

NEUROSCIENCE (DIV III)

Chair: Professor HEATHER WILLIAMS

Advisory Committee: Professors: N. SANDSTROM*, H. WILLIAMS, B. ZIMMERBERG. Assistant Professors: M. CARTER, T. LEBESTKY. Visiting Assistant Professor: L. WILLIAMSON. Affiliated Faculty: A. HANE. Lecturer: M. MARVIN.

Neuroscience is a rapidly growing interdisciplinary field concerned with understanding the relationship between brain, mind, and behavior. The interdisciplinary nature of the field is apparent when surveying those who call themselves neuroscientists. Among these are anatomists, physiologists, chemists, psychologists, philosophers, molecular biologists, computer scientists, linguists, and ethologists. The areas that neuroscience addresses are equally diverse and range from physiological and molecular studies of single neurons, to investigations of how systems of neurons produce phenomena such as vision and movement, to the study of the neural basis of complex cognitive phenomena such as memory, language, and consciousness. Applications of neuroscience research are rapidly growing and include the development of drugs to treat neurodegenerative disorders such as Alzheimer's disease and Parkinson's disease, the use of noninvasive techniques for imaging the human brain such as PET scans and MRI, and the development of methods for repair of the damaged human brain such as the use of brain explants and implants. Combining this wide range of approaches and research methods to study a single remarkably complex organ—the brain—and the behavioral outcomes of its activity requires a unique interdisciplinary approach. The Neuroscience Program is designed to provide students with the opportunity to explore this approach.

THE PROGRAM

The program in neuroscience consists of five courses including an introductory course, three electives, and a senior course. In addition, students are required to take two courses, Biology 101 and Psychology 101, as part of the program.

Neuroscience (Neuroscience 201) is the basic course and provides the background for other neuroscience courses. Ideally, this will be taken in the sophomore year. Either Biology 101 or Psychology 101 serves as the prerequisite. Electives are designed to provide in-depth coverage including laboratory experience in specific areas of neuroscience. At least one elective course is required from Biology (*Group A*) and one from Psychology (*Group B*). The third elective course may also come from *Group A* or *Group B*, or may be selected from other neuroscience-related courses upon approval of the advisory committee. *Topics in Neuroscience* (Neuroscience 401) is designed to provide an integrative culminating experience. Students take this course in the senior year.

Required Courses

- BIOL 101 The Cell
- NSCI 201/BIOL 212/PSYC 212 Neuroscience
- NSCI 401 Topics in Neuroscience
- PSYC 101 Introductory Psychology

Students can ask the Neuroscience Program Chair whether courses not listed here might count as electives.

Elective Courses

Three elective courses are required. At least one elective must be from *Group A* and at least one elective must be from *Group B*. The third elective may come from either *Group A* or *Group B* or the student may wish to petition the advisory committee to substitute a related course.

Group A

- BIOL 204/ NSCI 204 Animal Behavior
- BIOL 209T/NSCI 209T Animal Communication
- BIOL 310/NSCI 310 Neural Development and Plasticity
- BIOL 311/NSCI 311 Neural Systems and Circuits
- BIOL 407/NSCI 347 Neurobiology of Emotion

Group B

- PSYC 312/NSCI 312 Brain, Behavior and the Immune System
- PSYC 315/NSCI 315 Hormones and Behavior
- PSYC 316/NSCI 316 Clinical Neuroscience
- PSYC 317T/NSCI 317T Nature via Nurture: Topics in Developmental Psychobiology
- PSYC 318/INTR 223/NSCI 318 Image, Imaging, and Imagining: The Brain and Visual Arts
- PSYC 319/NSCI 319 Neuroethics

THE DEGREE WITH HONORS IN NEUROSCIENCE

The degree with honors in Neuroscience provides students with the opportunity to undertake an original research project under the supervision of one or more of the Neuroscience faculty. In addition to completing the requirements of the Neuroscience Program, candidates for an honors degree must enroll in Neuroscience 493-W31-494 and write a thesis based on an original research project. Presentation of a thesis, however, should not be interpreted as a guarantee of a degree with honors. Students interested in pursuing a degree with honors should contact the Neuroscience Advisory Committee at the beginning of the spring semester of their junior year.

STUDY AWAY

You can find general study away guidelines for Neuroscience [here](#).

NSCI 201(F) Neuroscience

Crosslistings: NSCI 201/BIOL 212/PSYC 212

A study of the relationship between brain, mind, and behavior. Topics include a survey of the structure and function of the nervous system, basic neurophysiology, development, learning and memory, sensory and motor systems, consciousness and clinical disorders such as schizophrenia, autism, Parkinson's disease, and addiction. The laboratory focuses on current topics in neuroscience.

Class Format: lecture, three hours a week; laboratory, every other week

Requirements/Evaluation: evaluation will be based on a lab practical, lab reports, two hour exams and a final exam

Extra Info: not available for the fifth course option

Prerequisites: PSYC 101 or BIOL 101; open to first-year students with permission of instructor

Enrollment Preferences: sophomores and Biology and Psychology majors

Enrollment Limit: 72

Expected Class Size: 72

Dept. Notes: does not satisfy the distribution requirement in the Biology major

Distribution Notes: meets Division 3 requirement if registration is under PSYC

Distributional Requirements:

Division 3

Other Attributes:

COGS Interdepartmental Electives

NSCI Required Courses

PSYC 200-level Courses

Fall 2016

LEC Section: 01 TR 09:55 AM 11:10 AM Instructors: Heather Williams, Lauren Williamson

LAB Section: 02 M 01:00 PM 04:00 PM Instructor: Martha Marvin

LAB Section: 03 T 01:00 PM 04:00 PM Instructor: Martha Marvin

LAB Section: 04 W 01:00 PM 04:00 PM Instructor: Martha Marvin

NSCI 204(S) Animal Behavior

Crosslistings: BIOL 204/NSCI 204

Making sense of what we see while watching animals closely is both an enthralling pastime and a discipline that draws on many aspects of biology. Explanations can be found on many levels: evolutionary theory tells us why certain patterns have come to exist, molecular biology can help us understand how those patterns are implemented, neuroscience gives insights as to how the world appears to the behaving animal, endocrinology provides information on how suites of behaviors are regulated. The first part of the course focuses upon how descriptive studies provide the basis for formulating questions about behavior as well as the statistical methods used to evaluate the answers to these questions. We then consider the behavior of individuals, both as it is mediated by biological mechanisms and as it appears from an evolutionary perspective. The second half of the course is primarily concerned with the behaviors of groups of animals from a wide variety of vertebrate and invertebrate species, concentrating upon the stimuli, responses, and internal mechanisms that maintain social systems and on the selection pressures that drive animals toward a particular social system.

Class Format: lecture/laboratory, six hours per week

Requirements/Evaluation: evaluation will be based on examinations, lab reports, and a research paper

Extra Info: may not be taken on a pass/fail basis

Prerequisites: BIOL 102, or PSYC 101, or permission of instructor

Enrollment Preferences: Biology majors and Neuroscience concentrators

Enrollment Limit: 32

Expected Class Size: 32

Dept. Notes: satisfies the distribution requirement in the Biology major

Distributional Requirements:

Division 3

Other Attributes:

COGS Interdepartmental Electives

NSCI Group A Electives

Spring 2017

LEC Section: 01 MWF 08:30 AM 09:45 AM Instructor: Heather Williams

LAB Section: 02 M 01:00 PM 04:00 PM Instructor: Heather Williams

LAB Section: 03 T 01:00 PM 04:00 PM Instructor: Heather Williams

NSCI 310(F) Neural Development and Plasticity

Crosslistings: BIOL 310/NSCI 310

Development can be seen as a tradeoff between genetically-determined processes and environmental stimuli. The tension between these two inputs is particularly apparent in the developing nervous system, where many events must be predetermined, and where plasticity, or altered outcomes in response to environmental conditions, is also essential. Plasticity is reduced as development and

differentiation proceed, and the potential for regeneration after injury or disease in adults is limited; however some exceptions to this rule exist, and recent data suggest that the nervous system is not hard-wired as previously thought. In this course we will discuss the mechanisms governing nervous system development, from relatively simple nervous systems such as that of the fruitfly, to the more complicated nervous systems of humans, examining the roles played by genetically specified programs and non-genetic influences.

Class Format: lecture

Requirements/Evaluation: exams

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: BIOL 212 (same as PSYC 212 or NSCI 201) and BIOL 202 (or permission of instructor)

Enrollment Preferences: Biology majors; Neuroscience concentrators; Psych majors

Enrollment Limit: 24

Expected Class Size: 24

Dept. Notes: does not satisfy the distribution requirement in the Biology major

Distributional Requirements:

Division 3

Other Attributes:

BIMO Interdepartmental Electives

NSCI Group A Electives

Fall 2016

LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Tim Lebestky

LAB Section: 02 M 01:00 PM 04:00 PM Instructor: Tim Lebestky

LAB Section: 03 T 01:00 PM 04:00 PM Instructor: Tim Lebestky

NSCI 311 Neural Systems and Circuits

Crosslistings: BIOL 311/NSCI 311

This course will examine the functional organization of the vertebrate brain, emphasizing both neuroanatomy and neurophysiology. How do specific populations of neurons and their connections analyze sensory information, form perceptions of the external and internal environment, make cognitive decisions, and execute movements? How does the brain produce feelings of reward/motivation and aversion/pain? How does the brain regulate homeostatic functions such as sleep, food intake, and thirst? We will explore these questions using a holistic, integrative approach, considering molecular/cellular mechanisms, physiological characterizations of neurons, and connectivity among brain systems. Laboratory sessions will provide experience in examining macroscopic and microscopic neural structures, as well as performing experiments to elucidate the structure and function of neural systems using classical and cutting-edge techniques.

Class Format: lecture/lab, six hours per week

Requirements/Evaluation: class participation, laboratory notebooks and posters, hour exams and a final exam

Prerequisites: BIOL 212 (same as PSYC 212 or NSCI 201) or BIOL 205

Enrollment Preferences: Biology majors and Neuroscience concentrators

Enrollment Limit: 24

Expected Class Size: 24

Dept. Notes: does not satisfy the distribution requirement in Biology

Distributional Requirements:

Division 3

Other Attributes:

NSCI Group A Electives

Not Offered Academic Year 2017

LEC Instructor: Matt Carter

NSCI 312(S) Brain, Behavior, and the Immune System

Crosslistings: PSYC 312/NSCI 312

In all animals, the immune system is the body's defense against the outside world. Immune function is strongly influenced by environmental and behavioral experiences, and the immune system has a dynamic relationship with the brain. We will study the interactions among the brain, behavior, and the immune system in models of health and disease. Specific topics to be examined include: immune cells and their signaling molecules, immune cells within the brain, sickness behaviors, learning and memory, nervous system development, multiple sclerosis, Alzheimer's disease, and nervous system injury and repair. Students will critically review data from both human and animal studies. All students will design and conduct an empirical research project as part of a small research team.

Class Format: seminar/lab

Requirements/Evaluation: presentations and participation in discussions, short papers, midterm, written and oral presentation of the research project

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: PSYC 212 (same as BIOL 212 or NSCI 201) or permission of instructor

Enrollment Preferences: Psychology majors and Neuroscience concentrators

Enrollment Limit: 16

Expected Class Size: 16

Distribution Notes: meets Division 3 requirement if registration is under PSYC

Distributional Requirements:

Division 3

Other Attributes:

NSCI Group B Electives

PSYC Area 1 - Behavioral Neuroscience

PSYC Empirical Lab Course

Spring 2017

SEM Section: 01 TR 08:30 AM 09:45 AM Instructor: Lauren Williamson

LAB Section: 02 R 01:00 PM 04:00 PM Instructor: Lauren Williamson

NSCI 315 Hormones and Behavior**Crosslistings:** PSYC 315/NSCI 315

In all animals, hormones are essential for the coordination of basic functions such as development and reproduction. This course studies the dynamic relationship between hormones and behavior. We will review the mechanisms by which hormones act in the nervous system. We will also investigate the complex interactions between hormones and behavior. Specific topics to be examined include: sexual differentiation; reproductive and parental behaviors; stress; aggression; and learning and memory. Students will critically review data from both human and animal studies. All students will design and conduct an empirical research project as part of a small research team.

Class Format: empirical lab course**Requirements/Evaluation:** presentations and participation in discussions, short papers, midterm, written and oral presentation of the research project**Prerequisites:** PSYC 212 (same as BIOL 212 or NSCI 201)**Enrollment Preferences:** Psychology majors and Neuroscience concentrators**Enrollment Limit:** 16**Expected Class Size:** 16**Distribution Notes:** meets Division 3 requirement if registration is under PSYC**Distributional Requirements:**

Division 3

Other Attributes:

NSCI Group B Electives

PSYC Area 1 - Behavioral Neuroscience

PSYC Empirical Lab Course

Not Offered Academic Year 2017

LEC Instructor: Noah Sandstrom

NSCI 316(F) Clinical Neuroscience**Crosslistings:** PSYC 316/NSCI 316

Diagnosing and treating neurological diseases is the final frontier of medicine. Recent advances in neuroscience have had a profound impact on the understanding of diseases that affect cognition, behavior, and emotion. This course provides an in-depth analysis of the relationship between brain dysfunction and disease state. We will focus on neurodegenerative disorders including Alzheimer's disease, Parkinson's disease, and Huntington's disease. We will consider diagnosis of disease, treatment strategies, as well as social and ethical issues. The course provides students with the opportunity to present material based upon: (1) review of published literature, (2) analysis of case histories, and (3) observations of diagnosis and treatment of patients both live and on videotape. All students will design and conduct an empirical research project.

Class Format: empirical lab course**Requirements/Evaluation:** evaluation will be based on position papers, class participation, and research project report**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option**Prerequisites:** PSYC 212 (same as BIOL 212 or NSCI 201)**Enrollment Preferences:** Psychology majors and Neuroscience concentrators**Enrollment Limit:** 16**Expected Class Size:** 16**Distribution Notes:** meets Division 3 requirement if registration is under PSYC**Distributional Requirements:**

Division 3

Other Attributes:

NSCI Group B Electives

PSYC Area 1 - Behavioral Neuroscience

PSYC Empirical Lab Course

Fall 2016

LEC Section: 01 M 07:00 PM 09:40 PM Instructor: Paul Solomon

LAB Section: 02 M 01:00 PM 04:00 PM Instructor: Paul Solomon

NSCI 317T Nature via Nurture: Topics in Developmental Psychobiology

Crosslistings: PSYC 317/NSCI 317

Do your genes determine who you are? This course examines the relative contributions of nature (genetics) and nurture (the environment) that lead to individual differences in behavior. Modern neuroscience techniques have discovered new relationships between genes and behavior. Conversely, recent studies on the effects of social factors suggest critical environmental influences on the expression of these genetic determinants. This tutorial will explore the theoretical and empirical issues in animal models of behavioral epigenetics. Topics include child neglect, antisocial behavior, addiction, anxiety, risk-taking, empathy, and depression. Each tutorial pair will design and conduct an empirical laboratory project that will explore their own experimental question about the interaction of genes and environment in determining behavioral phenotypes.

Class Format: tutorial

Requirements/Evaluation: each week, students will either present an oral argument based on a 5-page position paper or respond to their partners' paper; Weekly lab meetings will be held and empirical projects presented in a final poster session

Extra Info: may not be taken on a pass/fail basis, not available for the fifth course option

Prerequisites: PSYC 212 (same as BIOL 212 or NSCI 201)

Enrollment Preferences: Neuroscience concentrators and Psychology majors

Enrollment Limit: 10

Expected Class Size: 10

Distribution Notes: meets Division 3 requirement if registration is under PSYC

Distributional Requirements:

Division 3

Other Attributes:

NSCI Group B Electives

PHLH Biomedical Determinants of Health

PHLH Reproductive, Maternal and Child Health

PSYC Area 1 - Behavioral Neuroscience

PSYC Empirical Lab Course

SCST Related Courses

Not Offered Academic Year 2017

TUT Instructor: Betty Zimmerberg

NSCI 318(S) Image, Imaging, and Imagining: The Brain and Visual Arts

Crosslistings: PSYC 318/INTR 223/NSCI 318

This course will study the intersections of neuroscience and art. The brain interprets the visual world and generates cognitive and emotional responses to what the eyes see. It is also responsible for creating mental images and then directing the artist's motor output. We will first examine the neural mechanisms of how we perceive what we see. We will investigate how visual artists have used or challenged perceptual cues in their work. Understanding how the brain perceives faces will be used to analyze portraiture. We will consider the influence of neurological and psychological disorders on artistic work. We will examine neuroimaging studies questioning whether the brains of visual artists are specialized differently from non-artists. Finally, we will explore how contemporary artists are using brain images in their artwork, and how "outsider" artists have portrayed brain syndromes and mental states. Students will conduct an empirical laboratory project that will explore their own experimental question in response to the course material. The class will include field trips to local museums.

Class Format: seminar and empirical lab course

Requirements/Evaluation: evaluation will be based on a midterm, participation in class discussions, and a poster presentation of the empirical project

Extra Info: satisfies one semester of Division III requirement

may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: PSYC 101, an ARTH or ARTS course, or permission of instructor

Enrollment Preferences: Studio Art majors; Psychology majors and Neuroscience concentrators

Enrollment Limit: 12

Expected Class Size: 12

Distribution Notes: meets Division 3 requirement if registration is under INTR or PSYC

Distributional Requirements:

Division 3

Other Attributes:

FMST Related Courses

NSCI Group B Electives

PSYC Area 1 - Behavioral Neuroscience

PSYC Empirical Lab Course

Spring 2017

SEM Section: 01 TF 01:10 PM 02:25 PM Instructor: Betty Zimmerberg

LAB Section: 02 TF 02:35 PM 03:50 PM Instructor: Betty Zimmerberg

NSCI 319T(S) Neuroethics (W)

Crosslistings: PSYC 319/NSCI 319

Neuroscience studies the brain and mind, and thereby some of the most profound aspects of human existence. In the last decade, advances in our understanding of brain function and in our ability to manipulate brain function have raised significant ethical challenges.

This tutorial will explore a variety of important neuroethical questions. Potential topics will include pharmacological manipulation of "abnormal" personality; the use of "cosmetic pharmacology" to enhance cognition; the use of brain imaging to detect deception or to understand the ability, personality or vulnerability of an individual; the relationship between brain activity and consciousness; manipulation of memories; the neuroscience of morality and decision making. In addition to exploring these and other ethical issues, we will explore the basic science underlying them.

Class Format: tutorial

Requirements/Evaluation: evaluation will be based on five 5-page position papers and five short response papers as well as participation in discussions

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: PSYC 212 (same as BIOL 212 or NSCI 201); or permission of instructor

Enrollment Preferences: Psychology majors and Neuroscience concentrators

Enrollment Limit: 10

Expected Class Size: 10

Distribution Notes: meets Division 2 requirement if registration is under PSYC; meets Division 3 requirement if registration is under NSCI

Distributional Requirements:

Division 2

Writing Intensive

Other Attributes:

NSCI Group B Electives

PSYC Area 1 - Behavioral Neuroscience

Spring 2017

TUT Section: T1 TBA Instructor: Noah Sandstrom

NSCI 347(S) Neurobiology of Emotion

Crosslistings: BIOL 407/NSCI 347

Emotion is influenced and governed by a number of neural circuits and substrates, and emotional states can be influenced by experience, memory, cognition, and many external stimuli. We will read and discuss articles about mammalian neuroanatomy associated with emotion as defined by classic lesion studies, pharmacology, electrophysiology, fMRI imaging, knockout mouse studies, as well as new opti-genetic methods for investigating neural circuit function in order to gain an understanding of the central circuits and neurotransmitter systems that are implicated in emotional processing and mood disorders.

Class Format: discussion, three hours per week

Requirements/Evaluation: evaluation will be based on class participation and several short papers

Prerequisites: BIOL 202 and 212; open to juniors and seniors

Enrollment Preferences: senior Biology majors who have not taken a 400-level Biology course; then to eligible NSCI concentrators

Enrollment Limit: 12

Expected Class Size: 12

Dept. Notes: does not satisfy the distribution requirement in the Biology major

Distributional Requirements:

Division 3

Other Attributes:

BIMO Interdepartmental Electives

NSCI Group A Electives

Spring 2017

SEM Section: 01 TR 09:55 AM 11:10 AM Instructor: Tim Lebestky

SEM Section: 02 TR 11:20 AM 12:35 PM Instructor: Tim Lebestky

NSCI 397(F) Independent Study: Neuroscience

Independent study.

Class Format: independent study

Distributional Requirements:

Division 3

Fall 2016

IND Section: 01 TBA Instructor: Heather Williams

NSCI 398(S) Independent Study: Neuroscience

Independent study.

Class Format: independent study

Distributional Requirements:

Division 3

Spring 2017

IND Section: 01 TBA Instructor: Heather Williams

NSCI 401(S) Topics in Neuroscience

Neuroscientists explore issues inherent in the study of brain and behavior. The overall objective of this seminar is to create a culminating senior experience in which previous course work in specific areas in the Neuroscience Program can be brought to bear in a synthetic, interdisciplinary approach to understanding complex problems. The specific goals for students in this seminar are to evaluate original research and critically examine the experimental evidence for theoretical issues in the discipline. Topics and instructional formats will vary somewhat from year to year, but in all cases the course will emphasize an integrative approach in which students will be asked to consider topics from a range of perspectives including molecular, cellular, systems, behavioral and clinical neuroscience. Previous topics have included autism, depression, stress, neurogenesis, novel neuromodulators, language, retrograde messengers, synaptic plasticity, and learning and memory.

Class Format: seminar and tutorial meetings

Requirements/Evaluation: evaluation will be based on presentations, short papers, and a term paper

Extra Info: may not be taken on a pass/fail basis

Prerequisites: open only to seniors in the Neuroscience program

Enrollment Limit: 18

Expected Class Size: 14

Dept. Notes: required of all senior students in the Neuroscience program

Distributional Requirements:

Division 3

Other Attributes:

NSCI Required Courses

Spring 2017

SEM Section: 01 M 07:00 PM 09:40 PM Instructor: Lauren Williamson

NSCI 493(F) Senior Thesis: Neuroscience

Neuroscience senior thesis. Independent research for two semesters and a winter study under the guidance of one or more neuroscience faculty. After reviewing the literature in a specialized field of neuroscience, students design and conduct an original research project, the results of which are reported in a thesis. Senior thesis work is supervised by the faculty participating in the program.

Class Format: independent study

Extra Info: this is part of a full-year thesis (493-494)

Distributional Requirements:

Division 3

Fall 2016

HON Section: 01 TBA Instructor: Heather Williams

NSCI 494(S) Senior Thesis: Neuroscience

Neuroscience senior thesis. Independent research for two semesters and a winter study under the guidance of one or more neuroscience faculty. After reviewing the literature in a specialized field of neuroscience, students design and conduct an original research project, the results of which are reported in a thesis. Senior thesis work is supervised by the faculty participating in the program.

Class Format: independent study

Extra Info: this is part of a full-year thesis (493-494)

Distributional Requirements:

Division 3

Spring 2017

HON Section: 01 TBA Instructor: Heather Williams