

**Columbia University**  
**Department of Biological Sciences**  
**W3004/W4004: Cellular and Molecular Neurobiology**

Fall 2009

Lectures: Tu/Th 4:10-5:25;

Location: 501 Schermerhorn

**Recitations:**

Graduate students:	Tuesday	6:00 pm	Fairchild 900	TA: Jessica Brann
Group I	Tuesday	6:00 pm	Fairchild 1000	TA: Feifan Zhang
Group II	Tuesday	6:00 pm	Fairchild 700	TA: Bianca Marcolino
Group III	Wednesday	6:00 pm	Fairchild 900	TA: Gizem Orbey
Group IV	Thursday	6:00 pm	Fairchild 900	TA: Heather McKellar
Group V	Friday	2:30 pm	Fairchild 900	TA: Shari Saideman

**Instructors:**

Stuart Firestein, sjf24@columbia.edu

Jessica Brann, jb2602@columbia.edu

Shari Saideman, ss3109@columbia.edu

Office Hours by appointment through e-mail;

**TAs:**

Bianca Marcolino bfm2103@columbia.edu

Heather McKellar hm2126@columbia.edu

Gizem Orbey gao2104@columbia.edu

Feifan Zhang fz2124@columbia.edu

**Required Text:** *Neuroscience*, 4th ed., 2008, Purves et al.  
Sinauer Associates, Sunderland, MA

**Supplemental Texts:**

*From Neuron to Brain*, 4th ed., 2001, Nicholls et al.  
Sinauer Associates, Sunderland, MA

*Principles of Neural Science*, 4th ed., 2000.  
Eric Kandel, James Schwartz and Thomas Jessell  
McGraw-Hill Companies, New York

**Recitations:** A strong emphasis is placed on readings from the primary literature, which will be discussed in weekly recitations. Students will read and discuss in depth selected research papers. Attendance at the recitations is mandatory and active participation will count in the final grade (see below). Materials discussed in the recitations will be included in the exams.

**Class Attendance:** Attendance is not taken, however material will be presented in lectures that is not available in the text and which will appear on examinations

**Exams and Grading:** Exams and Grading: Three exams and a final examination are given. Each exam will cover material since the previous exam. The final examination is entirely on papers from the primary literature. The lowest grade of the three periodic exams will be dropped (students may choose to take only two tests). The remaining exams will each contribute 30% towards the semester grade; the final will contribute 30% and is required. 5% will come from recitation attendance and participation. Prior to most classes there will be a short quiz to be taken on-line at the courseworks class site. This quiz will consist of 5 simple questions that can be answered easily by a reasonably careful *skim* of the textbook material *to be covered in that day's lecture*, in other words in advance of the lecture. The grades from these quizzes will make up the final 5% of the grade.

**No make-up exams will be allowed** except in cases of serious illness or personal crisis and the student is required to present a letter from the undergraduate dean as well as other supporting evidence (such as doctor's notes, airline tickets etc.). Make up exams in a large class cause a great deal of trouble for instructors and TAs, and create issues of fairness. Please do not consider them an option.

## **Part 1: Electrical Properties of Neurons**

- Sept. 8:      **Lecture 1.** Introduction, The Nervous system and its molecular parts; Cell Biology of the Neuron  
(Chapter 1, pp. 1-11)
- Sept. 10:     **Lecture 2.** Ionic Basis of the Resting Membrane Potential  
(Chapter 2, pp. 25-34)

### **No recitation first week of class**

- Sept. 15:     **Lecture 3.** Ion Channels  
(Chapter 4, pp. 61-70)
- Sept. 17:     **Lecture 4.** Ion Channels and Transporters  
(Chapter 4 pp. 70-83)

[Recitation 1: Doyle et al., "The structure of the potassium channel: molecular basis of K<sup>+</sup> conduction and selectivity". Science 280, 69-77 \(1998\).](#)

- Sept. 22:     **Lecture 5.** Ionic Basis of the Action Potential  
(Chapter 2, pp. 36-39; Chapter 3, pp. 41-49)
- Sept. 24:     **Lecture 6.** Passive Electrical Properties of the Neuron  
(Chapter 3, pp. 49-60)

### [Recitation 2: Problem set](#)

- Sept. 29:     **Lecture 7.** Generation and Propagation of Action Potentials  
(Chapter 3, pp. 49-60)
- Oct. 1:        **EXAM I (Lectures 1-7, Recitations 1-2)**

## Part II: Synaptic Transmission

Oct. 6: **Lecture 8.** Synaptic Transmission: Overview, Neuromuscular Junction  
(Chapter 5, pp. 85-106)

Oct. 8: **Lecture 9.:** Presynaptic mechanisms: Transmitter Release  
(Chapter 5, pp. 85-106)

[Recitation 3: Transmitter release induced by injection of calcium ions into nerve terminals.](#) Miledi R. Proc R Soc Lond B Biol Sci. 1973 Jul 3;183(73):421-5.

Oct. 13: **Lecture 10.** Synaptic Transmission: Post synaptic mechanisms  
(Chapter 5, pp. 107-118)

Oct. 15 **Lecture 11.** Receptors and Neurotransmitters – Fast Signalling  
(Chapter 6, pp. 119-137)

**No recitation this week**

Oct. 20: SFN - NO CLASS

Oct. 22: **Lecture 12.** Receptors and Neurotransmitters: Slow Synapses  
(Chapter 5, pp. 137-151; Chapter 7 to review cell biology of intracellular signaling)

[Recitation 4: Biederer et al., "SynCAM, a synaptic adhesion molecule that drives synapse assembly".](#) Science 297, 1525-1531 (2002).

Oct. 27: **Lecture 13.** Synaptic Plasticity  
(Chapter 8, pp. 177-190)

Oct. 29: **Lecture 14.** Synaptic Plasticity II  
(Chapter 8, pp. 191-203)

[Recitation 5: Multiple forms of synaptic plasticity triggered by selective suppression of activity in individual neurons.](#) Burrone J, O'Byrne M, Murthy VN. Nature. 2002 Nov 28;420(6914):414-8.

### Part III: Sensory Physiology

Nov. 3: Academic holiday (Election Day)

Nov. 5: **EXAM II (Lectures 8-14, recitations 3-5)**

#### No recitation this week

Nov. 10: **Lecture 15.** Introduction: Coding of Sensory Signals  
Proprioception and Touch  
(Chapter 9, pp. 207-227)

Nov. 12: **Lecture 16.** Phototransduction and Color Vision  
(Chapter 11, pp. 253-286)

[Recitation 6: Palczewski et al., "Crystal structure of rhodopsin: A G protein-coupled receptor." Science 289, 739-745 \(2000\).](#)

Nov. 17: **Lecture 17.** Mechanotransduction in the Ear  
(Chapter 13, pp. 313-342)

Nov. 19: **Lecture 18.** Pain  
(Chapter 10, pp. 231-250)

[Recitation 7: Zheng et al., "Prestin is the motor protein of the cochlear outer hair cells". Nature 405, 149-155 \(2000\).](#)

Nov. 24: **Lecture 19.** Olfaction and Taste: The chemical senses  
(Chapter 15, pp. 363-393)

Nov. 26: Off (Thanksgiving)

#### No recitation this week

Dec. 1: **Lecture 20.** Vestibular System  
(Chapter 14, pp. 343-362)

Dec. 3: **Lecture 21.** Integrative Cellular Neuroscience  
Efferent copy and vision  
(Chapter 20, pp. 495-512)

[Recitation 8: The capsaicin receptor: a heat-activated ion channel in the pain pathway. Caterina MJ, Schumacher MA, Tominaga M, Rosen TA, Levine JD, Julius D. Nature. 1997 Oct 23;389\(6653\):816-24.](#)

Dec 8.        **Lecture 22.** Ignorance in Neuroscience, what's left to be done.

Dec 10       **EXAM III (Lecture 15-22, recitations 6-8)**

**Dec. XX       4:10-7 PM Final Exam**

The final exam will consist of three sets of questions on selected research articles. It is suggested the you read and analyze these papers prior to the exam, since the exam will be closed-book; i.e. you CANNOT look at the articles, notes or textbook during the exam. You may discuss these papers with other students, but not with the instructors or the TAs.