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 one of the Graduate School's 504 Coordinators, Cheryl Spitzenberger or Natalie Sirisaengtaksin. 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 2023** Course Number and Course Title: **GS14 1214: Molecular and Cellular Neuroscience** **Credit Hours: 4** Meeting Location: **UT- McGovern Medical School** Building/Room#: **MSB B.603** WebEx/Zoom Link: **N/A**	Program Required Course: **Yes** Approval Code: **No** **(If yes,** the Course Director or the Course Designee will provide the approval code.) **Audit Permitted: Yes** Classes Begin: **August 28, 2023** Classes End: **December 4, 2023** Final Exam Week: **December 6-14, 2023**

Class Meeting Schedule

Day	Time
M/W/F	**9 am – 10:20am**

Course Director Name and Degree: **Ruth Heidelberger, MD, PhD** Title: Professor Department: Neurobiology and Anatomy Institution: UTH Email Address: Ruth.Heidelberger@uth.tmc.edu Contact Number: 713-500-5624 **Course Co-Director/s:** (if any) Name and Degree: **Michael Beierlein, PhD** Title: Associate Professor Department: Neurobiology and Anatomy Institution: UTH Email Address: michael.beierlein@uth.tmc.edu Contact Number: 713-500-5619	**Instructor/s** (Use additional page as needed) 1. Name and Degree: **Neal Waxham, PhD** Institution: UTH Email Address: M.N.Waxham@uth.tmc.edu 2. Name and Degree: **Kristin Eckel-Mahan, PhD** Institution: UTH Email Address: Kristin.I.Mahan@uth.tmc.edu 3. Name and Degree: **Harel Shouval, PhD** Institution: UTH Email Address: Harel.Shouval@uth.tmc.edu 4. Name and Degree: **Shin Nagayama, PhD** Institution: UTH Email Address: Shin.Nagayama@uth.tmc.edu

	5. Name and Degree: **Andrea Stavoe, PhD** Institution: UTH Email Address: andrea.k.stavoe@uth.tmc.edu 6. Name and Degree: **Ruth Heidelberger, MD, PhD** Institution: UTH Email Address: Ruth.Heidelberger@uth.tmc.edu 7. Name and Degree: **Michael Beierlein, PhD** Institution: UTH Email Address: michael.beierlein@uth.tmc.edu

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 (if any)

(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 ciscuits.

***Specific Learning Objectives*:**

1. Understand the composition and electrical characteristics of biomembranes, 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 for each lecture 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. Attend and be prepared to participate in the scheduled review sessions.
5. Participate in and contribute to course discussions during lectures and review sessions
6. Prepare for and take each of the three, non-cumulative take-home examinations

Students are expected to peruse all assigned reading material (textbook sections and research literature) prior to class. Take-home examinations must be individually completed by each student without the assistance of another human being, but course notes and reading materials may be utilized. Engaging in unethical behavior 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
Take-home exams (100 %)	3 take-home exams of equal weight

SYLLABUS – Fall 2023

Week 1 (Aug. 28 - Sep. 1).

8-28, M: Introduction to neuronal cell biology (Stavoe)

8-30, W: Mechanisms of neuronal homeostasis. (Stavoe)

9-1, F: Membrane composition I – structural/functional roles of lipids –rafts (Waxham)

Movie of membrane fluidity - Movie of inner Life of the Cell

Week 2 (Sep. 4 – 10)

9-4, M: Labor Day, no class

9-6, W: Membrane composition II – Protein-lipid interactions (Waxham)
Structure of Amino Acids - AAs.jpg

9-8, F: Voltage-gated K+-channels (Waxham)

Week 3 (Sep. 11 - 15)

9-11**,** M: Voltage-gated Na+-channels (Waxham)

9-13, W: Introduction to neurons, synapses and neuronal networks (Beierlein)

9-15, F: Ionic basis of resting membrane potential (Beierlein)

Reading: http://nba.uth.tmc.edu/neuroscience/s1/chapter01.html (Links to an external site.) (Links to an external site.); Hammond, Chapter 3

Week 4 (Sep. 18 – 22)

9-18, M: Mechanisms of action potentials (Beierlein)

Reading: http://nba.uth.tmc.edu/neuroscience/s1/chapter02.html (Links to an external site.)

9-20, W: Microscopic and macroscopic Na and K currents (Beierlein)

Reading: Hammond, Chapter 4

9-22, F: Propagation of action potentials, space and time constant (Beierlein)

Reading: https://nba.uth.tmc.edu/neuroscience/s1/chapter03.html (Links to an external site.)

Week 5 (Sep. 25 – Sep 29)

9-25, M: Electrophysiological recording techniques (Beierlein).

Reading: Hammond, Chapter 4 (Figs. 4.25 to 4.29, A4.1-4.6, 4.9, 4.10)

9-27, W: Laboratory session

9-29, F: review session (weeks 1-5, Beierlein, Waxham, Stavoe)

Week 6 (Oct. 2-6)

10-2, M: Intracellular signaling I – GPCR structure/signaling at the membrane (Eckel-Mahan)

and **Distribution of Exam 1, Due by midnight October 12**

10-4, W: Intracellular signaling II – Diffusion, Ca2+ domains, intracellular stores (Eckel-Mahan)

10-6, F: **No Class** (**NGP retreat)**

Week 7 (Oct. 9 – 13)

10-9, M: Intracellular signaling III – forward/backward signaling – phosphor. (Eckel-Mahan)

10-11, W: Voltage-gated Ca2+-channels (Heidelberger)

Reading: Hammond, Chapter 5; nowycky,fox,tsien_85.pdf

10-13, F: Neurotransmitter release, Part I: "In the beginning" (Heidelberger)
Readings: Hammond Chapter 7, sections 7.1 , 7.2.1 and Appendix 7.1 and 7.2

Week 8 (Oct. 16 – 20)

10-16, M: Neurotransmitter release, Part II: "Calcium and timing" (Heidelberger)

Reading: Chapter 7, see also From Molecules to Networks, chapter 15 pages 448-453; if you would like additional discussion, heidelberger_etal_1994.pdf

10-18, W: Neurotransmitter release, Part III: "Synaptic design" (Heidelberger)

Reading: Chapter 7. (see also Chapter 15 in From Molecules to Networks). For additional information, you might like: 2013 Nobel Lecture.pdf

10-20, F: Ligand-gated channels - nAChR and GABA (Waxham)

Week 9 (Oct, 23 – 27)

10-23, M: Ligand-gated channels – Glycine/Glutamate (Waxham)

Reading: Chap 10 FMN3rded.pdf

10-25, W: Ionotropic synaptic signaling (Heidelberger)

Readings: Chapters 9 and 10, Hammond

10-27, F: Metabotropic synaptic signaling (Heidelberger).

Readings: Chapters 11 and 12, Hammond; FragileX_review.pdf

Week 10 (Oct 30 – Nov 3)

10-30, M: Review session (weeks 6-9, Heidelberger, Waxham, Eckel-Mahan)

11-1, W: Optical Approaches in Neurophysiology (Heidelberger/optional topic)

and **Distribution of Exam 2, Due by midnight November 9**

Readings; Appendix to Chapter 5, Hammond

11-3, F: Axons and dendrites (Stavoe)

Week 11 (Nov. 6 – 10)

11-6, M: Neuronal Polarity (Stavoe)

11-8, W: Synaptic integration in dendrites (Beierlein)

Reading: Chapter 13 (Hammond); Chapter 17 in FMN

11-10, F: Information processing in active dendrites (Beierlein).

Reading: Chapters 14-17 (Na and Ca channels) in Hammond; Chapter 17 in FMN; Stuart and Sakmann 1994.pdf

Week 12 (Nov. 13-17)

11-13, M: Electrical synaptic transmission (Beierlein)

11-15, M: Control of synaptic signaling by astrocytes (Beierlein)

11-17, W: Retrograde synaptic transmission (Beierlein)

Week 13 (Nov 20).

11-20, M: Long-term synaptic Plasticity – Induction (Shouval).

11-22, W: **No class**

11:25, F: **Thanksgiving holiday, No Class**

Week 14 (Nov. 27 – Dec. 1)

11-27, M: Long-term synaptic Plasticity – Expression (Shouval)

11-29**,** W: Sensory transduction I (Heidelberger)

Readings: fncel-15-761416.pdf and and Phototransduction in Rods and Cones by Yingbin Fu – Webvision.pdf

12-1, F: Sensory transduction II (Nagayama)

Week 15 (Dec. 4 – Dec 8).

12-4, M: Review session (weeks 10-14, Beierlein, Heidelberger, Shouval, Nagayama)

12-6, W: **Distribution of EXAM 3, Due 9 am on Thursday Dec 14th**.