

# Neuroscience

## Requirements

### *Natural Sciences*

Neuroscience studies brain-behavior relationships in order to understand the roles they play in regulating both animal and human behavior. A thorough knowledge of the functions of the nervous system is essential to understanding the vicissitudes of psychological experience, general behavior and clinical disorders. Therefore, the study of the nervous system and the brain — anatomically, physiologically and biophysically, at both the microscopic and macroscopic levels — is central to the Neuroscience Program.

In recent years, neuroscience has become the most rapidly developing interdisciplinary area in the sciences. This field integrates the knowledge, research methods and modern laboratory technology of biology, chemistry, psychology and other scientific fields toward the common goal of understanding animal and human behavior. For this reason, the program's curriculum and list of faculty reflect a diversity of subdisciplines within a variety of departments. A primary objective of this program is to prepare students for entrance into graduate training or research occupations in neuroscience, neurochemistry, neurobiology, anatomy, physiology, physiological psychology, clinical psychology, behavioral science and the health sciences (medicine and allied fields).

### **FIRST YEAR AND NEW STUDENTS**

Students who are considering a concentration or a major in neuroscience should inquire about the program from any of the affiliated faculty members and also should consult with the program's director.

NEUR 212 is the entryway into the neuroscience curriculum. It begins by emphasizing that neuroscience is truly an interdisciplinary field. Consistent with this view, a number of faculty members from various departments give lectures and lead discussions throughout the semester. After covering brain evolution and the genetic basis of behavior, there is a review of the organization of the nervous system and the processes responsible for neural conduction and synaptic transmission. This knowledge is then applied to a comprehensive examination of the neurochemical, sensory, motor, developmental, motivational, cognitive and emotional processes and structures that influence both normal and abnormal behavior.

### **CURRICULUM FOR THE MAJOR**

The neuroscience major is intended primarily for students who are planning to attend graduate school in the many specialized fields of neuroscience, such as medical neuroscience, developmental neuroscience, cognitive neuroscience or behavioral neuroscience. It also is an excellent major for students who are seriously interested in pursuing research careers or

becoming clinical practitioners concerned with the biochemical or the biopsychological aspects of the nervous system or behavior (e.g., psychopharmacology, psychiatry, clinical neuropsychology).

With the 2013-14 academic year, the following requirements for the neuroscience major and minor apply to the class of 2017 and those following. Students in the classes of 2014, 2015 and 2016 may choose these new requirements or the old requirements (next section) to fulfill their requirements for the major or the minor.

### **REQUIREMENTS FOR THE MAJOR (7 TO 7.25 UNITS)**

#### **Required Core Courses (4.75-5.25 units)**

##### **1. Neuroscience Required Courses (1 unit)**

NEUR 112/212 Neuroscience

NEUR 471 Topics in Neuroscience

##### **2. Neuroscience/Psychology Required Courses (1 unit)**

NEUR 305 Behavioral Neuroscience **or** NEUR 307 Sensory Processes

**And one** of the following laboratory courses:

NEUR 401 Research Methods in Electrophysiology and Biopotentials

NEUR 405 Research Methods in Behavioral Neuroscience

NEUR 406 Research Methods in Sensory Processes

PSYC 402 Research Methods in Cognition

PSYC 403 Research Methods in Learning and Motivation

PSYC 410 Research Methods in Human Neuroscience

**or** 2 semesters (.5 unit) of NEUR 385 Research in Neuroscience.

##### **3. Biology Required Courses (2.25 units)**

BIOL 109 Introduction to Experimental Biology (Lab)

BIOL 110 Introduction to Experimental Biology (Lab)

BIOL 115 Energy in Living Systems (or Biology AP score of 5)

BIOL 116 Information in Living Systems

BIOL 358 Neurobiology

BIOL 359 Experimental Neurobiology (Lab)

##### **4. Chemistry Required Courses (.5-1 unit)**

CHEM 121 and 124 Introductory Chemistry I and II **or** CHEM 122 Chemical Principles

#### **Electives**

2.25 units beyond the required core curriculum and selected from the elective list below. Overall the electives must span at least three departments, with at least 1 unit being from a single department and a minimum of .5 unit from the other two departments (this will aid both your breadth and depth of understanding).

**Biology Electives**

BIOL 243 Comparative Animal Physiology

BIOL 261 Animal Behavior

BIOL 263 Molecular Biology & Genomics

BIOL 266 Cell Biology

BIOL 321 Developmental Biology

**Chemistry Electives**

CHEM 231, 232 Organic Chemistry

CHEM 233, 234 Organic Chemistry Laboratory

CHEM 256 Biochemistry

CHEM 335 Chemical Kinetics and Thermodynamics

CHEM 341 Instrumental Analysis

CHEM 370 Computational Chemistry

CHEM 371 Biochemistry Laboratory

CHEM 401 Chemistry and Biochemistry Seminar (Permission of NEUR Chair required)

**Neuroscience Electives**

NEUR 291 Animal Cognition

NEUR 302 Comparative Psychology

NEUR 304 Human Neuropsychology

NEUR 305 Behavioral Neuroscience (if not taken as core course)

NEUR 307 Sensory Processes (if not taken as core course)

NEUR 347 Psychopharmacology

NEUR 491 Philosophical Neuroscience

**Psychology Electives**

PSYC 301 Cognitive Psychology

PSYC 303 Learning and Motivation

PSYC 306 Psychology of Language

PSYC 310 Cognitive Neuroscience

**Other Electives**

ANTH 111 Intro to Biological Anthropology

ANTH 321 Evolution and Human Evolution

ANTH 323 Bioarcheology of Sub-Saharan Africa

ANTH 421 Neanderthals

MATH 106 Elements of Statistics

MATH 108 Models of Life

PHIL 245 Philosophy of Natural Science

PHIL 260 Philosophy of Mind

PHIL 262 Philosophy of Perception

PHYS 210 Biological Physics

SCMP 118 Intro to Programming

**REQUIREMENTS FOR THE MINOR (4 UNITS)**

**Neuroscience Required Courses (1 unit)**

NEUR 112/212 Introduction to Neuroscience

NEUR 471 Topics in Neuroscience

**Basic Science Required Courses (2 units)**

NEUR 305 Behavioral Neuroscience or NEUR 307 Sensory Process

BIOL 115 Energy in Living Systems

BIOL 116 Information in Living Systems

NEUR/CHEM 109 Neurochemistry or CHEM 121 Introductory Chemistry I or CHEM 122

Chemical Principles and Labs

**Electives**

1 unit from the elective list above for the major

**OLD REQUIREMENTS**

These requirements may be used by the classes of 2014, 2015 and 2016 to fulfill their neuroscience major and minor requirements.

**Neuroscience Core Courses (4.5 units)**

NEUR 112/212 (.5 unit) Introduction to Neuroscience

NEUR 471 (.5 unit) Current Research Topics in Neuroscience

BIOL 115 and BIOL 116 (1 unit) Energy in Living Systems and Information in Living Systems

BIOL 358 (.5 unit) Neurobiology

CHEM 121, 124/125 (or CHEM 122, 124/125) (1 unit) Introductory Chemistry I, II (or Honors Introductory Chemistry I, II)

PSYC 305 (.5 unit) Physiological Psychology

NEUR 401 (.5 unit) Research Methods in Electrophysiology and Biopotentials, or PSYC 403 (.5 unit) Research Methods in Learning and Motivation, or NEUR 406 (.5 unit) Research Methods in Sensory Processes

**Biochemical Track (2.75 units)**

One selected biology course from the concentration list (see section on neuroscience concentration, below) (.5 unit)

BIOL 359 (.25 unit) Experimental Neurobiology, or CHEM 371 (.25 unit) Biochemistry Laboratory

CHEM 231, 232 (1 unit) Organic Chemistry I, II

Recommended courses:

CHEM 123 and 126

CHEM 233, 234

CHEM 256

One selected psychology course from the concentration list (below) (.5 unit)

MATH 111 (.5 unit) Calculus

### **Biopsychological Track (2.75 to 3 units)**

One selected biology course from the concentration list (below) (.5 unit)

BIOL 359 (.25 unit) Experimental Neurobiology, or NEUR 405 (.5 unit) Research Methods in Behavioral Neuroscience

CHEM 123 and 126 (.5 unit) Introductory Chemistry Laboratory I, II

PSYC 200 (.5 unit) Statistical Analysis in Psychology

Two selected psychology courses from the concentration list (below) (1 unit)

### **SENIOR EXERCISE**

The Senior Exercise consists of an original research proposal, written in a format appropriate for a scientific grant. The exercise is completed in the fall of the student's senior year. This Senior Exercise is evaluated by two faculty members: the Senior Exercise advisor and another member of the Neuroscience Program.

In preparation for the Senior Exercise, students can gain research experience by participating in independent research (NEUR 385) under the supervision of a faculty advisor. Although independent research is not required for the major, conducting research is a valuable educational experience, particularly for students planning to pursue graduate or medical training.

### **HONORS**

Seniors participating in the Honors Program (NEUR 497Y-498Y) must complete an honors project and pass an oral exam. Assessment of the honors candidates is conducted by two members of the advisor's department, one member of the Neuroscience Program from another department, and an outside examiner brought in by the advisor's department.

### **CONCENTRATION CURRICULUM AND REQUIREMENTS**

#### **Required Neuroscience Courses (1 unit)**

NEUR 112/212 (.5 unit) Introduction to Neuroscience

NEUR 471 (.5 unit) Current Research Topics in Neuroscience

**Required Basic Science Courses (2 units minimum)**

BIOL 115 Energy in Living Systems and BIOL 116 Information in Living Systems

CHEM 109 Neurochemistry (or CHEM 121 and 124/125 or CHEM 122 and 124/125)

NEUR 305 Behavioral Neuroscience

**Selected Advanced Science Courses (1 unit, selected from the following)****Biology courses**

BIOL 243 Comparative Animal Physiology

BIOL 261 Animal Behavior

BIOL 263 Molecular Biology and Genomics

BIOL 321 Developmental Biology

BIOL 358 Neurobiology

BIOL 366 Cell Physiology

**Chemistry courses**

CHEM 231, 232 Organic Chemistry I, II

CHEM 256 Biochemistry

CHEM 341 Instrumental Analysis

**Neuroscience courses**

NEUR 302 Neuroethology and Comparative Psychology

NEUR 304 Neuropsychology

NEUR 307 Sensory Processes

NEUR 347 Psychopharmacology

**Psychology courses**

PSYC 301 Cognitive Psychology

PSYC 303 Learning and Motivation

**Anthropology courses**

ANTH 111 Introduction to Biological Anthropology

ANTH 321 Evolution and Human Evolution

**NEUR Courses and Diversification Requirements**

The following courses may be paired to satisfy the natural sciences requirement:

- NEUR 105 and NEUR 112
- NEUR 105 and BIOL 103
- NEUR 105 and BIOL 105

**Please note: Beginning 2013-14, BIOL 103 and BIOL 105 can no longer be paired with NEUR 105 to satisfy the natural sciences requirement.**

## Courses

### **NEUR 105 FUNDAMENTALS OF NEUROSCIENCE**

*Credit: 0.5*

This introductory course will explore a range of topics and issues in the study of neuroscience. Specifically, the course will focus on the relationship between neuroscience, the arts and humanities. The course will treat the humanities and sciences as partners working together on the same problems. Usually, three topics are covered per semester. Examples of topics covered include the neuroscience of emotions, play behavior, film, visual and artistic perspective, space and time. Other topics may be covered. Assignments will include weekly quizzes, class discussion and a thesis paper. No prerequisite. NEUR 105 is a non-majors introductory course geared towards first- and second-year students, although others may take it. Anyone who plans to major or concentrate in neuroscience will need to take NEUR 112/212. NEUR 105 can be paired with NEUR 112/212 in order to satisfy the natural science distribution requirement. This course is repeatable for credit. However, this course taken twice or with a NEUR special topic does not satisfy the natural sciences diversification.

### **NEUR 212 NEUROSCIENCE**

*Credit: 0.5*

This course begins with a definition of neuroscience as an interdisciplinary field, in the context of the philosophy of science. Consistent with this view, a number of faculty members from various departments are responsible for giving lectures and leading discussions throughout the semester. After covering the basics of cellular neurophysiology, the course examines the development and organization of the human nervous system in terms of sensory, motor, motivational, emotional and cognitive processes. The neurological and biochemical bases of various brain and behavioral disorders also are examined. Prerequisite: BIOL 115 or 116, CHEM 121 or 122 or AP score of 5 in biology or chemistry.

### **NEUR 302 NEUROETHOLOGY AND COMPARATIVE PSYCHOLOGY**

*Credit: 0.5*

Comparative psychology is the study of behavior and mental processes of organisms, including humans. Until Darwin published his theory of evolution, it was commonly accepted that a huge gulf exists between human and nonhuman animals. In this course we will examine human and animal behavior and mental activity from an evolutionary perspective--that is, from a perspective in which humans are part of the continuum of life forms that inhabit the planet. We will consider the notion that, in contrast to the usual anthropocentric view of behavior and mental processes, many of the same evolutionary, ecological and biological principles explain both human and animal behavior. Prerequisite: NEUR 112/212 or PSYC 100 and PSYC 150. This course is offered at least every other year.

### **NEUR 304 NEUROPSYCHOLOGY**

*Credit: 0.5*

This course is designed to facilitate our learning about the connections and interactions among neuroanatomy, brain function and psychological phenomena. We do this by studying neuropsychological disorders, as well as the basic psychological processes such as perceptions and memory. Through readings, discussions and class presentations, we will learn some of the basic principles of the brain's organization and function, as well as its ability to recover function after damage. In addition, we will learn about the nature, causes and treatment of specific neuropsychological disorders such as Parkinson's disease, Alzheimer's disease, closed head injuries, Tourette's syndrome, and stroke-induced aphasia. Further, we will learn about neuropsychological assessment and the current level of research and discovery in the neuropsychology of specific disorders through student presentations. This course is cross-listed with psychology for diversification purposes. Prerequisite: PSYC 100 or 101 or NEUR 112/212. This course is offered at least every other year.

Instructor: McFarlane

### **NEUR 305 BEHAVIORAL NEUROSCIENCE**

*Credit: 0.5*

This course is designed to provide the student with an understanding of the physiological phenomena responsible for psychological experiences. The main focus of the course is a detailed study of the anatomy and physiology of the nervous system. This is followed by a study of the sensory and self-regulatory systems, a study of higher cognitive processing. With each new topic, the relevant anatomical and physiological systems will be discussed as they relate to the behavior under scrutiny. Thus the biological underpinnings of sleep, mood, learning and memory, motivation, and other topics will be studied. Prerequisite: PSYC 101, PSYC 111, or NEUR 112/212. This course typically is offered every year.

### **NEUR 307 SENSORY PROCESSES**

*Credit: 0.5*

This course focuses on the ways in which the brain gathers, processes and interprets information from the external environment in order to construct an internal representation that the organism perceives to be "reality." The goal is to provide students with an understanding of the evolution, structure and function of various sensory systems as well as an understanding of how the brain interprets incoming sensations and turns them into perceptions that allow organisms to act on their environment. Prerequisite: NEUR 112/212 or PSYC 100 and PSYC 150. This course typically is offered every year.



### **NEUR 347 PSYCHOPHARMACOLOGY**

*Credit: 0.5*

The emphasis of this course is on the biological mechanisms of the actions and effects of both legal and illegal psychoactive drugs. The course begins with a brief discussion of the history of psychopharmacology, followed by an in-depth examination of the biological basis of drug action in the brain. This is followed by a discussion of the basis of drug classification and of specific drugs, including illicit drugs such as cocaine, amphetamines, and heroin as well as legal psychoactive drugs such as caffeine, nicotine and alcohol. The course ends with a discussion of the action of drugs used in the treatment of mental disorders such as schizophrenia (antipsychotics) and depression (antidepressants). This course is cross-listed with psychology for diversification purposes. Prerequisite: PSYC 100 or NEUR 112/212. Recommended but not required: PSYC/NEUR 305. Offered as our schedule permits.

Instructor: McFarlane

### **NEUR 385 RESEARCH IN NEUROSCIENCE**

*Credit: 0.25*

This combined discussion and laboratory course aims to develop abilities for asking sound research questions, designing reasonable scientific approaches to answer such questions, and performing experiments to test both the design and the question. We consider how to assess difficulties and limitations in experimental strategies due to design, equipment, system selected, and so on. The course provides a detailed understanding of selected modern research equipment. Students select their own research problems in consultation with one or more neuroscience faculty members. This course is designed both for those who plan to undertake honors research in their senior year and for those who are not doing honors but who want some practical research experience. A student can begin the research in either semester. If a year of credit is earned, it may be applied toward the Research Methods course requirement for the major in neuroscience. Prerequisite: BIOL 109Y-110Y, NEUR 112/212, and permission of instructor.

### **NEUR 401 RESEARCH METHODS IN ELECTROPHYSIOLOGY AND BIOPOTENTIALS**

*Credit: 0.5 QR*

This methods course teaches students the skills necessary for conducting research in biopsychology and neuroscience. Students will gain first-hand experience with a number of concepts and measurement techniques as well as an understanding of the ways in which biopsychologists/neuroscientists investigate the brain and its relationship to behavior. Students will learn to design experiments; collect, analyze and present data using computer software packages; and write a scientific paper. Prerequisite: NEUR 112/212 or PSYC 200 as well as permission of instructor. Offered as our schedule permits.

## **NEUR 405 RESEARCH METHODS IN BEHAVIORAL NEUROSCIENCE**

*Credit: 0.5 QR*

This is a laboratory methods course that focuses on research methods used in physiological psychology and behavioral neuroscience. The emphasis of the course will be on designing, conducting and presenting research, as well as on mastering specific laboratory techniques. The primary goal is to examine the relationships between brain chemistry and behavior. To this end, students will engage in the designing and implementation of projects that examine these relationships using animal subjects. The course also will focus on data analysis and experimental design. Prerequisite: PSYC 101 or PSYC 100 and one of the following: NEUR/PSYC 347, NEUR/PSYC 305 or NEUR 112/212. This course typically is offered every other year.

## **NEUR 406 RESEARCH METHODS IN SENSORY PROCESSES**

*Credit: 0.5 QR*

This methods course teaches students the skills necessary for conducting research in sensation and perception. It will give students first-hand experience with a number of concepts and measurement techniques as well as an understanding of the ways in which sensory neuroscientist investigate how the brain gathers, processes, and interprets information from the external environment in order to construct an internal representation of reality. Students will learn to design experiments; collect, analyze, and present data using computer software packages; and write a scientific paper. Prerequisite: NEUR 112/212 or PSYC 200 and previous or concurrent enrollment in either PSYC 301, NEUR 305, or NEUR 307 as well as permission of instructor. This course is typically offered every other year.

## **NEUR 471 TOPICS IN NEUROSCIENCE**

*Credit: 0.5*

This capstone seminar is required of all students who plan to graduate with a neuroscience concentration or major. The seminar is intended to bring together the knowledge acquired from courses required for, or relevant to, the concentration and major. During the course of the semester, each student will submit a critique of a published article and write an integrative paper with the assistance of the instructor. Oral presentations are given in conjunction with each of these exercises. Prerequisite: NEUR 112/212, junior standing and completion of two of the three required basic science courses for the concentration.

## **NEUR 493 INDIVIDUAL STUDY**

*Credit: 0.25-0.5*

Students conduct independent research under the supervision of one of the faculty members affiliated with the Neuroscience Program. This course is restricted to juniors or seniors who are neuroscience majors or have taken (or are concurrently enrolled in) courses required for the

neuroscience concentration. Prerequisite: permission of instructor and neuroscience director, along with demonstrated special interest.

### **NEUR 497Y SENIOR HONORS**

*Credit: 0.5*

This program for senior honors students culminates in the completion of a senior honors research project. The research is expected to be on a topic of particular relevance to the student's postgraduate plans. Students must select a research advisor from the faculty members in the Neuroscience Program. They are expected to have completed a thorough bibliographic search of the literature, written a short review paper, and formulated some tentative hypotheses during the spring semester of their junior year. Prerequisite: The student must have a 3.33 overall GPA and a 3.5 GPA in the neuroscience core courses and must have completed at least 5 units toward the major. Permission of neuroscience director.

### **NEUR 498Y SENIOR HONORS**

*Credit: 0.5*

See course description for NEUR 497Y.

Instructor: Staff

### **ADDITIONAL COURSES THAT MEET THE REQUIREMENTS FOR THIS CONCENTRATION:**

ANTH 111: Introduction to Biological Anthropology

BIOL 115: Energy in Living Systems

BIOL 116: Information in Living Systems

BIOL 243: Animal Physiology

BIOL 261: Animal Behavior

BIOL 263: Molecular Biology and Genomics

BIOL 266: Cell Biology

BIOL 321: Developmental Biology

BIOL 358: Neurobiology

BIOL 359: Experimental Neurobiology

CHEM 109: Neurochemistry

CHEM 121: Introductory Chemistry

CHEM 122: Chemical Principles

CHEM 123: Introductory Chemistry Lab I

CHEM 124: Introductory Chemistry II

CHEM 126: Introductory Chemistry Lab II  
CHEM 231: Organic Chemistry I  
CHEM 232: Organic Chemistry II  
CHEM 233: Organic Chemistry Lab I  
CHEM 234: Organic Chemistry Lab II  
CHEM 256: Biochemistry  
CHEM 335: Chemical Kinetics and Thermodynamics  
CHEM 341: Instrumental Analysis  
CHEM 371: Advanced Lab: Biochemistry  
MATH 111: Calculus I  
PSYC 200: Statistical Analysis in Psychology  
PSYC 301: Cognitive Psychology  
PSYC 303: Learning and Motivation  
PSYC 310: Cognitive Neuroscience  
PSYC 403: Research Methods in Learning and Motivation  
PSYC 410: Research Methods in Human Neuroscience