article may be challenging to read, so give yourself extra time. Skip the sections "Conservation of structure in K+ channels" and "Lipid interactions."
Read **Bezanilla 2008** (https://canvas.uoregon.edu/courses/206804/files/14466871/download?download_frd=1) (optional historical perspective)
Workshop: **Worksheet 4.2.** (https://canvas.uoregon.edu/courses/206804/files/14466897/download?download_frd=1) **Answers** (https://canvas.uoregon.edu/courses/206804/files/14466896/download?download_frd=1) .

Module 5: **Bursting Neurons**

***Skipped in 2021* Topic: Voltage-clamp analysis and modeling of cell-autonomous bursting in the Aplysia neuron R15.**
Read **Adams & Benson 1985** (https://canvas.uoregon.edu/courses/206804/files/14466872/download?download_frd=1) (optional). Focus on Section III, which provides the biophysical basis for the model presented in the Adams 1985.
Read **Adams 1985** (https://canvas.uoregon.edu/courses/206804/files/14466873/download?download_frd=1) . Focus on Figs. 1, 3,4, 6, 7, and 9.
Do **Worksheet 5.1** (https://canvas.uoregon.edu/courses/206804/files/14466866/download?download_frd=1) in class (**Worksheet 5.1 answers** (https://canvas.uoregon.edu/courses/206804/files/14466874/download?download_frd=1))

Module 6: Cable Theory

<date> Topic: The cable equation
Read **Dayan & Abbott chapter 6.3** (https://canvas.uoregon.edu/courses/206804/files/14466898/download?download_frd=1) through equation 6.16. For definition of terms see **D&A chapter 5** (https://canvas.uoregon.edu/courses/206804/files/14466844/download?download_frd=1) .
Workshop: **Worksheet-6.1** (https://canvas.uoregon.edu/courses/206804/files/14466901/download?download_frd=1) . **Answers** (https://canvas.uoregon.edu/courses/206804/files/14466900/download?download_frd=1) .

<date> Topic: The cable equation and linear cable theory
Finish **Worksheet-6.1b** (https://canvas.uoregon.edu/courses/206804/files/14466899/download?download_frd=1) in class (**Works 6.1b answers** (https://canvas.uoregon.edu/courses/206804/files/14466848/download?download_frd=1))

Module 7: Synaptic transmission I - Presynaptic release mechanisms

<date> Topic: Quantal analysis of synaptic transmission (Part A)

Read **Augustine 2007** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466842/download?download_frd=1)** (optional historical perspective)

Read **Del Castillo and Katz 1954** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466840/download?download_frd=1)** (main paper)

Read **Johnson & Wu Chapter 11** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466850/download?download_frd=1)** , p293-4 and section 11.4.2.

Workshop: **Worksheet 7.1** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466903/download?download_frd=1)** . **Answers** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466902/download?download_frd=1)** .

<date> Topic: Quantal analysis of synaptic transmission (Part B)

Review of Worksheet 7.1 answers

Workshop: **Worksheet 7.2** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466795/download?download_frd=1)** . **Answers** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466796/download?download_frd=1)** .

Download **EPP-data-1** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466833/download?download_frd=1)**

Module 8: Synaptic transmission II - LTP

<date> Topic: Preliminary quantal analyses of LTP in hippocampal region CA1

Read: **Nicoll 2017** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466852/download?download_frd=1)** (required historical perspective)

Read: **Malinow 1990** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466890/download?download_frd=1)** (main paper for workshop).

Workshop: **Worksheet-8.1** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466806/download?download_frd=1)** . **Answers** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466808/download?download_frd=1)** . **Notes** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466891/download?download_frd=1)** on summation of synaptic potentials.

<date> Topic: Postsynaptic expression of LTP in hippocampal region CA1

Read: **Liao 1995** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466849/download?download_frd=1)** (main paper for workshop).

Workshop: **Worksheet-8.2** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466893/download?download_frd=1)** . **Answers** ↓ **(https://canvas.uoregon.edu/courses/206804/files/14466894/download?download_frd=1)** .

<date> Topic: Postsynaptic expression of LTP in hippocampal region CA1(cont.)

See above
End of course celebration with presentation of C. elegans chemosensory neuron model.

Cellular neuroscience and its significance

Cell biology and biophysics of neurons and synapses
Input-output functions of neurons

Course goals

Overview of biophysics of neurons (intrinsic signaling and synaptic transmission)
Development of skills in:
- Quantitative reasoning
- Critical evaluation of the primary scientific literature

Teaching philosophy

Less is more
Proponent of active learning (instructor as "coach")
Student-student collaborations encouraged*

Approach

Workshop format (mini lectures, in-class activities)
Readings (mainly classical original papers, supplemented by textbook chapters)
Worksheets* (in class)
Problem sets* (at home)

Teaching style is Socratic, but students can always "pass," without consequence, when called to answer a question.

* You are strongly encouraged to work together on class assignments.

Content

Mini-lectures, original articles and book chapters, workshops, worksheets, and problem sets

Source material (consider purchasing)

Hille, Ion Channels of Excitable Membranes (the most famous text book in cellular neuroscience)
Johnson and Wu, Foundations of Cellular Neurophysiology (excellent on biophysics of neurons)

Cook and Lipkin, Cellular Neurophysiology (compendium of classic papers)
Byrne, Heidelberger, Waxham, From Molecules to Networks (textbook)
Fain, Molecular and Cellular Physiology of Neurons (textbook)

Joke-of-the-day

Tell us a joke or funny story. To obtain credit, upload the joke or story in Assignments. **Sign-up sheet.** End of term contest: course points (5) for best overall joke (regardless of medium), best original joke (regardless), least funny joke (regardless), best cartoon/comic, best text-only joke, best neuroscience joke.

One-figure, 5 min

Read an original research article in cellular neuroscience (no reviews, please). Show and explain one figure panel from the paper. If plan to show physiological data (voltage, current, Ca2+ concentration etc.), please restrict yourself to intracellular signals from single neurons. Figures from non-physiological papers (e.g., anatomy, cell biology, molecular biology) are allowed in the case of single types of neurons. If you have questions about the suitability of material, please don't hesitate to ask the instructor for his opinion. Upload the paper in Assignments. **Sign-up sheet**.

Covid safety

Masks required
If you have symptoms, do not come to class
Instructor will be tested every Monday

Assessment

Attendance (self-report at end of term)	10%
Worksheets	40%
Problem sets	20%
Class participation	10%
Joke-of-the-day	10%
One figure, 5 min	10%
Exams	0%

Office hours

Fridays, 4-5 pm or by appointment

// Instructor note: Maybe add PIR //

// **https://www.tiny.cloud/docs/advanced/keyboard-shortcuts/ (https://www.tiny.cloud/docs/advanced/keyboard-shortcuts/)** //