

## Syllabus for Neurobiology (MCDB S320 Summer 2018)

Haig Keshishian, Professor MCDB, Instructor

May 28, 2018 – June 29, 2018

### Course description.

This is an ideal opportunity to learn about one of the most exciting and dynamic areas of science. Neurobiology, MCDB S320 is the core course for the Neuroscience major at Yale, as well as for the existing MCDB Neurobiology track. The summer session class is the same as the one taught regularly in the fall semester, covering the same material as MCDB 320. This course (taken during the summer or in the fall) is a required course for both the MCDB Neurobiology track and the Neuroscience major.

Students who take the summer course may then take the attached neurobiology lab, MCDB 321La, offered in the fall semester. This is a great way to get a head start on your course requirements for either major.

MCDB S320 provides a comprehensive introduction to neuroscience, divided into 3 course modules: 1) Cellular neurophysiology, addressing the excitable properties of neurons and the function of synapses, 2) Systems neurobiology, examining neural circuits as they relate to the functional properties of the nervous system, with each system that is addressed examined in detail, and 3) Neural development and plasticity, examining the cellular and molecular mechanisms governing neural development, plasticity, and the establishment of memory. The course takes specific topics and examines them in depth, seeking out general principles governing nervous system function.

**Prerequisites.** Students are expected to have the equivalent of a 1st year course in biology, and at least 1 semester of college chemistry. A course in physics or its equivalent is also recommended. *These prerequisites may be waived* at the discretion of the instructor. If you have questions, please contact haig.keshishian@yale.edu.

**Readings.** Readings are from Liqun Luo, *Principles of Neurobiology*. The readings are chapters relevant to the lecture material. You may read the entire chapters, *but focus on the parts most relevant to the lecture material*.

Reserved materials held for MCDB S320 are located in the Kline Library (CССИ).

**Schedule.** Fifteen 135 min lectures M-W-F. A 1h review session each week. Each session will generally have 2 parts, with each lecture lasting approx. one-half of the session, with 5-10 minute break.

**Exams.** Two 1h tests are given at the end of the first and second modules. Each hour test is worth 25%, the final exam 50%. A 3 1/2h final exam will be scheduled for the last day of class (June 29).

The *first hour test* will be held in class, but outside of regular class hours, on the Tuesday following the end of the module: June 12.

The *second hour test* is a take-home test, handed out Friday June 20, due Monday June 23.

The summer session does not have a reading period, so the final exam will be on the last day of the course, June 29. Our final class will be on Wednesday June 27. As a result, *the second-to-last lecture will be held at a special time and place, on Tuesday June 26*.

**Discussion sessions.** Each week there will be a discussion/review session conducted by the instructor. These meetings will cover the preceding week's lecture material, and provisionally will be immediately after our Monday sessions (or a time to be decided by the class). The meetings provide an excellent opportunity to discuss general questions concerning the course material, but are not mandatory.

**Course syllabus.** Each lecture is divided into either two or three sections, as indicated (1a,1b, etc), with a short break between each section.

**Web Site.** The course website is on Canvas, and will be updated throughout the session, and will include the lecture handouts, problem sets, and special class announcements. You can also upload material, and post questions on the web page.

**Instructor and office hours.** You are encouraged to meet with the instructor to discuss issues/questions arising in this course. We will schedule a meeting with you on an as-needed basis, as well as hold regular office hours at a time to be announced. You should contact the instructor as soon as possible if any problems arise concerning the course.

### Part 1: Cellular Neurophysiology (weeks 1 and 2)

Date	Lecture	Topic	Class reading assignments will be provided at the start of the class, and are from Liqun Luo's textbook <i>Principles of Neurobiology</i>
May 28	1a	Foundations of neural excitability: Ion channels and pumps	Ch1: 1.1-1.14
	1b	The resting membrane potential	Ch2: 2.4-2.8
May 30	2a	Conductance and ionic current	
	2b	Active versus passive spread of membrane potential	
	2c	Passive membrane properties	Ch2: 2.8
June 1	3a	Mechanism of the action potential	Ch2: 2.9-2.16 Ch13: 13.20-13.26 (to review methodology)***
	3b	Ion channel specializations	
	3c	Ion channels and computer models	
June 4	4a	Synapses	Ch3: 3.1-3.25
	4b	Synaptic inhibition, excitation, modulation	
June 6	5a	Neurotransmitter release	
	5b	Neurotransmitter release: Testing the calcium hypothesis	
June 8	6a	Synaptic cell biology	Ch2: 2.1-2.3 <i>and posted reading on website</i>
	6b	Cell Biology: life as a polarized cell	
June 12 (Tues)		<b>First hour test on Module 1.</b> <i>Note: This 1 hour test is given in class on a Tuesday, at a time and place to be announced.</i>	

### Part II. Neural systems (weeks 3-4)

June 11 (Mon)	7a	Synaptic connections I: Fundamental concepts of neural circuits and systems; phasic circuits	Ch1: 1.9 <i>and posted reading on website</i>
	7b	Synaptic connections II: Neural circuits and systems: oscillators	Ch8: 8.4-8.6
June 13	8a	Signal transduction; phototransduction	Ch4: 4.1-4.20
	8b	Retinal circuitry; outer plexiform layer	
	8c	Retinal circuitry: inner plexiform layer	

June 15	9a	Processing of visual information: area V1	Ch4: 4.21-4.29
	9b	Integration of visual information: areas V2 and beyond	
June 18	10a	Sensorimotor integration: Introduction to motor and somatosensory systems	Ch8: 8.1-8.7
	10b	Spinal cord circuitry and motor control	
	10c	Somatosensory and proprioceptive systems and loops	Ch6: 6.29-6.35
June 20	11a	Voluntary motor control	Ch8: 8.10-8.11
	11b	Cortical and brainstem motor systems: cortical reentrant loops	Ch8: 8.8-8.9; 8.12-8.14
	11c	Cerebellum; Vestibulo-ocular control; motor learning	
June 20		<b>Second hour test on Module 2.</b> <i>This test is a take-home test, handed out at the end of class on Friday June 20, and due back on Monday June 23.</i>	

### Part III Development, Memory, and Cognition (week 5)

June 23	12a	Synaptic plasticity I: Molecular mechanisms controlling synaptic plasticity	Ch10: 10.1-10.21
	12b	Synaptic plasticity II: Experience-dependent refinement of synapses. Hebb's hypothesis	
June 25	13a	Cellular determination and neuronal differentiation	Ch5: 5.1-5.16; 5.17-5.18 (optional)
	13b	Axon guidance: molecular mechanisms	Ch7: 7.1-7.9
	13c	Synaptogenesis and system development	Ch7: 7.10-7.15
June 26 (Tuesday) *	14	Medial temporal lobe memory systems	Ch10: 10.4-10.5 (review) 10.19-10.25
June 27 (Wed)	15a	Neurobiology of mood and thought	Ch11:11.15-11.19
	15b	Association cortex and the neurophysiology of mind	Ch12: 12.1-12.17; 12-18-12.25 (optional)
June 29 **		<b>Final Exam on all 3 modules.</b> 3 1/2 h 9:00-12:30	

\*The second-to last meeting is on a Tuesday, at a time and place to be announced.

\*\*The final exam will be held on the last day of the course, June 29.