**Cellular Neurophysiology**: GS14 1143, Spring 2017  
**Course Director**: Michael Beierlein, PhD

**Basics**: 3 credit course.

**Course Description**: This course is a graduate level treatment of cellular neurophysiology. It is designed for first-year graduate students and will introduce the basic concepts for understanding electrical and chemical signaling in the nervous system. The course will cover topics such as bioelectricity, synaptic transmission and short- and long term synaptic plasticity, and synaptic integration in neuronal dendrites.

**Course Prerequisites**: This course is appropriate for students with an interest in neuroscience who are comfortable with the use of mathematical concepts to describe events that occur in the natural world. It is recommended that students have one semester of a calculus-based physical or life sciences course prior to taking this course. Permission of Course Director required.

**Where/When**: This course meets in MSB B.612, Tues/Thurs from 9:00 -10:30 am


**Evaluation**: Three in-class examinations will be held. These examinations are non-cumulative and will be a combination of multiple choice and short answer/essays. Final grades will be based on the average examination performance.

**Examination Dates (all exams are in class)**:

Exam 1: February 9, March 21; Exam 3: May 2

**SCHEDULE OF LECTURES**

Jan 10: Introduction to neurons, synapses and small neural networks. *(Byrne)*  
Reading: *Neuroscience Online*, Introduction Chapter.

Jan 12: Membrane potential, pumps, leaks, and the equivalent electrical circuit of the membrane. *(Byrne)* Reading: *Neuroscience Online*; Chapter 1, Hammond, Chapter 3; FMN, Chapters 11 and 12.

Jan 17: Ionic mechanisms of action potentials. *(Byrne)* Reading: *Neuroscience Online*, Chapter 2; Hammond, Chapter 4; FMN, Chapters 12 and 13.

Jan 19: Action potentials, Na channels, microscopic and macroscopic Na currents. *(Byrne)*  
Reading: Hammond, Chapter 4 (Figs. 4.1 to 4.12); FMN, Chapter 12 and 13.

Jan 24: Properties of voltage-dependent Na⁺ and K⁺ channels. *(Byrne)*  
Reading: Hammond, Chapter 4 (Figs. 4.1 to 4.13); FMN, Chapters 12 and 13.
Jan 26: Diversity of Na⁺ and K⁺ channels, and single-channel and macroscopic recording techniques. (Byrne)
   Reading: Hammond, Chapter 4 (Figs. 4.25 to 4.29, A4.1 -4.6, 4.9, 4.10); FMN, Chapters 12 and 13

Jan 31: Propagation of action potentials, time constant and space constant. (Byrne)
   Reading: Hammond, Chapter 4 (Fig. 4.28); Neuroscience Online, Chapter 3; FMN, Chapter 12.

Feb 2: Voltage-gated calcium channels (Heidelberger)

Feb 7: Neurotransmitter release, part I (Heidelberger)

Feb 9: Lab exercise (held in MSE R419)

Feb 14: Exam 1 (through voltage gated Ca²⁺ channels)

Feb 16: Neurotransmitter release, part II (Heidelberger)
   Reading: Hammond Chapter 7, Appendix 7.1; FMN Chapter 15, p 443-466

Feb 21: Nicotinic acetylcholine receptors (Heidelberger)
   Reading: Hammond Chapter 8

Feb 23: Ionotropic glutamate receptors (Heidelberger)
   Reading: Hammond Chapter 10

Feb 28: GABA receptors (Heidelberger)
   Reading: Hammond Chapters 9, 11; Heidelberger & Matthews, PNAS 88:7135-9.

Mar 2: Metabotropic glutamate receptors (Heidelberger)
   Reading: Hammond Chapter 12

Mar 7: Synaptic integration in dendrites and spines (Beierlein) Class held in MSE R.649
   Reading: Hammond Chapter 13; see also FMN Chapter 17

Mar 9: Properties and functions of dendritic Na channels (Beierlein)
   Reading: Hammond Chapters 14, 15, 16, on Na channels; and Stuart and Sakmann, Nature 367, 69-72; see also FMN chapter 17

SPRING BREAK March 13-17 - no classes

Mar 21: Exam 2 (through dendritic signaling via Na channels)

Mar 23: Dendritic signaling via Ca channels (Beierlein)
   Reading: Hammond Chapters 14, 15, 16, on Ca channels; see also FMN Chapter 17
Mar 28: Control of voltage and calcium-dependent dendritic signals by K channels (Beierlein)
Reading: Hammond Chapters 14, 16 on K channels; see also FMN Chapter 17

Mar 30: Neuronal firing patterns (Beierlein)

Apr 4 and 6: Long-term changes in Synaptic Strength (Shouval)
Reading: FMN, Chapter 18

Apr 11 and 13: Electrical synapses (O’Brien)

Apr 18: Neurophysiological mechanisms of plasticity in Aplysia (Byrne)
Reading: FMN, Chapter 20

Apr 20: Functions of astrocytes in the brain (Beierlein)

Apr 25: Retrograde synaptic signaling via endocannabinoids (Beierlein)
Reading: Kreitzer and Regehr, Neuron 29: 717-727

May 2: Exam 3