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: **Spring 2024** Course Number and Course Title: **GS14 1024: Systems Neuroscience** Credit Hours: **4** Meeting Location: **UTHealth McGovern Medical School Building** Building Room#: **MSB 7.046** WebEx/Zoom Link: **N/A**	**Program Required Course: Yes** **Approval Code: No** **Audit Permitted: Yes** Classes Begin: **January 9, 2024** Classes End: **April 25, 2024** Final Exam Week: **April 26 - May 3, 2024**

Class Meeting Schedule

Days	Time
Tuesday & Thursday	**10:45 - 12:45**

Course Director Name and Degree: **Harel Shouval, PhD** Title: Professor Department: Neurobiology and Anatomy Institution: UTHealth Email Address: Harel.Shouval@uth.tmc.edu Contact Number: 832-754-2153 **Course Co-Director/s:** (if any) Name and Degree: **Fabricio Do Monte, DVM, PhD** Title: Assistant Professor Department: Neurobiology and Anatomy Institution: UTHealth Email Address: Fabricio.H.DoMonte@uth.tmc.edu	**Instructor/s:** 1. **Michael Beierlein, PhD** Institution: UTHealth Email Address: Michael.Beierlein@uth.tmc.edu 2. **Shin Nagayama, PhD** Institution: UTHealth Email Address : Shin.Nagayama@uth.tmc.edu 3. **Qingchun Tong, PhD** Institution: UTHealth/IMM Email Address: Qingchun.Tong@uth.tmc.edu 4. **Terry Walters, PhD** Institution: UTHealth Email Address: Edgar.T.Walters@uth.tmc.edu

Contact Number: 713-500-5613 **NOTE:** Office hours are available by request. Please email me to arrange a time to meet. **Teaching Assistant**: (if any) **N/A** Name and Email Address	**5. Fabricio Do Monte, DVM, PhD** Institution: UTHealth Email Address: Fabricio.H.DoMonte@uth.tmc.edu **6. Harel Shouval, PhD** Institution: UTHealth Email Address: Harel.Shouval@uth.tmc.edu

Course Description: This course cover the key concepts in systems neuroscience that allow students to understand how individual neurons and circuits process information and modulate behavior. The central idea behind this course is to illuminate the connection between physiology and function. In order to do this, we will concentrate on several key brain systems, and for each of these systems, we will interrogate how the structure and physiology of distinct brain circuits account for their function.

The aim is to understand fundamental principles, not to survey the entire brain. We chose several different systems that are qualitatively different to illustrate the basic principles of systems neuroscience. The course will provide students with fundamental knowledge about the function, connectivity, and plasticity of neuronal circuits. We will do this by exploring how selected brain systems form perceptions of the external world, execute movements, make decisions, represent space, and form memories. In addition, we will examine how stress, fear, and reward are encoded and regulated, how the brain controls internal metabolic needs such as food intake, energy expenditure, temperature regulation and sleep, and how pain sensation is initiated peripherally and perceived centrally. We will emphasize unifying principles, including how the brain processes information, how different cell types contribute to the function of circuits, and how the brain is modified during learning and experience.

An integral part of the course is a neuroanatomy lab that will relate the functional view presented during the lectures with the anatomical structures in which these functions are implemented. The course will also include article presentations in which each student has the opportunity to present a scientific paper related to the course material, discuss the findings, and ask questions.

Textbook/Supplemental Reading Materials (if any)

- No required textbook. Reading materials (book chapters, research articles, research reviews) will be posted in canvas at the beginning of each module.

Course Objective/s:

Upon successful completion of this course, students will: **a)** understand general principles of systems neuroscience; **b)** learn in several example systems how brain circuits and physiology mediate the observed perception and behavior; **c)** get familiarized with various neuroscience techniques as well as methods used to analyze experimental results; **d)** learn about functional neuroanatomy and how structure relates to function; and **e)** comprehend the scientific process and critically evaluate scientific articles.

***Specific Learning Objectives*:**

1. Learn how physiological mechanisms implement circuit function.
2. Learn to critically evaluate key concepts in systems neuroscience.
3. Learn how to analyze and understand physiological data.
4. Learn basic facts about neural plasticity.
5. Learn about the functional neuroanatomy of brain circuits.

Student Responsibilities and Expectations:

1. Attend all lectures in person, unless they are sick or have other justifiable reasons.
2. Read all the provided materials for a class or a topic before the classes.
3. Participate in and contribute to course discussions during the lectures and article presentations (this contributes 10% to the final grade)
4. Ask questions when the presented material is not understood.
5. Schedule appointments with the instructor(s) to improve their knowledge in case they have pending questions after the classes.
6. Read and present a research article to the class (This contributes 15% to the final grade).
7. Prepare for and take three course exams, and submit answers on time (Each exam contributes 25% to the final grade).
8. Plagiarism, cheating, or engaging in unethical behavior during examinations (quizzes and final), and failure to properly cite scientific literature and other sources will not be tolerated and 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
Presentation (15 %)	Each student will read and present to the class a research article, which will be chosen by the instructors.
Midterm Exams (50 %)	Two take home exams, each covering the material of two modules, and each determining 25% of the grade
Final Exam (25 %)	Based on material presented during the last third of the course
Participation and attendance (10%)	Includes class attendance and participation during the classes.

The weighted percentage grade will be converted to letter grades.
85-100% A
70-85% B
60-70% C
<60% F

Systems (GS14 1024) Schedule: 2024

Introduction

1. 1/9 10:45-11:45 Introduction (Shouval)
2. 1/9 11:45-12:45 Introduction (Shouval)
3. 1/11 10:45-11:45 Introduction to Anatomy (Nagayama)
4. 1/11 11:45-12:45 Introduction to Anatomy (Nagayama)

Part 1

Module 1 – Vision (Shouval)

5. 1 /16 10:45-11:45 Functional Neuroanatomy of the visual system
6. 1/16 11:45-12:45 Receptive fields in V1 and their organization
7. 1/18 10:45-11:45 Spike statistics and correlations
8. 1/18 11:45-12:45 Signal detection theory
9. 11/23 10:45-11:45 Receptive field plasticity
10. 11/23 11:45-12:45 Parallel visual streams and higher order visual areas
11. 11/25 10:45-11:45 Relating Physiology to behavior I
12. 11/25 11:45-12:45 Relating Physiology to behavior II
13. 1/30 10:45-11:45 Student presentation
14. 1/30 11:45-12:45 Student presentation

Neuroanatomy lab 1

15. 2/1 10:45-11:45 Neuroanatomy lab I
16. 2/2 11:45-12:45 Neuroanatomy lab I

Module 2 – Motor Control (Beierlein)

17. 2/6 10:45-11:45 Introduction
18. 2/6 11:45-12:45 Spinal cord circuits and motor control 1
19. 2/8 10:45-11:45 Spinal cord circuits and motor control 2
20. 2/8 11:45-12:45 Basal Ganglia and movement initiation
21. 2/13 10:45-11:45 Cerebellum and motor learning 1
22. 2/13 11:45-12:45 Cerebellum and motor learning 2
23. 2/15 10:45-11:45 Student paper presentation
24. 2/15 11:45-12:45 Student paper presentation

Midterm Take home Exam 1 2/13-2/21

Part 2

Module 3 – Representation of Space and Memory (Shouval)

25.	2/20	10:45-11:45	The role of Hippocampus in memory space representation.
26.	2/20	11:45-12:45	The representation of space – Place cells
27.	2/22	10:45-11:45	The plasticity of place cell representations.
28.	2/22	11:45-12:45	Phase precession, replay and pre-play.
29.	2/27	10:45-11:45	The entorhinal cortex and grid cells.
30.	2/27	11:45-12:45	Where is memory stored?
31.	2/29	10:45-11:45	Student paper presentation
32.	2/29	11:45-12:45	Student paper presentation

Neuroanatomy lab 2

33.	3/5	10:45-11:45	Neuroanatomy lab 2
34.	3/5	11:4512:45	Neuroanatomy lab 2

Module 4 – Stress, fear and reward (Do Monte)

35.	3/7	10:45-11:45	Neural circuits of stress 1
36.	3/7	11:45-12:45	Neural circuits of stress 2
37.	3/12	10:45-11:45	Neural circuits of fear 1
38.	3/12	11:45-12:45	Neural circuits of fear 2
39.	3/14	10:45-11:45	Neural circuits of reward 1
40.	3/14	11:45-12:45	Neural circuits of reward 2

Spring Break 3/18-3/22

41.	3/26	10:45-11:45	Student paper presentation
42.	3/26.	11:45-12:45.	Student paper presentation

Midterm exam 2 Dates: 3/26-4/4

Part 3

Module 5 - Homeostatic regulation in systems neuroscience (Tong)

43.	3/28	10:45-11:45	Homeostatic regulation of feeding and energy expenditure
44.	3/28	11:45-12:45	Homeostatic regulation of feeding and energy expenditure
45.	4/2	10:45-11:45	Homeostatic regulation of water balance and temperature
46.	4/2	11:45-12:45	Homeostatic regulation of water balance and temperature
47.	4/4	10:45-11:45	Homeostatic regulation of sleep
48.	4/4	11:45-12:45	Homeostatic regulation of sleep
49.	4/9	10:45-11:45	Student presentation
50.	4/9	11:45-12:45	Student presentation

Neuroanatomy lab 3

51.	4/11	10:45-11:45	Neuroanatomy lab 3
52.	4/11	11:45-12:45	Neuroanatomy lab 3

Module 6 – Pain. (Walters)

53.	4/16	0:45-11:45	Pain definition, pain measurement, pain systems overview
54.	4/16	11:45-12:45	Peripheral systems (neuronal and non-neuronal) driving pain
55.	4/18	10:45-11:45	Spinal systems processing nociceptive information
56.	4/18	11:45-12:45	Brain systems processing nociceptive information and affective pain
57.	4/23	10:45-11:45	Chronic pain mechanisms across pain systems
58.	4/23	11:45-12:45	Evolutionary and systems perspectives on conscious pain
59.	4/25	10:45-11:45	Student presentation
60.	4/25	11:45-12:45	Student presentation

Final Exam 4/25-5/3