

Syllabus for Systems Neuroscience (03-363)

Spring 2017

“Critique is not some peripheral feature of science, but rather is core to its practice, and without [it], the construction of reliable knowledge would be impossible.”

- Jonathan Osborne, 2010

“[I do not] carry such information in my mind since it is readily available in books... The value of a college education is not the learning of many facts but the training of the mind to think.”

- Albert Einstein, 1921

“The most exciting phrase to hear in science, the one that heralds new discoveries, is not ‘Eureka!’ but ‘That’s funny...’”

- Isaac Asimov, attributed, no date/source

Course Description:

Modern neuroscience is an interdisciplinary field that seeks to understand the function of the brain and nervous system. This course provides a comprehensive survey of systems neuroscience, a rapidly growing scientific field that seeks to link the structure and function of brain circuitry to perception and behavior. This course will explore brain systems through a combination of classical, Nobel prize-winning data and cutting edge primary literature. Topics will include sensory systems, motor function, animal behavior and human behavior in health and disease. Lectures will provide fundamental information as well as a detailed understanding of experimental designs that enabled discoveries. Finally, students will learn to interpret and critique the diverse and multimodal data that drives systems neuroscience.

Prerequisite: 03161 or 85219 or 42202 or 03240 or 03320

Educational goals:

In this course, you will learn to read and evaluate scientific results, both on your own and during in-class discussions. There are key facts about neurons and brains that you will have to memorize. Beyond that, you will be able to determine why some results provide compelling evidence for a particular theory and other results may cause difficulty for the theory. You will learn how to provide thoughtful judgments of competing theories, based on evidence, and begin to develop capabilities to participate meaningfully in scientific discussions. Most importantly, you will learn the value of the scientific approach and of weighing evidence and the impact of science.

Class times: TR 9:00 – 10:20 pm, HH B103

Required Texts: *Neurobiology: A Functional Approach* (Striedter)
The Tale of the Dueling Neurosurgeons (Kean)

Instructor: Daniel (DJ) Brasier
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Office Hours: Tuesdays 3:30 pm to 4:30 pm & by appointment (**don't be shy**)

TA: Teresa Spix
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Office Hours: By appointment

Guiding philosophy: My goal is to show you the connections between what you are learning in this course to chemistry, physics, math, statistics, psychology, and other disciplines. It is not to have you master chemistry, physics, and neuroscience all in a semester, nor is it to close the door to neuroscience for those without significant chemistry and/or physics (they are NOT pre-requisites); rather, my goal is to show you the value of other sciences in their path toward developing a deep appreciation of brain function at all stages of your educational journey.

Specific Learning Objectives:

- Be conversant in a wide range of systems neuroscience topics, including:
 - o Electrical and chemical processes in neurons
 - o Synaptic communication, plasticity, and memory
 - o Simple circuit motifs in the brain and their functional role
 - o Large-scale circuits connecting multiple brain areas
 - o Senses: vision, olfaction, somatosensation, audition
 - o Sensorimotor integration and perception
 - o Motor control in the cortex and regulation by subcortical regions
- Be able to read and evaluate original research papers in any of the above topics including
 - o Identifying a research question or hypothesis
 - o Understanding techniques used by neuroscientists to study brain function
 - o Identifying appropriate techniques to test research questions and hypotheses
 - o Linking a hypothesis to a specific predicted experimental outcome
 - Identifying background knowledge and assumptions made
 - Describing the logical flow between background, assumptions, methods, results, and interpretation
 - o Proposing a follow-up experiment to further advance knowledge beyond a single study
 - o Evaluating the limitations of a methodology or a broader study and consider other interpretations

For this class, I am conducting research on the value of primary-literature as a teaching tool, on the usefulness of blogs in understanding science, and also on the relationship between chemistry/physics background knowledge and success in neuroscience. There is no chemistry or physics pre-requisite and I will not assume you know anything beyond high school chemistry or physics. In this course, you will learn some physics and chemistry, and you will be responsible for the chemistry and physics material I teach you. In this course, you will also be required to make regular blog posts on Blackboard and those posts will be graded and contribute to your final grade in the course as well as to your learning of the other required course material. The research I am doing will not require you to do anything above and beyond the required activities and assignments that are part of this course. You are free to choose to not participate in this research, and your participation will have no influence on your grade for this course or your academic career at CMU. Participants will not receive any compensation. The data collected as part of this research will include student grades. All analyses of data from participants' coursework will be conducted after the course is over and final grades are submitted. The Eberly Center may provide support on this research project regarding data analysis and interpretation. To minimize the risk of breach of confidentiality, no one aside from Dr. Brasier will ever have access to data from this course containing your personal identifiers. All published data will be analyzed in de-identified form and presented in the aggregate, without any personal identifiers. Please contact me at any time if you have questions or concerns about your participation.

Grading

50 points	Lowest midterm exam (10%)
100 points	Second-highest midterm exam (20%)
100 points	Highest midterm exam (20%)
100 points	Final Exam (20%)
40 points	Blog assignments (details in week 2 – 8%)
50 points	Written report (10%)
60 points	Other homeworks, quizzes, & activities (12%)

Total: 500 points

Guaranteed cutoffs:

A = 450 or more points (90% and above)

B = 400-449.999 points (80% to 89.99999%)

C = 350-399.999 points (70% to 79.99999%)

D = 300-349.999 points (60% to 69.99999%)

(These cutoffs may be slightly adjusted in the students' favor, depending on final grade distribution)

- **Exams.** The mid-terms test material from each unit. Although they are not explicitly cumulative, many questions will assume a solid understanding of material from earlier units. No calculators, computers, or other electronic devices are permitted on the mid-terms.
- **The final exam.** This will be during finals week. *It will be open book, open notes (as many pages as you can carry), and you may bring a computer with whatever data you like on it.* Unlike the mid-terms, you will be permitted to use a computer or tablet, including a scientific calculator application. The only restriction is that **you may not access the internet and any device must have *** all communication disabled ***** (no cell data, no texting, **no access to another person in any way**, no Bluetooth, no short-wave radio, no Morse code). In other words, no contact with another person and no accessing data that is not already on the hard drive of your machine. If you do not own a laptop, you may talk to me about arranging to borrow one from the campus libraries.
- **Homeworks, quizzes, and in-class/out-of-class activities.** Students are required to participate in all classroom activities and to engage in classroom discussions. These include participating in discussion during lecture times and doing activities. Some activities will be in class, some will be homework assignments. There will be occasional quizzes, including perhaps some “pop” quizzes.
- **Final report.** Students must choose a topic relevant to the class and an original scientific paper about that topic and write a report. Deadlines are listed in the schedule. (More details during the second week of classes.)
- **Blog assignments.** You will be assigned a group during the second week of classes and then have to do assignments in which you find an original scientific article and discuss it on a blog visible to the whole class. More details in week 2.
- **Quizzes.** There will be 3 planned quizzes (see schedule) and 3-5 pop quizzes. The top 5 of all the quizzes will count for the final grade for each student (so if we have 7 quizzes, 2 are dropped).
 - **Pop quizzes.** There will be some announced quizzes and occasional pop quizzes at the beginning of class that may cover ANY material, including: material since the last exam/quiz, reading/ homework due that day, and/or old material from earlier in the course. The purpose of this is to ensure students stay on top of the course material and to encourage reviewing material regularly.

Students enrolled in 03-763 will be given grading information on the first day of classes.

Other policies

Academic Integrity

- **Cheating.** Cheating of any sort will not be tolerated. For example, if exam answers are copied from another student, both students will receive zeros; if graded exams are altered and resubmitted for a higher score, the revised score will be zero. In addition, these and other forms of cheating may also be referred to the Academic Review Board for more severe penalties. This warning has two purposes: 1) to dissuade a small number of students from considering cheating; and 2) to persuade the large majority that they will get a fair grade based on their individual performance.
Collaboration on homeworks is acceptable (encouraged, in fact).
- **Plagiarism.** Cheating also includes plagiarism, the presentation of the work of another person as one's own. This applies whether the source of the material is a printed book, a web site, or work of another student from this course or any other course. Lifting even a single sentence without appropriate attribution constitutes plagiarism. Read Promoting Academic Integrity (<http://www.cmu.edu/policies/documents/Cheating.html>) for official university policy on this issue. Any source you reference (aside from the class text book) must be referenced, **even if you only used the source for ideas and did not quote a single word.** This applies to all work at CMU, but is especially relevant in this class on the neurotransmitter presentation and written reports.

Exam re-grades. We are committed to grading as fairly as possible. If you think a mistake was made in grading your exam, you can submit your exam and a written explanation of why you think you deserve more points than you were given and your exam will be re-graded. Re-grades must be submitted **no more than one week** after exams have been returned. The instructor reserves the right to re-grade the entire exam in addition to the disputed question, and add or subtract points.

Technology use policy

The use of cell phones is strictly prohibited in class. Computers are permitted, but only if you are using them to take notes. Multi-tasking on computers (having multiple windows open including class materials) is prohibited. If you are using technology in an unauthorized way during class, you may be asked during or after class to stop. Repeated violations may result in point deductions and if your technology use is distracting to others you may be asked to leave.

Students with Disabilities:

If you wish to request an accommodation due to a documented disability, please inform your instructor and contact Disability Resources as soon as possible.

They can be reached at access@andrew.cmu.edu or 412-268-2013.

Final note on filming:

I will be filming some lectures. The purpose is to create an archive for use by later students. They take time to edit together and export into usable video. I will make the raw movies available as soon as possible provided that attendance and participation remain high. Student questions and comments will be available in the raw lectures that you all will be able to see; however, before these are more widely publicized, we will edit out your questions and comments or transcribe them to text but mute your voice as per requirements of the Family Educational Rights and Privacy Act (FERPA).

Classroom citizenship

The choice to take this course is entirely up to you. If you do choose to take the course, please do your best to be a good course citizen. This means you should attend all classes on time and to participate in class discussions and activities.

In turn, we will make every effort to build a valuable learning experience for every student. If there is ever any way we can improve your learning, or if any topic doesn't capture your interest, we welcome feedback (either in class, outside of class, or anonymously).

Finally, it is everyone's responsibility to be respectful of others during class, including respecting each other's ideas and listening to one another and to the instructor.

"The test will measure whether you are an informed, engaged, and productive citizen of the world, and it will take place in schools and bars and hospitals and dorm rooms and in places of worship. You will be tested on first dates, in job interviews, while watching football, and while scrolling through your Twitter feed. The test will judge your ability to think about things other than celebrity marriages, whether you'll be easily persuaded by empty political rhetoric, and whether you'll be able to place your life and your community in a broader context. The test will last your entire life, and it will be comprised of the millions of decisions that, when taken together, will make your life yours. And everything, everything, will be on it!"

- John Green (Vlogbrothers, Crash Course)

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 some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

ALSO

If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:

CaPS: 412-268-2922

Re:solve Crisis Network: 888-796-8226

If the situation is life threatening, call the police:

On campus: CMU Police: 412-268-2323

Off campus: 911

Systems Neuroscience (03-363) Schedule (subject to change)

** Please check Blackboard regularly for required readings & course updates. **

Unit 1: Methodology & cellular foundations

- 1/17 Course introduction, main objectives, and course themes (Chapter 1.1, 1.2, 1.3, 1.4)
1/19 Core methodologies, part 1: single cell, optogenetics, & immuno (*PHY*; Chapter 1.1)
1/24 Core methodologies, part 2: fMRI, behavioral genetics, and patch clamp (Chapter 1.1)
1/26 Resting potential, Nernst (*PHY*, Chapter 2.2); also, group assignments & first blog assignment
1/31 Action potential (Chapter 2.3)
2/2 Synaptic transmission, part 1 (Chapter 2.4)
2/7 Synaptic transmission, part 2 (Chapter 2.4); blog 1, recap
2/9 Information processing (Chapter 2.6)
2/14 Exam 1

Unit 2: Remote sensors

- 2/16 Vision (*PHY*; Chapter 6.1, 12.2); blog 2, assignment
2/21 Labeled lines, lateral inhibition, coding strategies (Chapter 6.4, 11.1, 12.1)
2/23 Olfaction (Chapter 6.2, 6.3)
2/28 Audition (Chapter 6.3, 11.2); blog 2, recap
3/2 Principles of sensory organization (Chapter 6.4, 11.4)
3/7 Exam 2

Unit 3: Touch and bodily control

- 3/9 Taste & contact sensor organization (Chapter 7.4, 7.7); blog 3, assignment
3/10-3/19 *No class*
3/21 Touch & vibration: encapsulation (Chapter 7.1)
3/23 Pain (Chapter 7.2)
3/28 Temperature (Chapter 7.3)
3/30 Sensing internal condition (Chapter 7.5); blog 3, recap
*** **Written report paper topic due by 4/3 at 10:00 pm via e-mail**
4/4 Regulation of internal condition (Chapter 9.1, 9.2); blog 4, assignment
4/6 Regulation of internal condition (Chapter 9.2), part 2

Unit 4: Reflexes & sensorimotor systems

- 4/11 Muscle control & motor units (*PHY*; Chapter 8.1)
4/13 Exam 3 (unit 3 material)
4/18 Basal ganglia (*TS*; Chapter 15.1, 15.2, 15.3)
4/20 *Carnival: no class*
4/25 Proprioception & vestibular sense (Chapter 7.6)
4/27 Reflexes & spinal cord (Chapter 10.1, 10.2, 10.3, 10.4) ; blog 4, recap
5/2 Motor cortex & cerebellum (Chapter 10.5, 10.6)
*** **Final written report due by 5/3 at 10:00 pm via e-mail**
5/4 Recap of sensorimotor principles (Chapter 12 & 15)

TBA Final Exam, cumulative, some emphasis on unit 4

Do not book travel for before May 16th!