PSY 445/545: Brain Mechanisms of Behavior
Spring 2023

The schedule in this syllabus is preliminary and will definitely change.
Last updated Monday, June 5, 2023

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	Tuesday & Thursday 2:00–3:20 PM; [Gerlinger 301](.) Lecture notes are available on Canvas.
Instructor	Mike Wehr wehr@uoregon.edu Office hours: Monday 3:00-4:00 pm (or by appointment) in 213 LISB or at [https://uoregon.zoom.us/j/9040862467](.). If you want to do zoom office hours, make sure to email me ahead of time so I know to launch zoom.
Teaching Assistant	Xi Yang [xiy@uoregon.edu](.) Office hours: TBA or by appointment, 133 Straub
Textbook	none

Reading   All required course readings will be available on Canvas.

Optional reading There are also some optional readings in the <u>excellent</u> book "Behavioral Neurobiology" by Thomas Carew, which is at the Science Library, or you can get it on Amazon for about $15 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.

Exams

The midterm will be an in-class exam, on May 4th (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 8th (Day 20), and due by 11:59 p.m. on the following Wednesday, June 14th. 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. They are 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.

AI and ChatGPT

Artificial Intelligence tools such as ChatGPT are revolutionizing the way we read, write, and do research. These tools are rapidly becoming so powerful that they are transforming how students learn, how professors teach, and how individuals discover and synthesize information. The impact on society will be profound. You will find AI to be incredibly useful, but it comes at a cost. One concern is privacy; to use ChatGPT (for example) you will need to create an account with openai.com, which will track your identity and activity. A more important concern is accuracy; ChatGPT works by generating responses pulled from the entire internet, and is therefore subject to the biases and distortions that pervade the internet. It's important to remember that ChatGPT generates responses by making things up — the 'facts', citations, or inferences it generates can in some cases be completely imaginary. Thus if you're using it to do research on a topic, you need to think critically about what it says, fact-check the results, and follow up with the original sources (if they even exist). A deeper concern is intellectual honesty and integrity. It is dishonest to use ChatGPT to generate a term paper and then submit it as your own work. The point of including a term paper in this course is to allow you to (1) explore topics about brain mechanisms of behavior that greatly interest you, and that go beyond the selected examples we cover in class, and (2) to develop your critical thinking and writing skills by developing those topics into a paper, project, or presentation. AI is an excellent tool to use for accomplishing these goals — ChatGPT is fantastic for exploring topics, examining the relationships between ideas and articles, and for structuring an essay. But cheating, by using ChatGPT to generate a term paper without bothering to reflect or evaluate the resulting output, deprives you of all the benefits of learning to critically read and write. You would only be cheating yourself. **Policy for using ChatGPT or other AI tools in this course**: I encourage you to use AI to explore topics, do research, and generate text. It is acceptable to include AI-generated text in your term paper or other assignments, as long as you attribute it properly. If you include AI-generated text, set it in block quotes, like this:

> When using AI-generated text in a term paper, it's important to properly attribute the source of the content to avoid plagiarism and ensure academic integrity. Here are some tips on how to attribute AI-generated text in a term paper:
> 1. Identify the source of the AI-generated text: Determine the specific AI tool or platform that generated the text you are using.

2. Use appropriate citation format: Follow the citation guidelines provided by your instructor or the academic institution you're affiliated with. Generally, you can use the same citation format you would use for other sources, such as books or articles.
3. Clarify the extent of AI-generated content: Be clear about which portions of your paper were generated by AI and which were written by you. This can help avoid confusion and ensure that you receive appropriate credit for your own work.
4. Acknowledge limitations of AI-generated text: While AI-generated text can be a useful tool for research, it's important to acknowledge its limitations. Be sure to discuss any issues related to accuracy or bias that may be associated with the AI-generated text.

[Generated by chat.openai.com from the query, "How should students attribute AI-generated text in a term paper?"]

Note that this guidance from ChatGPT seems reasonable and appropriate, but I did edit it down because tip #1 was duplicated in another tip with slightly different wording (this seems to be a common pitfall of ChatGPT).

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 25th. The topic can be anything related to the course. Regardless of which topic you choose, you must submit the topic for approval by May 11th (submit through Canvas in Problem Set 10). 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 10 on Canvas.

Format for the term paper:
- The filename must include your last name, for example: smith-psy445-termpaper.pdf
- 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: https://pubmed.ncbi.nlm.nih.gov/. 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. I encourage you to use your personal voice.

- 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.

- Creative response. The neural mechanisms of behavior are as intriguing to artists as they are to scientists, and have inspired great science fiction novels, comic books, 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)

Latest 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

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.
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 15.
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 16.
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 17.
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 18
Flight control.
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 19.
Field trip to Wehr Lab
Meet in LISB Atrium at 2pm (click here for a map)

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 11:59 p.m. the following Wednesday

Monday	Tuesday	Wednesday	Thursday
	April 4 Day 1 Introduction	5 Reading: Okobi-Long-2019	6 Day 2 Vocal interaction Problem Set 1 due
10 Reading: Huber-Svoboda-2008	11 Day 3 Optogenetics Problem Set 2 due	12 Reading: Tovote-Lüthi-2016	13 Day 4 Fear Problem Set 3 due
17 Reading: Pastalkova-Buzsaki-2008	18 Day 5 Replay Problem Set 4 due	19 Reading: Gelbard-Sagiv-Fried-2008	20 Day 6 Recall Problem Set 5 due
24 Reading: Reichert-Wine-1982	25 Day 7 Crayfish escape 1 Problem Set 6 due	26 No additional reading	27 Day 8 Crayfish escape 2 Problem Set 7 due
May 1 Reading: Suga-O'Neill-1979	2 Day 9 Echolocation Problem Set 8 due	3 No reading	4 Day 10 **Midterm**
8 No reading	9 Day 11 Discuss midterm Finish echolocation Problem Set 9 due	10 Reading: Castellucci-Kandel-1970	11 Day 12 Habituation Problem Set 10 due **Paper topics due in Problem Set**
15 Marlin-Froemke-2015	16 Day 13 Maternal social behavior Problem Set 11 due	17 Reading: Lin-Anderson-2011	18 Day 14 Fight club Problem Set 12 due
22 Reading: Labouèbe-Thorens-2016	23 Day 15 Eating Problem Set 13 due	24 Reading: Platt-Glimcher-1999	25 Day 16 Decision-making Problem Set 14 due **Papers due by beginning of class**
29 Reading: Redish-2004	30 Day 17 Addiction Problem Set 15 due	31 Bialek 1991	June 1 Day 18 Flight control Problem Set 16 due
June 5 No reading	6 Day 19 Raccoon behavior	7 Reading: Lim-Young-2004	8 Day 20 Love Problem Set 17 due **Final available** **Final is due at 11:59 pm on Wed, June 14th**