

Neural System Designs – BENG 350 / NEUR 461

Prerequisites: BIOL 213 and BENG 214 (aka BENG 313) or permission of instructor.

Content and Goals: This course introduces essential architectural principles of the mammalian nervous system. The recurring theme is that Evolution successfully managed to re-arrange the same building blocks (neurons, synaptic transmission, and membrane physiology) in different networks exquisitely tuned to their functions, though often in incompletely understood ways.

Instructor: Giorgio A. Ascoli (ascoli@gmu.edu)

Teaching Assistant / Grader: Zara Asif (zasif3@masonlive.gmu.edu)

Meeting days/times: Tuesdays from 12 noon to 2:40pm (class)
Mondays from 1pm to 2pm or by appointment (office hours)

Texts: Purves, D., et al. (2017) Neuroscience, 6th Ed., Sinauer Associates. ISBN: 9781605353807
Ascoli, G.A. (2015) Trees of the Brain, Roots of the Mind, MIT Press. ISBN: 9780262028981

Technological requirements: Access to Blackboard, Zoom, and Respondus Lockdown Browser.

(Approx.) Class Schedule of Topics

- 1/26** Introduction, class policies, learning goals, assignments, and assessment.
Systems architecture: CNS and non-invasive brain imaging; neurons & glia.
[Assignment due by 1/29 at 12 noon: complete example Assessment quiz on Blackboard.](#)
[Assignments due 2/2: read TBRM Ch1&3; study TBRM Ch2 & wk1 slides.](#)
- 2/2** **Quiz on week 1 material.**
Neuronal components: soma, axons, dendrites, synapses, myelin.
Membrane biophysics & electrophysiology: gradients, pumps, channels, cable, spikes.
[Assignments due 2/9: study TBRM Ch3 & wk2 slides; read TBRM Ch4. Pick topic & meet team!](#)
- (2/3 Last day to drop with 100% refund)
- 2/9** **Quiz on week 2 material.**
Synaptic machinery: vesicles, receptors, signals, and drugs.
Protagonists & supporters: principal cells, interneurons, and modulators.
[Assignments due 2/16: study wk3 slides; read TBRM Ch5&6. Collect source material.](#)
- 2/16** **Quiz on week 3 material.**
Neuronal diversity: transcriptomics, firing patterns, and connectomics.
From neural activity to behavior and cognition.
[Assignments due 2/23: study wk4 slides; read TBRM Ch7&8. Draft report & organize refs.](#)
- 2/23** **Quiz on week 4 material.**
Plasticity and memory: the ever-changing brain.
Associative conditioning, molecular mechanisms, & potential connections.
[Assignments due 3/2: study wk5 slides; read TBRM Ch9; read Purves Ch15. Start slides.](#)
- 3/2** **Quiz on week 5 material.**
Review of neural foundations [*a. memristors, cmos, and fpgas*]
Olfaction & taste (des.: lateral inhibition enhances contrast) [*b. gas & liquid chromatography*]
[Assignments due 3/9: study wk6 slides; study Purves Ch15, read Purves Ch16. Refine slides.](#)
- 3/9** [Exam on neural foundations](#)

Spinal cord & Central Pattern Generation [*c. servo motor & robotic actuators*]

Assignments due 3/16: study wk7 slides; study Purves Ch16, read Purves Ch30. Refine report.

3/16 Quiz on week 6+7 material.

Hippocampal formation (EC, DG, CA3, and CA1): grid & place cells [*d. GPS*]

Pattern separation, completion, comparison [*e. face/speech recognition, FAISS*]

Assignments due 3/23: study wk8 slides; study Purves Ch30, read Purves Ch27. Submit draft.

3/23 Quiz on week 8 material.

Neocortex: functional modularity and specialization [*f. deep learning + applications*]

Language, semantic maps, & Amazon ads [*g. Alexa/Siri, Google knowledge graph, AI*]

Assignments due 3/30: study wk9 slides; study Purves Ch27, read Purves Ch19. Work on tips.

3/30 Quiz on week 9 material.

Cerebellum: error correction and ballistic action [*h. control theory & precision targeting*]

Grand review of circuits and functions. Marr's levels of analysis + ethics

Assignments due 4/6: study wk 10 slides; study Purves Ch 19. Review neural foundations.

4/6 Exam on Circuits & Functions

Neuroinformatics & industrialization of neuroscience; discussion of presentation previews

Assignments due 4/13-27: complete & submit presentation written report & slides.

4/13 Presentations (visual + mechanosensory) & ethics debate

Presentations a+b & ethics debate

4/20 Presentations c+d & ethics debate

Presentations e+f & ethics debate

4/27 Presentations g+h & ethics debate

Challenges ahead, BMIs, DISCUSSION, feedback.

Assessment: Weekly Quizzes (8x5mc@0.5pt ea) - 20 points

Neural Foundation Exam (40mc@0.5pt ea) - 20 points

Circuits & Functions Exam (40mc@0.5pt ea) - 20 points

Presentation written report & bibliographic search - 20 points

Presentation slides and delivery - 20 points

Perfect attendance record - up to 14 *make-up* points !

Grading: A, >93.3; A-, (86.6-93.3); B+, (80-86.6); B, (73.3-80); B-, (66.6-73.3); C+, (60-66.6); C, (53.3-60); C-, (46.6-53.3); D, [33.3-46.6]; F, <33.3.

Class communication: The instructor reserves the right to make any changes in the course he determines academically advisable. Changes will be announced in class and by *email solely through the students Mason account*. It is the student's responsibility to keep up with any changed policies.

Mandatory Attendance: Students are expected to attend class on time and participate in all discussions and activities for the whole duration of each lecture. Graded weekly quizzes will be at the beginning of each class, so punctuality is required. There will be no make-up quizzes/exams. Students with an excused absence (sick with a doctor's note, death in the family, religious observance) should contact instructor before missing class/exams to discuss options for alternative arrangements. In the event of illness, you must present a doctor note explicitly stating that you were too ill to take the exam. Car/transportation trouble, traffic, routine doctor appointments, vacations, and any avoidable conflicts are not considered excused absences.

Writing Center: George Mason University provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) for supporting students as they work to construct and share knowledge through writing. See writingcenter.gmu.edu

Academic Integrity: George Mason has an honor code with clear guidelines for academic integrity. Honesty expectation and requirement are taken very seriously, and breaches of this trust are treated gravely. Students must be responsible for their own work. When in doubt (of any kind) please ask for guidance and clarification. Cheating of any form is not tolerated. Students and faculty must take on the responsibility of dealing explicitly with violations.

Professional disposition: Students are expected to exhibit professional behavior at all times.

Disability Accommodations: If you have a documented learning disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Office of Disability Services (SUB I, Rm. 4205; 993-2474; ods.gmu.edu) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

Counseling and Psychological Services: George Mason University has a staff of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops, and outreach programs) to enhance students' personal experience and academic performance. See caps.gmu.edu