Department of Bioengineering
Swanson School of Engineering

University of Pittsburgh

Course name	**Quantitative Cellular Neuroscience**
Course number	**BIOENG 2585**
Semester	**Fall 2025**
Course time	**9 am – 10:15 am, Tuesday – Thursday**
Location	**# 1045, Benedum Hall, 3700 O'Hara St, Pittsburgh**
Credits	**3**
Max class enrollment	**30**

Instructor	**Bistra Iordanova, PhD**
Contact information	**bei3@pitt.edu**
Office location	**Center for Bioengineering # 209** **300 Technology Drive** **Pittsburgh, PA15219**

Teaching Assistant	**Saba Gharooni Khorrami**
Contact information	**SAG492@pitt.edu**

Office hour	**Tuesdays, 10:15 am – 11:15 am + by appointment**
Office hour location	**#317 Benedum Hall**

Prerequisites	Enrolled students should have a basic background in cellular biology, electromagnetism, matrix algebra, first order dynamic systems and basic programing in MATLAB environment.
Course Texts	"From Molecules to Networks: An Introduction to Cellular and Molecular Neuroscience" by John Byrne, Ruth Heidelberger and Neal Waxham, ISBN: 9780123971791 published 2014
Required Software	MATLAB

Course Description

This course is designed to be a comprehensive introduction to cellular neuroscience for engineers. Modern cellular neuroscience is an interdisciplinary field that seeks to understand the function of single cells and populations in the context of the thinking brain. This course provides a survey of cellular brain science ranging from molecules to simple neural circuits. In addition to principles and theory this class will also cover basic quantitative concepts and provide opportunity to analyze real-life data from molecular and cellular neural engineering. In the context of each cellular brain function we will also address cellular dysfunction with translational engineering applications to neurological brain disease.

Learning Objectives

Upon this course completion you should have a working knowledge of the cellular make-up of the brain, brain energy metabolism, activity-dependent and environmental regulation of gene expression, electrical properties of neurons, neurotransmitter systems, neural communication, mechanisms of brain plasticity and the architecture of simple neural circuits. At the end of the course, you should also become familiar with common cellular experimental strategies and be able to evaluate critically scientific work in the field of cellular neuroscience.

Grading information	Grade	Percent %
Class participation 10%	A	100 – 93
Homework 30%	A-	92 – 90
Midterm 25%	B+	89-87
Final 25%	B	86-83
Collaborative project 10%	B-	82-80
	C+	79-77
	C	76-73
	C-	72-70
	D+	69-67
	D	66-63
	D-	62-60
	F	<60

Class participation is worth 10%
You must participate at least once per class - either ask a question or answer a question from the lecturer. You also get participation credit for the lectures with Top Hat question for the whole class. The Top Hat participation questions will be available only for Dr Iordanova's lectures. The TA will keep track of the participation and 10% towards the final grade will be distributed over the number of class meetings proportionally. Participation credit is only given to those that attend in person. The goal is to engage and to be present, to encourage dialog and help the whole class to learn.

Each homework is worth 6% adding up to 30%
Two weeks on average to complete each HW. Pay attention to the deadlines. Late submission will lose 10% of the grade. No submissions will be considered 24 hours after the deadline.
HW1 – Analysis of cellular morphology in a two-photon z-stack
HW2 – Microglia migration towards vascular injury, two-photon timeseries
HW3 – *In vivo* dopamine fast-scan cyclic voltammetry
HW4 – Extracellular recording in the somatosensory cortex
HW5 – Neuronal activity using GCaMP Ca^{+2} reporter protein – wide field

Collaborative project proposal is worth 10%
Pick one partner from the class, meet, and discuss how your research can benefit from collaboration. Find an intersection between your interest and those of your partner that can be in the science, the engineering, or the approach. Think of a problem that this collaboration can solve by using a unique skill, knowledge, or tool that the other person does not have. Put one page text in the format of specific aims similar to the specific aims format for your preliminary exam, no limit on the references. and upload on canvas. Make sure you include title and the names of the team. The teams should be self assigned on canvas as well. Present during the last two classes of the semester. The presentation should have 8-10 slides in 10-15 min + 5 min for questions = total 20 min per team. Each of you can show 1-2 slides about your own research and the specific area that will be involved in the collaboration so we can understand where you are coming from. The rest is your proposal slides (you agree who speaks, ideally you take turns) propose the collaborative project - briefly describe the problem and why it's important, propose your collaborative solution – set up and expected outcome.

Midterm and final each worth 25%
Each exam to be completed within 24 hours. Includes questions on the theory covered in class and basic computations covered in the homework. Pay attention to the deadlines. Late submission will lose 10% of the grade. No submissions will be considered 24 hours after the deadline.

Extra credit 2% After you submit your exam, on the next day there will be exam key posted. You will be assigned anonymously at random to grade one peer for extra credit in the class (1% of the class grade per exam). The goal is to engage fully with the exam key and make up for unforeseen class absences.

Extra credit 1% - OMETS filled by 90% of the class. Teaching Surveys open Nov. 17 to Dec. 7

Bold entries indicate confirmed guest speakers.

Date	L#	Topic	HWs/exam
T – 08/26	1	Meet and greet + Primer for optics in the brain	HW1 given
R – 08/28	**2**	**Neurulation and neurogenesis** ***Lance Davidson, PhD, Bioengineering Dept, lad43@pitt.edu***	
T – 09/02	**3**	**Protein synthesis and vesicular transport** ***Carsten Stuckenholz, PhD, Bioengineering, cstucken@pitt.edu***	
R – 09/04	**4**	***The molecular biology of memory formation*** ***Carsten Stuckenholz, PhD, Dept. of Bioengineering***	HW1 due
T - 09/09	5	Neurons	HW2 given
R - 09/11	6	Resting and action potentials	
T - 09/16	**7**	**Classical neurotransmitters** ***Helen Schwerdt, PhD, Dept. of Bioengineering, hes100@pitt.edu***	
R - 09/18	8	Non-classical neurotransmitters	HW2 due
T - 09/23	**9**	***Glial cells*** ***Nicholas Fitz, PhD, School of Public Health, nffitz@pitt.edu***	HW3 given
R - 09/25	**10**	**Cellular communication** ***Nicholas Fitz, PhD, School of Public Health, nffitz@pitt.edu***	
T - 09/30	**11**	**Neurotransmitter Receptors** ***Tija Jacob, PhD, Dept of Pharmacology, tcj11@pitt.edu***	
R - 10/02	12	Post-synaptic potential and synaptic integration	HW3 due
T - 10/07		MIDTERM – covers lectures 1-12	
R - 10/09	**13**	**Cable properties of neurons** ***Lee Fisher, PhD, Dept. of Physical Medicine, lef44@pitt.edu***	HW4 given
T – 10/14	**14**	**Synaptic plasticity and learning** ***Patrick Mayo, PhD, Dept of Ophthalmology***	
R – 10/16	**15**	**Information processing in simple circuits and networks** ***Patrick Mayo, PhD, Dept of Ophthalmology***	
T – 10/21	16	Brain barriers and glymphatic system	HW4 due
R – 10/23	**17**	**Neurovascular coupling and brain energy metabolism** ***Alberto Vazquez, PhD, Dept. of Radiology, alv15@pitt.edu***	HW5 given
T – 10/28	**18**	**Brain rhythms and sleep** ***Alberto Vazquez, PhD, Dept. of Radiology, alv15@pitt.edu***	
R – 10/30	**19**	**Spinal cord – neuronal circuits, injury, and bladder control** ***Chaitanya Gopinath, PhD, Dept. of Physical Medicine and Rehabilitation***	
T – 11/04	20	Municipal Elections. No class	HW5 due
R – 11/06	**21**	**Sex-specific transcriptional signatures of depression** ***Marianne Seney*, PhD, *Dept of Psychiatry, seneyml@upmc.edu***	
T – 11/11	**22**	**Neural basis for brain-gut communication** ***David Levinthal, MD, PhD, Dept of Medicine, levinthald@upmc.edu***	
R – 11/13	**23**	**Cellular effects of stroke** ***George Wittenberg, MD, PhD, Dept of Neurology, geowitt@pitt.edu***	Collab team proposal due
T – 11/18	24	Adult neurogenesis	OMET opens
R – 11/20		FINAL – covers lectures 13 - 24	
T – 11/25		No class - Thanksgiving Recess	
R – 11/27		No class - Thanksgiving Recess	
T – 12/02		Collaborative project proposals	
R – 12/04		Collaborative project proposals	OMET closes

Class Climate
All of us should feel responsible for creating a space that is both intellectually rigorous and respectful. Above all, be respectful (even when you strongly disagree) and be mindful of the ways that our identities position us in the classroom. I expect everyone to come to class prepared to discuss the readings in a mature and respectful way. You can approach your instructor or teaching assistant ahead of time if you need more information about a topic or reading. If you need to leave or miss class, you are still responsible for the material you missed.

Academic Integrity
Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. To learn more about Academic Integrity, visit the Academic Integrity Guide for an overview of the topic. For hands-on practice, complete the Understanding and Avoiding Plagiarism tutorial.

Disability Services
If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Inclusion
The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. I ask that everyone in the class strive to help ensure that other members of this class can learn in a supportive and respectful environment. If there are instances of the aforementioned issues, please contact the Title IX Coordinator, by calling 412-648-7860, or e-mailing titleixcoordinator@pitt.edu. You may also choose to report this to a faculty/staff member; they are required to communicate this to the University's Title IX Coordinator. If you wish to maintain complete confidentiality, you may also contact the University Counseling Center (412-648-7930).

Take Care of Yourself
Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep, and taking time to relax. Despite what you might hear, using your time to take care of yourself will help you achieve your academic goals more than spending too much time studying. All of us benefit from support and guidance during times of struggle. There are many helpful resources available at Pitt. An important part of the college experience is learning how to ask for help. Take the time to learn about all that's available and take advantage of it. Ask for support sooner rather than later – this always helps. If you or anyone you know experiences any academic stress, difficult life events, or difficult feelings like anxiety or depression, we strongly encourage you to seek support. Consider reaching out to a friend, faculty or family member you trust for assistance connecting to the support that can help. The University Counseling Center is here for you: call 412-648-7930 and visit their website.
If you or someone you know is feeling suicidal, call someone immediately, day or night:
University Counseling Center (UCC): 412 648-7930
University Counseling Center Mental Health Crisis Response: 412-648-7930 x1
Resolve Crisis Network: 888-796-8226 (888-7-YOU-CAN)