IMPORTANT: This syllabus form should be submitted to OAA (gsbs_academic_affairs@uth.tmc.edu) a week before the start of each semester.

NOTE to STUDENTS: If you need any accommodations related to attending/enrolling in this course, please contact the Graduate School's 504 Coordinator, Natalie Sirisaengtaksin, PhD. We ask that you notify GSBS in advance (preferably at least 3 days before the start of the semester) so we can make appropriate arrangements.

Term and Year: Fall 2025 **Course Number and Course Title:** GS14 1214: Molecular and Cellular Neuroscience **Credit Hours:** 4 **Prerequisites:** None **Meeting Location:** UTHealth Houston McGovern Medical School **Building/Room#:** MSB B.620	**Program Required Course:** Yes **Approval Code:** No **Audit Permitted:** No **Classes Begin:** August 25, 2025 **Classes End:** Dec 5, 2025 **Final Exam Week:** Dec 8-12, 2025

Class Meeting Schedule

Day	Time
M/W/F	**9:00-10.20am**

Course Director

Name and Degree: **Ruth Heidelberger, MD, PhD**
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Course Co-Director/s:

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Course Description: This course is a graduate level treatment of molecular and cellular neuroscience. It will introduce basic concepts of molecular, electrical and chemical signaling in individual neurons, synapses, and local neuronal circuits. Topics covered include the functional properties of membranes, receptors, and channels, intracellular signaling cascades, synaptic transmission, short- and long-term forms of synaptic plasticity, and information processing in neuronal dendrites and local circuits.

Textbook/Supplemental Reading Materials

(Textbook copies can be signed out from Amanda Williamson, MSB 7.262): electronic versions may be available through the TMC Library)

- Molecular Cell Biology, Lodish et al., eds. 7th edition
- From Molecules to Networks, Byrne et al., eds. 3rd edition (FMN)
- Cellular and Molecular Neurophysiology, 3rd, Constance Hammond (Academic Press/Elsevier)
- Neuroscience Online: An Electronic Textbook for the Neurosciences, http://nba.uth.tmc.edu/neuroscience/
- Neuron simulation program: MetaNeuron, download at http://www.metaneuron.org/

Course Objective/s:

Upon successful completion of this course, students will learn basic concepts of molecular, electrical, and chemical signaling in individual neurons, synapses, and local neuronal circuits.

***Specific Learning Objectives*:**

1. Understand the composition and electrical characteristics of bio-membranes, including their passive and active properties.
2. Understand the structure and function of voltage- and ligand gated ion channels and G-protein coupled receptors.
3. Understand the mechanisms underlying intracellular signaling pathways in neurons.
4. Understand the molecular and cellular properties underlying synaptic transmission and synaptic plasticity.
5. Understand the integration of signals in neuronal dendrites and circuits.

Student responsibilities and expectations:

Students enrolled in this course will be expected to perform the following activities each week.

1. Read assigned readings and review lecture slides prior to that lecture.
2. Attend class and be prepared to discuss possible solutions to questions posed by the lecturer
3. Attend and contribute to one of the lab sessions
4. Present results from assigned science paper.
4. Attend and participate in the review sessions prior to exam
5. Complete homework assignments
6. Prepare for and take each of the three, non-cumulative take-home examinations

Students are expected to complete all assigned reading material (reviews and research literature) prior to class. While you may work and discuss all course materials and assignments in groups, all writing assignments must be your own. Plagiarism and failure to properly cite scientific literature and other sources will not be tolerated and are grounds for dismissal from the course and further GSBS disciplinary action.

Cheating or engaging in unethical behavior during examinations (quizzes and final) will be grounds for dismissal from the course without credit and further GSBS disciplinary action.
Grading System: Letter Grade (A-F)
Student Assessment and Grading Criteria: *(May include the following:)*

Percentage	Description
Presentations (10 %)	One paper presentation, and one presentation during review session
Take-home Exams (90 %)	Three non-cumulative take-home exams that each count 30%

CLASS SCHEDULE (All classes are 9:00-10.20 am)

Week 1 (Aug 25 – Aug 29)

8-25, M: Introduction to neuronal cell biology (Stavoe)

8-27, W: Mechanisms of neuronal homeostasis. (Stavoe)

8-29, F: Membrane composition I – structural/functional roles of lipids –rafts (Waxham)

Week 2 (Sep 1 – Sep 5)

9-1, M: Labor Day, no class

9-3, W: Membrane composition II – Protein-lipid interactions (Waxham)

9-5, F: Voltage-gated K+-channels (Waxham)

Week 3 (Sep 8 – Sep 12)

9-8, M: Voltage-gated Na+-channels (Waxham)

9-10, W: Introduction to neurons, synapses and neuronal networks (Beierlein)

9-12, F: Ionic basis of resting membrane potential (Beierlein)

Week 4 (Sep 15 – Sep 19)

9-15, M: Mechanisms of action potentials (Beierlein)

9-17, W: Microscopic and macroscopic Na and K currents (Beierlein)

9-19, F: Propagation of action potentials in axons and dendrites (Beierlein)

Week 5 (Sep 22 – Sep 26)

9-22, M: Neurophysiology lab, **MSE R419,** Time TBD

9-24, W: class presentations

9-26, F: review session **Exam 1**

Week 6 (Sep 29 – Oct 3)

9-29, M: Intracellular signaling I – GPCR structure/signaling at the membrane (Eckel-Mahan)

10-1, W: Intracellular signaling II – Diffusion, Ca2+ domains, intracellular stores (Eckel-Mahan)

10-3 F: Intracellular signaling III – forward/backward signaling – phosphor. (Eckel-Mahan)

Week 7 (Oct 6 – Oct 10)

10-6, M: Voltage-gated Ca2+-channels (Heidelberger)

10-8, W: Neurotransmitter release, Part I: "In the beginning" (Heidelberger)

10-10, F: Neurotransmitter release, Part II: "Calcium and timing" (Heidelberger)

Week 8 (Oct 13 – Oct 17)

10-13, M: Neurotransmitter release, Part III: "Synaptic design" (Heidelberger)

10-15, W: Ligand-gated channels - nAChR and GABA (Waxham)

10-17, F: Ligand-gated channels – Glycine/Glutamate (Waxham)

Week 9 (Oct 20 – Oct 24)

10-20, M: Ionotropic synaptic signaling (Heidelberger)

10-22, W: Metabotropic synaptic signaling (Heidelberger)

10-24, F: Optical Approaches in Neurophysiology (Heidelberger)

Week 10 (Oct 27 – Oct 31)

10-27, M: class presentations

10-29, W: Review session **Exam 2 (Bender)**

10-31, F: Axons and dendrites (Stavoe)

Week 11 (Nov 3 – Nov 7)

11-3, M: Synaptic Cell Biology (Stavoe)

11-5, W: Dendritic integration (Beierlein)

11-7, F: Electrical synaptic transmission (Beierlein)

Week 12 (Nov 10 – Nov 14)

11-10, M: Control of synaptic signaling by astrocytes (Beierlein)

11-12, W: Short-term plasticity mediated by endocannabinoids (Beierlein)

11-14, F: Long-term synaptic Plasticity–Induction (Shouval)

Week 13 (Nov 17 – Nov 21)

11-17, M: Long-term synaptic Plasticity–Expression (Shouval)

11-19, W: Sensory transduction (Heidelberger)

11-21, F: Sensory circuits (Heidelberger)

Week 14 (Nov 24 – Nov 28)

11-24, M: Mechanisms of Alzheimer's Disease I (Ma)

11-26, W: No Class, Thanksgiving

11-28, F: No Class, Thanksgiving

Week 15 (Dec 1 – Dec 5).

12-1, M: Mechanisms of Alzheimer's Disease II (Ma)

12-3, W: student presentations

12-5, F: review session **Exam 3 (Bender)**

RH-MB/jal-07.09.25
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