# Department of Neurobiology and Behavior

Marcelo Wood, Department Chair  
Kim Green, Department Vice Chair  
2205 McGaugh Hall  
949-824-8519  
http://neurobiology.uci.edu/

## Overview

The Department of Neurobiology and Behavior programs provide a broad foundation in neuroscience combined with proficiency in a specific area of research. Faculty members in the Department address questions in neuroscience at the molecular, cellular, systems, and behavioral levels. Research focuses on a range of topics including learning and memory, neurodegenerative disorders, addiction, sensory neurobiology, developmental neurobiology, and neural plasticity.

## Undergraduate Major in Neurobiology

The Neurobiology major is designed to teach students how neurobiologists apply cellular, molecular, systems, and behavioral analyses in understanding how the nervous system works. The hallmark of the major is a year-long, in-depth exploration of the intellectual tools used to create, advance, and disseminate knowledge about the nervous system. Through neurobiology satellite courses, students acquire advanced factual knowledge about neurobiology. In addition, Neurobiology majors may choose to participate in research through BIO SCI 199, where they will learn technical skills and receive mentoring from faculty members.

Students completing the Neurobiology major will be well qualified for admission to graduate or professional schools in preparation for careers in biological research, medicine, dentistry, veterinary medicine, nursing, and other related fields. Even without additional education, they will be competitive for positions in the pharmaceutical industry, the health care delivery industry, or in medically or biologically related technologies. The major also provides valuable preparation for students interested in entering other disciplines that increasingly interface with biology and biotechnology, such as law, business administration, and government policy. Additionally, the major provides excellent preparation for students who wish to become high school science teachers.

## Requirements for the B.S. in Neurobiology

**All students must meet the University Requirements.**  
**All students must meet the School Requirements.**

### Major Requirements

<table>
<thead>
<tr>
<th>A. Upper-Division Core:</th>
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<tbody>
<tr>
<td>BIO SCI N110</td>
<td>Neurobiology and Behavior</td>
</tr>
<tr>
<td>and select one of the following:</td>
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<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
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<tr>
<td>BIO SCI D104</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
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<thead>
<tr>
<th>B. Required Major Courses:</th>
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<tbody>
<tr>
<td>BIO SCI N115A- N115B</td>
<td>Advanced Neurobiology I</td>
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<tr>
<td>and Advanced Neurobiology II</td>
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<thead>
<tr>
<th>C. Upper-Division Laboratories:</th>
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<tbody>
<tr>
<td>BIO SCI N113L</td>
<td>Neurobiology Laboratory</td>
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<tr>
<td>and select two of the following:</td>
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<tr>
<td>BIO SCI D111L</td>
<td>Developmental and Cell Biology Laboratory</td>
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<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
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<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
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<td>BIO SCI E131L</td>
<td>Image Analysis in Biological Research</td>
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<tr>
<td>BIO SCI E140L</td>
<td>Evolution and the Environment Laboratory</td>
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<tr>
<td>BIO SCI E160L</td>
<td>Biology of Birds Lab</td>
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<td>BIO SCI E166L</td>
<td>Field Biology</td>
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<tr>
<td>BIO SCI E179L</td>
<td>Field Freshwater Ecology</td>
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<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
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<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
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### Sample Program — Neurobiology

#### Freshman

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<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
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<tbody>
<tr>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>MATH 2A or 5A</td>
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<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>CHEM 1C or 1LC</td>
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<tr>
<td>Lower-Division Writing 1</td>
<td>Lower-Division Writing 1</td>
<td>Lower-Division Writing 1</td>
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<tr>
<td>BIO SCI 2A</td>
<td>General Education</td>
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#### Sophomore

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<tbody>
<tr>
<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
<td>BIO SCI 99</td>
</tr>
<tr>
<td>CHEM 51A</td>
<td>CHEM 51B- 51LB</td>
<td>CHEM 51C- 51LC</td>
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<tr>
<td>CHEM 1LD</td>
<td>STATS 7, 8, MATH 2D, or MATH 3A</td>
<td>BIO SCI N110</td>
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<tr>
<td>MATH 2B or 5B</td>
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<tr>
<td>BIO SCI 194S</td>
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#### Junior

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<tr>
<td>Bio. Sci. Elective</td>
<td>BIO SCI N113L</td>
<td>PHYSICS 3C- 3LC</td>
</tr>
<tr>
<td>BIO SCI 100</td>
<td>PHYSICS 3B- 3LB</td>
<td>Research/Elective</td>
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<tr>
<td>PHYSICS 3A</td>
<td>Research/Elective</td>
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#### Senior

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<th>Fall</th>
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<tbody>
<tr>
<td>Research/Elective</td>
<td>Bio. Sci. Elective</td>
<td>Research/Elective</td>
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<tr>
<td>General Education/Elective</td>
<td>General Education/Elective</td>
<td>General Education/Elective</td>
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1. Students have the option of taking HUMAN 1AS, HUMAN 1BS, HUMAN 1CS or WRITING 39A, WRITING 39B, WRITING 39C in order to fulfill the lower-division writing requirement.

### Graduate Program

The Department of Neurobiology and Behavior offers the Ph.D. in Biological Sciences. Graduate students must complete a sequence of core courses (lectures and laboratories) during their first year, and maintain an overall GPA of 3.3 or better. They also must take a minimum of four advanced courses.
before graduation and participate in directed research each year and a minimum of two quarters of teaching by their fourth year. Students will advance to candidacy for the Ph.D. at the end of their third year by means of a written critical review of the literature in the area in which they plan to do their dissertation, a research proposal, and an oral examination. Graduation depends on successful preparation and oral defense of a dissertation based on the student’s research. The normative time for completion of the Ph.D. is five years, and the maximum time permitted is seven years.

Ideally, applicants for this program should have taken undergraduate courses in biology (one introductory year plus some advanced work), and/or psychology (experimental, physiological), chemistry through biochemistry, introductory physics, calculus, and statistics. They also must submit GRE Aptitude test scores. Because graduate training emphasizes research, preference is given to applicants having laboratory research experience. Applicants with substantial outside commitments that would curtail laboratory research or prolong the time to degree are not accepted. The deadline for application is December 2.

The Department of Neurobiology and Behavior also participates in the Interdepartmental Neuroscience Program (http://www.inp.uci.edu).

Faculty

Ruth M. Benca, Ph.D. University of Chicago Pritzker School of Medicine, Professor of Neurobiology and Behavior
Mathew M. Blurton-Jones, Ph.D. University of California, San Diego, Assistant Professor of Neurobiology and Behavior
Jorge A. Busciglio, Ph.D. Universidad Nacional de Córdoba, Professor of Neurobiology and Behavior
Lawrence F. Cahill, Ph.D. University of California, Irvine, Professor of Neurobiology and Behavior; Psychology and Social Behavior
Susana Cohen-Cory, Ph.D. The Rockefeller University, Professor of Neurobiology and Behavior
Carl W. Cotman, Ph.D. Indiana University, Professor of Neurology; Biomedical Engineering; Neurobiology and Behavior
Karina S. Cramer, Ph.D. California Institute of Technology, Professor of Neurobiology and Behavior
Howard J. Federoff, M.D. Ph.D. Albert Einstein College of Medicine, Vice Chancellor for Health Affairs and Professor of Neurobiology and Behavior
Norbert Fortin, Ph.D. Boston University, Associate Professor of Neurobiology and Behavior
Christie Fowler, Ph.D. Florida State University, Assistant Professor of Neurobiology and Behavior
Ron D. Frostig, Ph.D. University of California, Los Angeles, Professor of Neurobiology and Behavior; Biomedical Engineering
Christine M. Gall, Ph.D. University of California, Irvine, Department Chair and Professor of Anatomy and Neurobiology; Neurobiology and Behavior
Sunil P. Gandhi, Ph.D. University of California, San Diego, Assistant Professor of Neurobiology and Behavior
Kim Green, Ph.D. University of Leeds, Associate Professor of Neurobiology and Behavior
Joshua Grill, Ph.D. Wake Forest University School of Medicine, Associate Professor of Neurobiology and Behavior
John F. Guzowski, Ph.D. University of Pennsylvania, Professor Emeritus of Neurobiology and Behavior
Claudia H. Kawas, M.D. University of Louisville, Nichols Term Chair in Neuroscience and Professor of Neurology; Neurobiology and Behavior
Herbert P. Killackey, Ph.D. Duke University, Professor Emeritus of Neurobiology and Behavior
Frank M. Laferla, Ph.D. University of Minnesota, Dean of the School of Biological Sciences and Professor of Neurobiology and Behavior; Neurology
Michael Leon, Ph.D. University of Chicago, Professor of Neurobiology and Behavior
Stephen V. Mahler, Ph.D. University of Michigan, Assistant Professor of Neurobiology and Behavior
John F. Marshall, Ph.D. University of Pennsylvania, Professor Emeritus of Neurobiology and Behavior
James L. McGaugh, Ph.D. University of California, Berkeley, Research Professor and Professor Emeritus of Neurobiology and Behavior; Logic and Philosophy of Science
Bruce L. McNaughton, Ph.D. Carleton University, UCI Distinguished Professor of Neurobiology and Behavior
Raju Metherate, Ph.D. McGill University, Professor of Neurobiology and Behavior

John Middlebrooks, Ph.D. University of California, San Francisco, Professor of Otolaryngology; Biomedical Engineering; Cognitive Sciences; Linguistics; Neurobiology and Behavior (hearing research, neurophysiology, psychophysics, auditory prosthesis, computational neuroscience)
Ricardo Miledi, M.D. Universidad Nacional Autonoma De Mexico, *Professor Emeritus of Neurobiology and Behavior*

Andrea C. Nicholas, Ph.D. University of Chicago, *Lecturer with Potential Security of Employment of Neurobiology and Behavior*

Ian Parker, Ph.D. University College London, *Professor of Neurobiology and Behavior; Physiology and Biophysics*

Steven L. Small, M.D. University of Rochester, *Dr. Stanley van den Noort Endowed Chair and Professor of Neurology; Cognitive Sciences; Neurobiology and Behavior*

George Sperling, Ph.D. Harvard University, *UCI Distinguished Professor of Cognitive Sciences; Neurobiology and Behavior* (empirical studies of human information processing: short-term visual memory systems, attention, visual perception, 3-D object recognition; mathematical, computational, and neural models of visual processes: light adaptation, temporal sensitivity, contrast-D)

Craig Stark, Ph.D. Carnegie Mellon University, *James L. McGaugh Chair in the Neurobiology of Learning and Memory and Professor of Neurobiology and Behavior*

Arnold Starr, M.D. New York University, *Research Professor of Neurobiology and Behavior*

Oswald Steward, Ph.D. University of California, Irvine, *Reeve-Irvine Chair in Spinal Cord Injury Research and Professor of Anatomy and Neurobiology; Neurobiology and Behavior*

Georg F. Striedter, Ph.D. University of California, San Diego, *Professor of Neurobiology and Behavior*

Katumi Sumikawa, Ph.D. Imperial College London, *Professor of Neurobiology and Behavior*

Andrea Tenner, Ph.D. University of California, San Diego, *Professor of Molecular Biology and Biochemistry; Neurobiology and Behavior*

Leslie M. Thompson, Ph.D. University of California, Irvine, *Professor of Psychiatry and Human Behavior; Biological Chemistry; Neurobiology and Behavior*

Marcelo A. Wood, Ph.D. Princeton University, *UCI Chancellor's Fellow and Department Chair and Professor of Neurobiology and Behavior*

Michael Yassa, Ph.D. University of California, Irvine, *UCI Chancellor's Fellow and Director of the Center for the Neurobiology of Learning and Memory and Associate Professor of Neurobiology and Behavior*

**Courses**

**NEURBIO 200A. Research in Neurobiology and Behavior. 2-12 Units.**

Individual research with Neurobiology and Behavior faculty.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only. Neurobiology and Behavior Majors only.

**NEURBIO 200B. Research in Neurobiology and Behavior. 2-12 Units.**

Individual research with Neurobiology and Behavior faculty.

Prerequisite: NEURBIO 200A

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only. Neurobiology and Behavior Majors only.

**NEURBIO 200C. Research in Neurobiology and Behavior. 2-12 Units.**

Individual research with Neurobiology and Behavior faculty.

Prerequisite: NEURBIO 200B

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only. Neurobiology and Behavior Majors only.
NEURBIO 201A. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 201B. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.
Prerequisite: NEURBIO 201A
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 201C. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.
Prerequisite: NEURBIO 201B
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 202A. Foundations of Neuroscience. 2 Units.
Intended to expose students to critical reading and analysis of the primary neuroscience literature. Instructors from departments associated with the Interdepartmental Neuroscience Program participate and discuss topics of current interest.
Grading Option: Satisfactory/unsatisfactory only.

NEURBIO 202B. Foundations of Neuroscience. 2 Units.
Intended to expose students to critical reading and analysis of the primary neuroscience literature. Instructors from departments associated with the Interdepartmental Neuroscience Program participate and discuss topics of current interest.
Prerequisite: NEURBIO 202A
Grading Option: Satisfactory/unsatisfactory only.

NEURBIO 206. Molecular Neuroscience. 5 Units.
Surveys molecular and cellular mechanisms involved in neuronal function, including control of gene expression, post-transcriptional and post-translational processing, RNA and protein targeting, cell death mechanisms, and molecular genetic basis of neurological disorders. Overview of the molecular aspects of developmental neurobiology.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 207. Cellular Neuroscience. 5 Units.
Neurophysiological and neurochemical mechanisms of electrical and chemical signaling in neurons. Topics include generation of resting- and action-potentials, voltage- and ligand-gated ion channels, second messenger systems, and synaptic transmission and integration.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 207L. Cellular Neuroscience Laboratory. 2 Units.
Intensive hands-on laboratory experience of contemporary techniques for studying ion channels and synaptic function. Experiments include microelectrode recording, patch clamp, quantal analysis of synaptic transmission, heterologous expression of genes for channels and receptors, brain slice, and fluorescence calcium imaging.
Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.
NEURBIO 208A. Systems Neuroscience. 5 Units.
Study of the mammalian nervous system at the systems level. Anatomy and physiology of sensory, motor, and integrative functions.

Repeatability: May be taken for credit 2 times.

Same as ANATOMY 210A.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 209. Behavioral Neuroscience. 5 Units.
Overview of fundamental conceptual and experimental issues in the neurobiology of learning and memory. The approach is a cross-level integration of research in molecular-genetic, cellular, circuit, systems, and behavioral analyses.

Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 220. Neural Coding, Computation, and Dynamics. 4 Units.
Theoretical principles and biological mechanisms underlying how brains acquire, assimilate, store, and retrieve information, compute adaptive responses to external inputs, and how knowledge is extracted from experience to generate an internal model of the world.

Prerequisite: At least one upper-division course in the field of Neuroscience or one upper-division course in Cognitive Science or Machine Learning.

NEURBIO 221. Scientific Presentation Skills. 1 Unit.
A tutorial seminar on developing skills for presenting research to scientific audiences.

Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only.

NEURBIO 225. Rigor, Reproducibility, and Research Methods. 1 Unit.
Understanding key concepts in experimental design, execution, and analysis that enhance or detract from scientific rigor.

Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only.

NEURBIO 230. Epigenetics in Health and Disease . 4 Units.
Focuses on the role of chromatin/nuclear structure organization (histone and DNA modification, chromatin remodeling, higher order chromatin structure and nuclear organization) on gene regulation, DNA replication and repair, relevant to development, metabolism, learning and memory, and human disease.

Prerequisite: MOL BIO 203 or MOL BIO 204 or NEURBIO 206
Same as BIOCHEM 225.
Restriction: Graduate students only.

NEURBIO 231. Clinical and Epidemiological Aspects of Neurodegenerative Diseases. 4 Units.
Clinical and epidemiological aspects of neurodegenerative disorders causing dementia will be reviewed, including AD, PD, FTD, HD and cerebrovascular disease. Seminar format will include student presentations and group discussion.

Restriction: Graduate students only.

NEURBIO 232. Regenerative Neurobiology. 4 Units.
Surveys the latest research on regenerative neurobiology. Both basic stem cell discoveries and their potential clinical application to brain disorders will be examined.

NEURBIO 233. Neurobiology of Drug Addiction. 4 Units.
Provides a comprehensive overview of topics in the addiction field, including drug pharmacology, models/approaches to investigate addiction, brain circuits, genetics, epigenetics, and the cellular and molecular biology of drug addiction.

Restriction: Graduate students only.

NEURBIO 234. Cognitive Neuroepigenetics. 4 Units.
Covers current topics in the emerging field of cognitive neuroepigenetics, focusing on understanding the underlying epigenetic mechanisms of memory formation and persistence. Primary literature will be used to explore these processes.

Repeatability: May be repeated for credit unlimited times.
NEURBIO 235. Balancing Research and Teaching. 1 Unit.
The goal of this course is to offer graduate students who have commitments outside of their research program (such as teaching) an opportunity to learn to balance these commitments.

NEURBIO 236. Cortex: Structure, Function, and Plasticity. 4 Units.
Structured to include lectures and presentation of papers about cortex with emphasis on sensory-motor cortex. Both historical and current perspectives on cortical structure-function relationship will be critically evaluated.

NEURBIO 237. Neurobiology of Brain Aging. 4 Units.
Outlines some of the significant changes that occur in the aging brain, with a special emphasis on risk factors and protective strategies that promote successful brain aging. Topics include changes in synaptic plasticity, neurotrophic factors, and molecular mechanisms in aging.
Prerequisite: NEURBIO 209

NEURBIO 239. Functional Imaging of the Nervous System. 4 Units.
Overview of technical and applied aspects of imaging techniques available for studying the nervous system. The areas emphasized are cellular and subcellular imaging of neural function, systems-level imaging of brain function, and imaging of the human brain.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 240. Advanced Analysis of Learning and Memory. 4 Units.
Advanced analysis of contemporary research concerning the nature and neurobiological bases of learning and memory. Special emphasis is given to time-dependent processes involved in memory storage.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 247. Programming for Neuroscience Research . 4 Units.
A neuroscience-specific introduction to programming and data analysis using either MATLAB or Scientific PYTHON. Students will learn general programming skills and effective use of programming for data management, statistical analysis, and image analysis.
Overlaps with PSYCH 205A.

NEURBIO 248. Topics in Neurobiology and Behavior. 4 Units.
Studies in selected areas of Neurobiology and Behavior. Topics addressed vary each quarter.
Repeatability: May be taken for credit 3 times.

NEURBIO 249. Electronics for Biologists. 4 Units.
Basic principles of electricity; properties and use of discrete components and integrated circuits; circuit analysis and design. Intended for advanced students in the life sciences.
Same as PHYSIO 205.

NEURBIO 254. Molecular Neurobiology. 4 Units.
The application of genetic and recombinant DNA technology to neurobiology. Topics include the study of neuronal proteins which play important roles in the formation of synapses and synaptic transmission.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 255. History of Neuroscience. 4 Units.
An overview of the conceptual and technical foundations of contemporary neuroscience from ancient times to the present. The subjects include synapses, neurons, brain organization, sensory, motor and regulatory systems, learning and memory, human brain function and dysfunction.
Repeatability: May be taken for credit 2 times.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.
Concurrent with BIO SCI N119.

NEURBIO 257. Statistics for Neurobiologists. 4 Units.
Introduction to common methods for statistical analysis used in neurobiology. Topics covered include t-tests, ANOVAs, correlations and regressions, general linear model, power analysis, and non-parametric tests.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.
NEURBIO 260. Auditory Neuroscience. 4 Units.
Multidisciplinary overview of brain mechanisms of hearing. Emphasizes breadth of auditory function and research: single neurons to psychoacoustics, the cochlea to the cortex, and basic science to clinic.

Concurrent with BIO SCI N147.

NEURBIO 290. Colloquium in Neurobiology and Behavior. 1.3 Unit.
Presentation of contemporary research problems in neurobiology and behavior and related areas by invited speakers.

Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 292. Scientific Communication. 4 Units.
Students learn how to effectively communicate scientific ideas and results. Activities include learning how to effectively write a scientific proposal, how to perform a coherent, persuasive slide presentation, and how to give meaningful, constructive review critiques.

Restriction: Graduate students only. Neurobiology and Behavior Majors only.

NEURBIO 399. University Teaching. 1-4 Units.
Limited to Teaching Assistants.

Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.