PSY 445/545: Brain Mechanisms of Behavior
Spring 2022

The schedule in this syllabus is preliminary and will definitely change.

Last updated Monday, February 14, 2022

Check for the latest version of the syllabus **here.**

Overview	What are the neural mechanisms underlying behavior? How do neural circuits operate to achieve sensory processing, sensorimotor integration, motor control, and behavioral choice? How do neuroscientists investigate these questions? How can basic principles learned from particular species be applied to brain mechanisms in humans? In this course we will read original scientific research articles (many of them at the cutting edge) to try and answer these questions.
Objectives	To develop the tools and knowledge to ask meaningful questions about the neural mechanisms underlying behavior, how to frame these questions, and how one might attempt to answer them. After completing this course, you should be able to describe the neural mechanisms underlying behavior in a variety of model systems. You should also be able to read an original scientific research article, extract the background, main question, main experimental findings, and interpretations in the article, and clearly explain these in writing and orally.
Lectures	Monday & Wednesday 10:00–11:20 AM; Lawrence 166 Lecture notes are available on Canvas.
Instructor	Mike Wehr wehr@uoregon.edu Office hours: Monday 2:00-3:00 PM in 213 LISB or by appointment.
Teaching Assistant	TBA Office hours: TBA or by appointment
Textbook	none
Reading	All required course readings will be available on Canvas.

Optional reading There are also some optional readings in the excellent book "Behavioral Neurobiology" by Thomas Carew, which is at the Science Library, or you can get it on Amazon for about $10 here.

Plagiarism Is taken very seriously and is grounds for failure or expulsion. You are responsible for understanding what constitutes plagiarism and how to avoid it in your work. Excellent guides on plagiarism can be found at https://researchguides.uoregon.edu/citing-plagiarism and http://www.plagiarism.org.

Grading

Midterm Exam	25%
Final Exam	25%
Paper	25%
Problem Sets	25%
	100%

Expectations This course will be difficult. The material is advanced and the pace will be fast. The exams will be very challenging. Nevertheless, I expect that any student who does the readings, shows up to class, and asks questions should be able to master the material and succeed in the course. Typically, the top 20-25% students earn A's in the course. I do not take attendance, but there are no make-ups for in-class Problem Sets.

Exams

The midterm will be an in-class exam, on April 27th (Day 10). The final will be a take-home exam, will cover the material from the entire course, and will be available on Canvas after the last class on June 1st (Day 20), and due by 5 p.m. on the following Monday, June 6th. Both exams will include multiple choice, short answer, and brief essay questions.

Problem Sets

You must do the assigned reading *before* each lecture. There will be a problem set due almost every class day. There are no make-ups. Problem sets are open book and open notes. Usually the first question or two will help me make sure you understood the important points from the readings. Problem sets will often include some review questions from previous classes, in addition to the readings, so it helps to pay attention in class. The first problem set will be in-class. After that they will be online, on Canvas, and due before the start of class. The problem sets together count for 25% of your grade, so you should take them seriously. But because there are 18 of them, any one problem set only counts for 1.5% of your grade, so skipping one or two will not have a big impact on your grade. **There are no make-ups.** I will drop your lowest-scoring Problem Set, so don't worry if you miss one.

The purpose of the problem sets is fourfold: (1) Lots of relatively easy points (if you've done the reading) distributed daily throughout the term. This takes some pressure off the exams, in case you have a bad exam day. (2) Motivation to do the reading, show up to class, and pay attention. (3) Review concepts and material to help prepare for the exams. (4) Constant feedback to me about how much you're understanding, and what concepts need more emphasis in class.

Paper/Project

The paper or project write-up should be roughly 8-10 pages, double spaced, and is due at the beginning of class on May 18th. The topic can be anything related to the course. Regardless of which topic you choose, you must submit the topic for approval by May 4th (submit through Canvas in Problem Set 11). Topic submission should fit on one page, and should include your name, paper title, a one-paragraph abstract, and a bibliography of no less than 3 of the sources you plan to use. Submit your topic in Problem Set 11 on Canvas.

Format for the term paper:

- The filename must include your last name, for example: smith-psy445-termpaper.doc
- Include page numbers.
- Include a header with your name and a shortened title (that fits on 1 line).
- Include an abstract, section headers for organization, and a summary or concluding paragraph. Figures should include legends.
- Use .doc or .pdf

No matter how cool or interesting your project or paper, it must be well organized, clearly written, and grammatically correct. Here is the rubric that I will use to assess your paper, which gives you some guidelines about the important criteria:
http://www.uoneuro.uoregon.edu/wehr/lecturenotes/PaperRubric.pdf

You don't need to write yet another dull term paper on a topic that doesn't really interest you. In fact, you don't need to write a paper at all — below are some ideas for projects or presentations, as well as some starter ideas for paper topics that you can get excited about. *Be creative, find a topic you can get enthusiastic about, and then let that enthusiasm show in your work*. Here are some ideas for paper/project topics:

- Find an original research article that interests you, and read it. A good website to search for neuroscience articles is PubMed: http://www.ncbi.nlm.nih.gov/sites/entrez. Then read another article by a different author on a related topic (the references of the first article would be a good place to look). Compare and contrast the articles: Why did they do these experiments? How are their results related? Do their results agree? Why or why not? Which methodology is better, or are they both flawed? What experiment should they do next, and why?

- Figure out what the next step should be in the series of experiments that have been done, and propose an experiment that can address that next step. This could be a real, doable experiment, or what is sometimes more fun is to imagine impossible thought experiments... if you could record from every neuron in the brain, what might you expect to see? What could you learn? Where are the real limitations in current understanding? The format for a research proposal often has the following sections: Abstract, Specific Aims, Background and Significance, Research Design and Methods. There are many, many websites with guidelines for how to write an effective grant proposal, for example: http://wpacouncil.org/node/3386, https://www.nsf.gov/pubs/1998/nsf9891/nsf9891.htm. You may ignore non-scientific aspects of grants, such as budgets and deadlines, if you like (or you could try including a budget for your proposal, why not?).

- Find an issue on which some authors disagree. Controversies always make for a rousing paper. You can lay out the characters and their positions, build suspense, root for the underdog, etc.

- A vanilla review paper can still be fun to write (and to read) if you try to personalize it. Why did you start researching this topic? What were you hoping to find out more about? Did you? What did you learn and how does that relate to what motivated you in the first place? etc.

- Instead of writing a paper, you can give a presentation to the class. For example, you could pick one of the regularly scheduled lectures below, and teach the class. Depending on which one you choose, you may even be able to take advantage of slides and lecture notes that I have already prepared. Or you could choose any relevant article that interests you, make your own slides, and present it to the class. This way you don't have to write a paper at all. Aim for a 20-minute presentation at minimum.

- Creative response. The neural mechanisms of behavior are as intriguing to artists as they are to scientists, and have inspired great science fiction novels and short stories, performance art, and visual art. A creative response can be anything relevant to the course… perhaps a short story, or how about an interpretive dance of the crayfish escape response (in front of the class, of course!).

Tips for reading and presenting research articles:
Focus on the Introduction, Abstract, and Discussion (probably in that order). Try not to get hung up on methodological details or unfamiliar vocabulary. As you read, ask yourself: What did the authors basically do in the key experiment? Why did they choose to do this particular experiment? What were the major findings of this experiment? How did they interpret these findings, i.e., what did the results tell them? Is their interpretation reasonable? Do the data figures really support the authors' conclusions? It usually takes me 2-3 times re-reading an article before I understand it.

Schedule (subject to change: please be sure to download the Syllabus from Canvas for the most up-to-date schedule)

Hot new cutting edge research

Day 1.
Introduction to Brain Mechanisms of Behavior
No reading

Day 2.
Vocal interaction in singing mice.
Reading: Motor cortical control of vocal interaction in neotropical singing mice. Okobi, Banerjee, Matheson, Phelps, and Michael Long, 2019.

Day 3.
Optogenetics.
Reading: Sparse optical microstimulation in barrel cortex drives learned behaviour in freely moving mice
Daniel Huber, Leopoldo Petreanu, Nima Ghitani, Sachin Ranade, Tomás Hromádka, Zach Mainen & Karel Svoboda, 2008.
http://www.neuro.uoregon.edu/wehr/coursepapers/Huber-Svoboda-2008.pdf
lecture notes

Day 4.
Fear
Reading: Midbrain circuits for defensive behaviour
Philip Tovote, Maria Soledad Esposito, Paolo Botta, Fabrice Chaudun, Jonathan P. Fadok, Milica Markovic, Steffen B. E. Wolff, charu Ramakrishnan, Lief Fenno, Karl Deisseroth, Cyril Herry, Silvia Arber & Andreas Lüthi
Prefrontal neuronal assemblies temporally control fear behaviour
Cyril Dejean, Julien Courtin, Nikolaos Karalis, Fabrice Chaudun, Hélène Wurtz, Thomas C. M. Bienvenu & Cyril Herry

Day 5.
Internally generated cell assembly sequences in the hippocampus.
Reading: Internally generated cell assembly sequences in the rat hippocampus.
Eva Pastalkova, Vladimir Itskov, Asohan Amarasingham, György Buzsáki, 2008.
http://www.neuro.uoregon.edu/wehr/coursepapers/Pastalkova-Buzsaki-2008.pdf
lecture notes

Day 6.
Reactivation in Human Hippocampus During Free Recall.
Reading: Internally Generated Reactivation of Single Neurons in Human Hippocampus During Free Recall.

Hagar Gelbard-Sagiv, Roy Mukamel, Michal Harel, Rafael Malach, and Itzhak Fried, 2008.
http://www.neuro.uoregon.edu/wehr/coursepapers/Gelbard-Sagiv-Fried-2008.pdf
lecture notes

Neuroethology

Day 7.
Neural mechanisms of escape behavior in crayfish 1.
Reading: Neural mechanisms for serial order in a stereotyped behaviour sequence.
Heinrich Reichert and Jeffrey Wine, 1982.
http://www.neuro.uoregon.edu/wehr/coursepapers/Reichert-Wine-1982.pdf
lecture notes

Day 8.
Neural mechanisms of escape behavior in crayfish 2.
No additional reading.

Day 9.
Neural mechanisms of echolocation in bats.
Reading: Neural axis representing target range in the auditory cortex of the mustache bat.
Nobuo Suga & William O'Neill, 1979.
http://www.neuro.uoregon.edu/wehr/coursepapers/suga-oneill-1979.pdf
lecture notes

Day 10.
Midterm in class
No reading

Day 11.
Discuss midterm results
Finish Echolocation.
No reading

Day 12.
Paper topics due in Problem Set
Neural mechanisms of habituation and dishabituation in Aplysia.
Reading: Neuronal Mechanisms of Habituation and Dishabituation of the Gill-Withdrawal Reflex in Aplysia
Vincent Castellucci, Harold Pinsker, Irving Kupfermann and Eric Kandel, 1970.

http://www.neuro.uoregon.edu/wehr/coursepapers/Castellucci-Kandel-1970.pdf
lecture notes

Day 13.
Maternal social behavior
Oxytocin enables maternal behaviour by balancing cortical inhibition.
Marlin BJ, Mitre M, D'amour JA, Chao MV, Froemke RC, 2015.

Day 14.
Flight control in the blowfly.
Reading: Reading a neural code.
William Bialek, Fred Reike, Robert de Ruyter van Steveninck, David Warland, 1991.
http://www.neuro.uoregon.edu/wehr/coursepapers/bialek-warland-1991.pdf
lecture notes

Day 15.
Fight Club for Mice.
Reading: Lin & Anderson, 2011, "Functional identification of an aggression locus in the mouse hypothalamus."
http://www.neuro.uoregon.edu/wehr/coursepapers/Lin-Anderson-2011.pdf
lecture notes

Day 16.
Sucrose-seeking behavior
Reading: Glucose-responsive neurons of the paraventricular thalamus control sucrose-seeking behavior
Gwenaël Labouèbe, Benjamin Boutrel, David Tarussio & Bernard Thorens, 2016

Day 17.
Neural mechanisms of decision-making in parietal cortex.
Reading: Neural correlates of decision variables in parietal cortex.
Michael Platt & Paul Glimcher, 1999.
http://www.neuro.uoregon.edu/wehr/coursepapers/platt-glimcher-1999.pdf
http://www.neuro.uoregon.edu/wehr/coursepapers/platt-glimcher-1999-nv.pdf
lecture notes

Papers due by beginning of class (through Canvas).

Day 18.
Field trip to Wehr Lab
Meet in LISB Atrium at 10 am (click here for a map)

Sex, drugs, and the brain

Day 19.
Neural mechanisms of drug addiction.
Reading: Addiction as a Computational Process Gone Awry.
David Redish, 2004.
http://www.neuro.uoregon.edu/wehr/coursepapers/Redish-2004.pdf
lecture notes

Day 20.
Neural mechanisms of love.
Reading: Enhanced partner preference in a promiscuous species by manipulating the expression of a single gene.
Miranda Lim, Zuoxin Wang, Daniel Olazábal, Xianghui Ren, Ernest Terwilliger, and Larry Young.
http://www.neuro.uoregon.edu/wehr/coursepapers/Lim-Young-2004.pdf
lecture notes
Take home final exam becomes available

Final due by 5 p.m. the following Monday

Brain Mech **Calendar** **2022**

Sunday	Monday	Tuesday	Wednesday
	March 28 Day 1 Introduction Problem Set 1 in class	29 Reading: Okobi-Long-2019	30 Day 2 Vocal interaction Problem Set 2 due
April 3 Reading: Huber-Svoboda-2008	4 Day 3 Optogenetics Problem Set 3 due	5 Reading: Dejean-Herry-2016, Tovote-Lüthi-2016	6 Day 4 Fear Problem Set 4 due
10 Reading: Pastalkova-Buzsaki-2008	11 Day 5 Replay Problem Set 5 due	12 Reading: Gelbard-Sagiv-Fried-2008	13 Day 6 Recall Problem Set 6 due
17 Reading: Reichert-Wine-1982	18 Day 7 Crayfish escape 1 Problem Set 7 due	19 No additional reading	20 Day 8 Crayfish escape 2 Problem Set 8 due
24 Reading: Suga-O'Neill-1979	25 Day 9 Echolocation Problem Set 9 due	26 No reading	27 Day 10 **Midterm**
May 1 No reading	2 Day 11 Discuss midterm Finish echolocation Problem Set 10 due	3 Reading: Castellucci-Kandel-1970	4 Day 12 Habituation Problem Set 11 due **Paper topics due in Problem Set**
8 Marlin-Froemke-2015	9 Day 13 Maternal social behavior Problem Set 12 due	10 Reading: Lin-Anderson-2011	11 Day 14 Fight club Problem Set 14 due
15 Reading: Labouèbe-Thorens-2016	16 Day 15 Eating Problem Set 15 due	17 Reading: Platt-Glimcher-1999	18 Day 16 Decision-making Problem Set 16 due **Papers due by beginning of class**
22 Reading: Redish-2004	23 Addiction Problem Set 17 due	24 No Reading	25 Day 18 Field trip to Wehr Lab Meet in LISB Atrium
29 No reading	30 Day 19 No Class	31 Reading: Lim-Young-2004	June 1 Day 20 Love Problem Set 18 due **Final available** **Final is due at 5 pm on Monday, June 6th**