Neurobiology of Behavior

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Teaching Fellows (TBA):

Course Website: **https://canvas.harvard.edu/courses/136424**

Lectures:

- Pre-recorded content available via Canvas.
- Interactive lecture questions due Tuesday/Thursday mornings at 9 am EST
- In-person classes on Tuesdays and Thursdays (10:30 - 11:45 am) will offer a mix of guest lectures, hands-on demonstrations and workshops that review and apply the video lecture material

Sections:

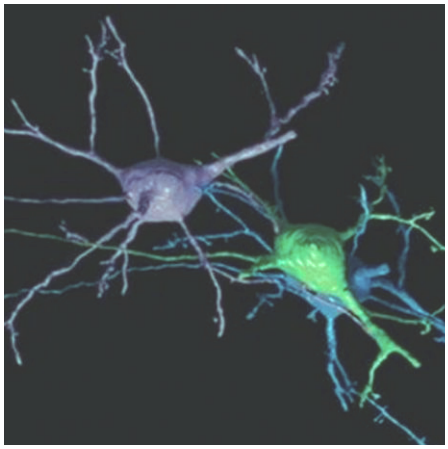
- 75 minute weekly discussion sections starting the week of 9/2/24 Sections are held on either Thursdays or Fridays *(Note: the course catalog lists a separate lab, but we include small labs and demonstrations during the 75 min section - no separate lab scheduled)*

Course Description

The goal of this course is to provide you with an in-depth introduction to the brain. In particular, we aim to provide a biologically inspired conceptual framework for thinking about how the brain works. We will try to demystify the brain -- but this is no easy task because the brain is arguably the most mysterious object on the planet. Nonetheless we will see how far neurobiology takes us in bridging the chasm between the physical brain and the more elusive mind.

The course will begin by taking a close look at the nuts and bolts of this amazing machine. Brain tissue is composed of billions of highly specialized cells known as neurons. To understand how the brain works you will need to understand how electrical signals travel though individual neurons and how neurons communicate with each other via synapses to form the immensely complicated neural networks that underlie brain function. You will look at a few of these networks in detail including the pathways of the visual and motor systems. You will then investigate deeply interesting aspects of brain function including memory, learning, brain development, emotion and several brain disorders and diseases.

The formal study of neurobiology has from its outset been multidisciplinary. To appreciate the brain requires studying the brain at the level of biomolecules, cells, ensembles of cells in so-called systems, and the output of these systems in terms of behavior. In this class, you will confront this wide range of topics and disciplines with the hope that you will have, by the completion of the course, a well-informed conceptual framework for thinking about the brain. There are no prerequisites for taking this class. This course is the gateway course for students who plan to concentrate in Neuroscience.



General Information

- **Lecture Material**: Given what we have learned in the past several years as we continue to optimize the course, we have recorded all of the lectures in approximately 25 minute segments, usually 3 segments per lecture, specifically for this format and adapted for the 2024 semester. This way all of the students can view and study the material at a time that works for them. Treat these videos like lectures, we suggest watching them at a consistent time each week and taking notes. There is no assigned reading for the course - these lectures and the accompanying slides and notes should serve as your references. You can post questions about the videos within the video format, on the discussion board, submit questions for Thursday workshops, or ask in person.
- **Active Videos**: ***It is critical that you watch and keep up with the lecture videos!*** To ensure you are keeping up with the videos, and because watching the videos can be a passive process where it is easy to lose focus, the lectures include questions embedded in the videos via Canvas. These interactive questions are not graded, though you will not be able to advance the video or receive participation credit, until you have answered the question. These questions are designed to make you think about the material, sometimes even predicting outcomes we are about to discuss and/or review, and consolidate concepts we have just covered. Research has shown that having to recall knowledge that you have just learned is actually one of the best ways to remember information, so while the questions are not graded, you are encouraged to answer to the best of your ability. Your answers are not seen by the other students, and these questions may reappear on exams.
- **In Person Lectures:** on Tuesdays and Thursdays from 10:30-11:45 am, in Science Center, Hall B, we will hold large in-person lectures designed to expand, enhance, and clarify the material you have learned in the videos. ***For 2024, we have adopted a flexible attendance policy (see Grading policy for details) to allow you to attend the portions that best fit your learning needs/goals.***
  - We will have a mix of guest lectures, hands-on demonstrations and problem solving workshops. The guest lectures are not only designed to be fun, but also should help you connect the course content to the "real world" while the demos will give you an opportunity to apply what you have learned and see some neuroscience experiments for yourself. We will frequently hold large workshops that will give you the opportunity to practice problem solving and ask questions both ahead of time and in person. It is aimed to both extend your understanding of the weeks topics and help clarify the concepts.
- **Sections** will be held Thursdays or Fridays throughout the semester. If during the semester you have to miss a section, see grading policy for details on how to request a single section switch. Attendance is expected and more than 1 unexcused absence will result in a lower participation grade. Please note: As there will be no discussion sections held during the week of 11/25 (Thanksgiving week),the final official sections will be the week of 11/18.

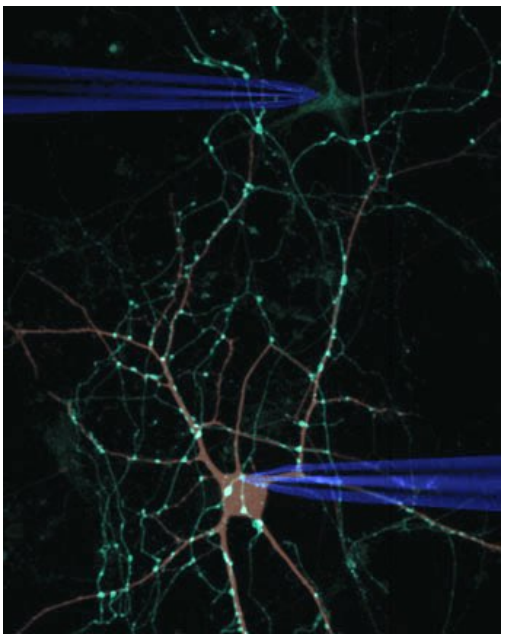
  Sections are a setting where you get to practice, discuss, and build upon the lecture topics. We have designed this aspect of the course based on scientific studies about how students learn and we will be using be active learning techniques. This means you will be asking/answering questions, working in groups, working on problems and activities, and hopefully having fun as you work through the material using techniques that have been shown to be effective learning strategies.

We want to build a classroom climate that is comfortable for all. It is important that we 1) display respect for all members of the classroom – including the instructor and students; 2) pay attention to and participate in all class sessions and activities; 3) avoid unnecessary disruption during class time (e.g. having private conversations, reading the newspaper, surfing the Internet, doing work for other classes, making/receiving phone calls, text messaging, etc.); and 4) avoid racist, sexist, homophobic, or other negative language that may unnecessarily exclude members of our campus and classroom. This is not an exhaustive list of behaviors; rather, it represents examples of the types of things that can have a dramatic impact on the class environment.

- **Notes**: We have prepared notes that introduce the major concepts of the lectures - including definitions, equations and figures for you to look at before or during the videos. Think of these like a condensed Textbook - they will not have all of the details, but give you basic information and listing of the learning objectives. Additionally, there will excerpts from *Neuroscience,* one of the recommended textbooks, that can be read if you want to hear the same material from a slightly different vantage point (that textbook is not required nor tested on).
- **Textbooks**: There is no required textbook for the course. We provide notes and the slides for students to read and reference. Some students may find it helpful to read further into the background of a subject, but all test questions will be based on the lectures and/or notes. We recommend the following resources:

  Neuroscience edited by Purves et al., Sixth Edition, 2017 (ISBN: 9781605353807)

  Neuroscience: Exploring the Brain edited by Bear et al., 4th Edition, 2015 (ISBN: 9780781778176)
- **Academic Integrity Policy**: Discussion and the exchange of ideas are essential to doing academic work. For assignments in this course, you are encouraged to consult with your classmates as you work on problem sets. However for the problem sets, after discussions with peers (or course instructional staff such as tutors, TF/TAs, course assistants), make sure that you can work through the problem yourself and ensure that any answers you submit for evaluation are the result of your own efforts. In addition, you must cite any outside books, articles, websites, etc that have helped you with your work using appropriate citation practices. Similarly, you must list the names of students with whom you have collaborated on problem sets. Regarding generative AI, we believe that AI has its uses and can be a great tool when reviewing or explaining new material. However don't use it for answers on assignments. AI is not permitted during tests and exams, and the problem sets are designed as . .If you are unsure if something constitutes cheating or plagiarism, please ASK.
- **Accommodations for students with disabilities**: Harvard University values inclusive excellence and providing equal educational opportunities for all students. Our goal is to remove barriers for disabled students related to inaccessible elements of instruction or design in this course. If reasonable accommodations are necessary to provide access, please contact the Disability Access Office (DAO). Accommodations do not alter fundamental requirements of the course and are not retroactive. Students should request accommodations as early as possible, since they may take time to implement. Students should notify DAO at any time during the semester if adjustments to their communicated accommodation plan are needed. If needed, please set up a meeting with Katie to discuss any accommodations. All discussions will remain confidential.



- **General Absence/Flexibility Policy**: ***We have adopted a flexible attendance and grading policy for everyone.***
  - To get the most of the course, we recommend that you attend all guest lectures, workshops, and sections and complete video lecture assignments on time. We understand that life happens which is why you will receive full participation points for attending at least 50% of the in-person lectures and completing 80% of the lecture assignments by their deadline (Tu or Th, 9am).

- Section attendance is required. Everyone is allowed to miss 1 section without it impacting their grade. If you know in advance you must miss section, please try to attend a different section. You can find the details (room/time/TF) listed on Canvas, then email your TF, the TF of the section you can attend, and Katie so that we can facilitate the switch. If you cannot make one of the other sections for an excusable absence (sports, conference, illness, etc.) we can excuse additional absences, but you need to let your TF know as soon as possible, show proper documentation, complete the section activities on your own, and set up a time to meet with your TF (preferably during their office hours) to review the material. This make up typically must be completed within a week.
- There is a late policy for problem sets and quizzes (20% off per day), but we can occasionally give extensions for those assignments only (no extensions on videos or excused lecture attendance). IF YOU ARE NOT SURE IF YOU QUALIFY FOR AN EXTENSION OR OTHER ACCOMMODATION, PLEASE ASK. We try to accommodate for different situations (e.g. medical/family emergencies, police incidents, attendance at conferences, etc.) but please make sure each of these situations are documented and you let us know as soon as possible. The general policies are on the following pages, but we can work with students who need exceptions on a case by case basis.

- **Canvas**: Canvas will play a critical role in the course. You will use it to access the lectures, material, turn in assignments, etc. ***You can see your raw grades on Canvas, but please note that the grades posted do not include any drops, the "curved" participation and/or some of the extra credit.*** Please use it to monitor your performance and then calculate your grades based on that information. We will use a separate spreadsheet that takes all of the dropped scores/extra credit into account when calculating final grades. Please check the course website regularly for more information, FAQs, updates, pre-lecture notes, quizzes, problem sets, review sessions, exam preparation, discussion threads, and videos!
- **Discussion Board**: Communication is key, and to make it easier to communicate with the teaching staff as a group, as well as with each other, we will be using the Canvas discussion board. If you have a clarifying, technical or other question whose answer might benefit the entire course, we recommend you post it on the discussion board. There are options to post anonymously if you are hesitant, but we encourage everyone to post and check.
- **Office hours**: All dates, times and locations for office hours by the course staff can be found on the course website. If you would like to schedule additional office hours, please don't hesitate to email the TFs, Katie and/or Prof. Lichtman. We strongly encourage you to take advantage of any of the office hours with the teaching faculty including the two instructors. Office hours are a good way not only to clear up material that is confusing but also a time to discuss your own interests and career or research opportunities in this field. You do not need to prepare before attending any office hour.

  Jeff's office hours: Wed 5 pm, Rm 251 Northwest Building

  Katie's office hours: Thur 2-3:30 pm, Science Center, Office 419
  zoom hours: Fri 11 am, link on Canvas
  individual appointments: https://calendly.com/kquast/20min, email for additional times

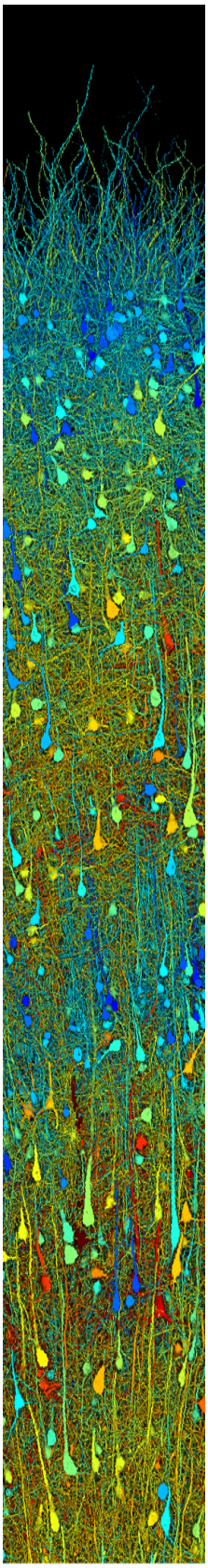
  TF Office hours are posted on Canvas

  Sunday evening problem solving sessions: Sun evenings (likely 6-8 pm), Science Center Room: TBA

Grading Policy

Your final grade for this course will be determined by a grade scheme based on the following components:

- Participation 18%
  - Video Lectures (8%)
  - In-Person Lectures & Workshops (8%)
  - Section (2%)
- Weekly Quizzes 5%
- Problem Sets 20%
- Tests 15%
- Midterm 20%
- Final Exam 22%



Participation (18%): We hope that this university course and active learning will benefit you. To get the most of the class, you will need to engage in the material and work through the questions embedded in the videos, participate in section and answer the Poll Everywhere questions or physical questions during the in-person lectures.

Neuro 80 has adopted a flexible attendance policy for all students.

Video Lectures and associated questions will need to be completed by ***Tuesday 9 am*** (1st lecture's material), or ***Thursday 9 am*** (2nd lecture's material), to receive credit. It is critical that you keep up with the video lectures so the rest of the course makes sense, thus ***we cannot excuse lecture question and there are NO points for late lecture questions***. However, we know that sometimes you can't make the deadline, thus we have some flexibility. If you complete 80% (or more) of the interactive videos/questions/reflections for the semester, you will receive the full 8 points towards your final course grade. Video participation scores will not exceed 100%. (eg completing 52/65 = 80% + 20% = 100%, while completing 40/65 = 61.5% + 20% = 81.5%)

To receive credit for *In-Person Lectures*, you need to be present in the lecture room, participate in the polls or hand in the physical question sheet, AND answer the questions appropriately. (No credit for answers like "this was a great lecture" or similar.) We think that each of the in person lectures, demos, and guests are important, but we want to give you the flexibility so we ask that you attend 50% or more of the in-person lectures to receive full participation credit, beyond that, you have the opportunity to earn extra credit for the in-person portion of your participation grade.

For example, if there are 25 in person lectures/workshops
Attendance of 50% or more of the lectures receives full credit. (13/25 is 52%, so would get 100%)
Attendance of 60-70% (16-18) gets 1% additional lecture participation score
Attendance of 70-80% (19-20) gets 2% additional lecture participation score
Attendance of 80-90% (21-22) gets 3% additional lecture participation score
Attendance of 90-100% (23-25) gets 4% additional lecture participation score

Discussion sections are a place where you and your classmates work through problems, ask questions and interact with course staff each week. Attending and participating during your section is important. 2% of your total grade is for section participation, adding to the discussion, etc. You may miss 1 section without it impacting your grade, after that each unexcused absence will result in a 0.5% reduction in your total grade.

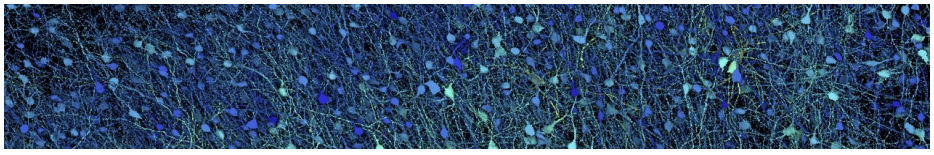
Quizzes (5%): There will be a short (graded) quiz on Canvas at the end of each week. The quizzes will be available Wednesday-Friday. The goal of these quizzes is to help you review and keep up with the material each week. We hope that this will act as a hedge against cramming and help you accrue lasting knowledge. You may use any of the course material while completing the quizzes. The quizzes will be administered through Canvas and must be completed by 8 pm Eastern each Friday. We will drop 1 quiz score.. On the two weeks with an online test, there will be a practice quiz for that week's material. Because you will have several days in which to complete the quiz, there will be no make up quizzes. Late quizzes will be penalized (20% per day immediately after the time they are due).

Problem Sets (20%): Problem sets provide a good way to master the material and prepare for the tests and exams. Each of the problem sets will be due as a **PDF** (legible and in the correct orientation) through Canvas on Monday mornings (9 am EST). Late assignments will be penalized (20% per day immediately after the time they are due). ***We will drop your lowest problem set grade.*** You are welcome to consult with each other as you work through the problems, but each student must submit their own personal solution. Please indicate any collaborators and any applicable office hours on your PSet.

Online Tests (15%): To give students a read out of how they are performing, we will be holding two online tests/ knowledge checks during the semester. The test will be available for 24 hours. These tests (unlike the quizzes) will be timed and contain randomized questions. Together the tests are worth 14% of the final grade.

Midterm (20%): There will be a proctored, timed, midterm on ***Tuesday, October 15th***, that covers material from the first 6 weeks.

Final (22%): There will also be a cumulative final given during finals week, scheduled by the registrar's office. The final exam will focus on the second half of the semester, but about 30-40% of the questions will be review questions from the first half.



How to do well in this course

- Watch video lectures seriously! Take notes during the videos, and answer questions sincerely. Take note of any items that are unclear for that week's workshop.
- Participate in the live sessions. Ask questions, answer polls (bring a charged, connected device). If you have issues with the polls, please see Katie/course staff before leaving the lecture hall.
- Read through the notes and learning objectives. After lecture topic, honestly try to answer each objective.
- Likewise, use the quizzes and problem sets for monitoring your own learning. (Quizzes due Fridays 8 pm, PSets due Mondays 9 am). Before exams, go through the questions again answering them on your own, without notes.
- Make the most of section. Bring questions, ask about any confusion in the activities and problem sets.
- Exams and Tests are based on the learning objectives and very similar to quizzes, problem sets and section activities.
- There are plenty office hours to choose from (including Sunday evening problem solving sessions)! Don't hesitate to come by for any reason - even to vent or to play with the bikes. Set up a meeting time as needed.
- Please reach out to Katie or any of the staff if you feel overwhelmed by the class or feel that you are struggling. We are happy to listen confidentially. There are excellent tutors at the ARC (https://academicresourcecenter.harvard.edu/peer-tutoring). You can also contact Counseling Services if you need additional mental health support. More information is available at https://camhs.huhs.harvard.edu.

Dates (Week)	Lecture Video Topic	Due Date (Videos)	In Person Sessions: Tu/Th 10:30-11:45
9/2-9/6 (Week 1)	1 - Cells of the nervous system	Tu 9/3, 9 am	Tu: Live lecture: Introduction to the neurobiology of behavior
	2 - A brief introduction to neuroanatomy	Th 9/5, 9 am	Th: Neuroscience Activity Fair - Location TBA
9/9-9/13 (Week 2)	3 - Bioelectricity in the nervous system	Tu 9/10, 9 am	Tu: Bioelectricity workshop
	4 - The resting potential	Th 9/12 , 9 am	Th: Resting Potential Workshop
9/16-9/20 (Week 3)	5 - Behavior from the perspective of bioelectricity: the knee-jerk reflex	Tu 9/17, 9 am	Tu: Reflex demonstration and Workshop
	6 - Ionic basis of the action potential	Th 9/19, 9 am	Th: Action Potential 1 Workshop
9/23-9/27 (Week 4) Test1 9/27	7 - Voltage-gated ion channels in the action potential	Tu 9/24, 9 am	Tu: Bruce Bean, PhD
	8 - Conduction of the action potential	Th 9/26, 9 am	Th: Action Potential 2 Workshop
9/30-10/4 (Week 5)	9 - The Synapse - Presynaptic mechanisms	Tu 10/1, 9 am	Tu: Synapses Workshop 1
	10 - The Synapse - Postsynaptic mechanisms	Th 10/3, 9 am	Th: Synapses Workshop 2
10/7-10/11 (Week 6)	11 - Synaptic Inhibition and Integration	Tu 10/8, 9 am	Tu: Dr. Aimee Boegle, "Neurology and Synaptic disorders" & Workshop
	12 - Short term synaptic plasticity and synaptic modulation	Th 10/10, 9 am	Th: Synapses Workshop 3
10/14-10/18 (Week 7)	**Study for exam**		**Tuesday 10/15 - MIDTERM**
	13 - Vision 1 - Turning light into bioelectricity	Th 10/17, 9am	Th: Vision 1: Retina Workshop
10/21-10/25 (Week 8)	14 - Vision - Relaying visual information from eye to brain	Tu 10/22, 9 am	Tu: Vision Workshop 2
	15 - Vision - Cortical mechanisms	Th 10/24, 9 am	Th: Vision Workshop 3
10/28-11/1 (Week 9)	16 - Motor - Spinal Reflexology	Tu 10/29, 9 am	Tu: Margaret Livingstone, PhD "Art, Illusions, and the visual system"
	17 - Motor - How the brain moves the body	Th 10/31, 9 am	Th: Motor Workshop
11/4-11/8 (Week 10) Test2 11/8	18 - Development - Building a nervous system	Tu 11/5, 9 am	Tu: Development Workshop 1
	19 - Development - How axons find their targets	Th 11/7, 9 am	Th: Development Workshop 2
11/11-11/15 (Week 11)	20 - Development - The last (and longest) stage of neural development: synaptic rearrangements	Tu 11/12, 9 am	Tu: Neuroplasticity Fair
	21 - Long-term synaptic plasticity	Th 11/14, 9 am	Th: Development 2 Workshop
11/18-11/22 (Week 12)	22 - Memory - the biggest mystery of neuroscience	Tu 11/19, 9 am	Tu: Gabriel Kreiman, PhD
	23 - Emotion	Th 11/21, 9 am	Th: Memory/Emotion Workshop
11/25-11/29 (Week 13)	24 - The aging brain and neurodegenerative diseases	Tu 11/26, 9 am	Tu: Aging & NeuroDegen Workshop
			Thanksgiving
12/2-12/4 (Week 14)	25 - Individuality	Tu 12/3, 9 am	Tu: Last lecture
Reading Period & Exam	**Final Exam - Date TBA (scheduled by registrar)**		