NEU 350: Laboratory in Principles of Neuroscience

Spring 2022 Syllabus

Course Description

This course is designed to introduce undergraduate students to modern methods of analysis applied to the activity of single neurons, the synaptic connections between neurons, and the dynamics of networks of neurons underlying learning and decision-making. The course will include methods for intracellular and extracellular recording of neural activity, the application of optogenetic approaches to analysis of neuronal function, and noninvasive measurement of human cognitive information processing using fMRI. The capstone of the course is a 2-week independent research project designed and carried out by students.

Contact Information

instructors		AIs	
Anthony Ambrosini (he/him)	a.ambrosini@	**David Allen** (he/him)	da9769@
Lindsay Collins (she/her)	lindsay.collins@	**Wayan Gauthey** (he/him)	wgauthey@
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Office hour scheduling and zoom links will be posted on Canvas. You can attend any office hours you like, not just those with instructors from your section.

A link to an Ed Discussion board is also available on Canvas. This is a good place to pose questions whose answers may be useful to your colleagues.

Webpage

https://princeton.instructure.com/courses/10329

Schedule

Lecture:	M 12:30-1:20pm PNI A32	Lecture will cover relevant background material and specific aspects of the weekly laboratories.
Laboratory:	M/W 1:30-4:20pm T/Th 1:30-4:20pm T/Th 7:30-10:20pm {F 9:00-11:50am + 1:30-4:20 pm} PNI A35	Laboratory is comprised of a series of exercises in which biophysical and computational properties of neurons, muscles and their synaptic interactions will be studied using the central nervous systems of several invertebrate model systems and human subjects. During the last two weeks of the term students will pursue Independent Projects of their own design, using methods and insights obtained during the previous formal laboratory exercises.

S	M	T	W	Th	F	S
Jan 29	30	31	**Feb 1**	2	3	4
	introduction to equipment & dissection workshop **python skills workshops**					
5	6	7	8	9	10	11
	1: action potentials & synaptic potentials extracellular & intracellular recordings in the crayfish motor system					
12	13	14	15	16	17	18
figure 1 due	**2: synaptic connectivity & plasticity** crayfish neuromuscular junction					
19	20	21	22	23	24	25
figure 2 due	**3: sensory coding** crayfish MRO stretch receptor					
26	27	28	**Mar 1**	2	3	4
figure 3 due	**4: sensory processing** *Sarcophaga* visual system / H1 neuron					
5	6	7	8	9	10	11
figure 4 due	**5: human EEG** alpha waves and visual input					
12	13	14	15	16	17	18
figure 5 due *– if you want feedback before LR1; otherwise due 3/13*	SPRING BREAK					
19	20	21	22	23	24	25
lab report 1 due 11:59pm	**6: optogenetics & behavior I** Drosophila courtship song & pose estimation					
26	27	28	29	30	31	**Apr 1**
figure 6 due	**7: optogenetics & behavior II**				*final project rank list due*	
2	3	4	5	6	7	8
figure 7 due	**8: neuroimaging I** human fMRI and 2-photon microscopy	*proposal due*	*final project conferences*			
9	10	11	12	13	14	15
figure 8 due	**9: NeuroImaging II**					
16	17	18	19	20	21	22
figure 9 due	**independent projects**					
23	24	25	26	27	28	29
	independent projects					

final lab report due Dean's Date (Tue May 9, 5pm)

Texts

This course uses a lab manual that is available in hard copy and is also available on Canvas. Supplementary readings are available on Canvas and/or on Course Reserve at Lewis Library, including:

Excitable Cells, FA Miles
Crawdad, a Laboratory Manual for Neurophysiology, Robert Wyttenbach et al.
Visual Display of Quantitative Information and Visual Explanations, Edward Tufte
Neural Data Science, Erik Nylen and Pascal Wallisch
Data Visualization, Kieran Healy
The Design of Experiments in Neuroscience, Mary Harrington

Grading

Laboratory participation 10%; figures 30%; two laboratory reports @ 30% each.

Grades are computed on a 4-point scale, which minimizes the outsize effect of late or incomplete work on the traditional 100% grade scale (see lateness policy below).

Students will prepare a one-page figure with legend from data collected during each of the 9 laboratory exercises. These figures are due by noon on the Sunday before the following module. The lowest figure grade will be dropped.

Lab report #1, due March 19 by 11:59pm, can be based on any of the exercises accomplished before Spring Break. Lab report #2, due May 9 by 5pm, will be based on the Independent Project. Guidelines and advice for the generation of figures and lab reports can be found in Appendix 5. Sample reports and figures with grades and commentary are available on Canvas.

Lateness policy

All assignments except the final lab report due on Dean's date have a 24-hour grace period. Any assignments turned in during the grace period will incur no lateness penalty. After the grace period, there is a 10% per diem penalty on graded work, which we will accept up to 1 week late.

Additionally, we will accept one figure assignment any time before Dean's date with no lateness penalty (i.e., we will ignore your steepest lateness penalty).

Collaboration & own work policy

Figures and lab reports are written individually and should represent your own work. In practice this means that you are free to discuss your analytical approach with your lab partner (and classmates), but that the quantitative analyses, figures, and text should be your own.

In the event that you are unable to collect analyzable data for a particular lab, you may share data with other willing lab groups, so long as their contribution is properly attributed.

Our expectations of Neu 350 students

Background knowledge. We expect that as neuroscience juniors you will have ready knowledge of basic cellular neurobiology and some aspects of electrochemistry having direct relevance to electrophysiology. In particular, you should understand the following concepts:

- voltage, current, resistance, conductance. Ohm's law.
- the electrochemical basis of membrane potential.
- the electrochemical basis of the action potential.
- voltage clamp and current clamp recordings.
- the shape of an intracellular recording of an action potential, and the ionic conductances/currents governing the shape of an action potential.
- the shape of an intracellular recording of a synaptic potential, and the ionic conductances/currents governing it.
- rate/frequency coding of action potentials.
- models of the molecular basis of short- and long-term synaptic plasticity.

If you are not clear in your understanding of any of these concepts, you are encouraged to refer to Excitable Cells by FA Miles (posted in its entirety to Canvas) and/or your Neu 201 notes/text.

Coding experience. A large part of your work for this course will involve writing code to analyze your data. Our most complete set of analysis tutorials is for python, but aside from the fMRI module, we are platform-agnostic — i.e., we will not force you to use a particular language for your analysis. You should have prior coding experience, but we do not expect that it will have been in python. Basic python programming tutorials are available on Canvas and we will offer a few python workshops at the beginning of the semester.

Learning curve & asking for help. Neu350 is a demanding course. It can take a lot of time and effort to get up to speed in the early part of the course, with both the laboratory techniques and analysis methods proving challenging for many students. We have tried to reduce some of the pressure with our data sharing policy, the pacing of laboratory exercises and analysis techniques, and our approach to grading (especially the weekly figures).

Please do not be shy about asking for help if you find yourself out of your depth in the lab or in trying to perform analysis for your figures. If you've spent a few minutes in the lab trying to troubleshoot a problem and remain stuck, flag down one of the instructors or AIs. If you're struggling with analysis, make a post on Ed: odds are your classmates are facing the same issues, and they can either chime in with advice or benefit from seeing an explanation. In either case, take the time to evaluate precisely where the difficulties lie – the better resolution in your query, the more efficiently we can help you.

Preparedness for class. Making electrophysiological recordings is a complicated business, and three hours go by quickly each afternoon. It is imperative that you show up to lab prepared to work each session. Being familiar with the protocol will let you and your partner work efficiently, and having prior expectations of what your collected data should look like will let you error correct on the fly and avoid complications down the road at analysis time. Further, your being prepared helps you make streamlined use of our assistance. We have assembled a crack team to help you in your adventures, but we would like to minimize questions like "what do we do now?" in favor of time for troubleshooting electrical interference or explaining how the bridge balance or stimulus isolator works.