Advisory Committee: Professors: N. Sandstrom, H. Williams, B. Zimmerberg. Associate Professor: T. Lebestky. Assistant Professor: M. Carter. Visiting Assistant Professor: M. Clasen. Affiliated Faculty: Professor A. Hane. Lecturer: M. Marvin.

On leave Spring only: Associate Professor T. Lebestky.

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 310/NSCI 310 Neural Development and Plasticity
- BIOL 311/NSCI 311 Neural Systems and Circuits
- BIOL 407/NSCI 347 Neurobiology of Emotion
- BIOL 412/NSCI 342 Neural and Hormonal Basis of Hunger

**Group B**

- PSYC 314/NSCI 314 Drug Addiction and Obesity: Tales of a Disordered Brain
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 ABROAD

FAQ

- Students MUST contact departments/programs BEFORE assuming study away credit will be granted toward the major or concentration.

  - Can your department or program typically pre-approve courses for major/concentration credit?
    - Yes, in some cases, if appropriate course information is available in advance (e.g. syllabi and/or course descriptions), though students should be sure to contact the department. Securing syllabi is often difficult, so a discussion with the program Chair is certainly necessary.

  - What criteria will typically be used/required to determine whether a student may receive major/concentration credit for a course taken while on study away?
    - Course title and description, and complete syllabus, including readings/assignments. Exams or other written work will be considered. Written work may be requested if the course description suggests that it is only tangentially related to the field of neuroscience. Written work would, therefore, need to demonstrate that there was sufficient emphasis on neuroscience material.

  - Does your department/program place restrictions on the number of major/concentration credits that a student might earn through study away?
    - Yes. Generally there is a maximum of 2 credits that can be completed through a study abroad program.

  - Does your department/program place restrictions on the types of courses that can be awarded credit towards your major?
    - No.

  - Are there specific major requirements that cannot be fulfilled while on study away?
    - Yes. NSCI 201 and NSCI 401 can not generally be completed abroad. NSCI should be taken during the sophomore year if possible and includes a laboratory component that is rarely comparable in study abroad courses.

  - Are there specific major requirements in your department/program that students should be particularly aware of when weighing study away options? (Some examples might include a required course that is always taught in one semester, laboratory requirements.)
    - No.

  - Give examples in which students thought or assumed that courses taken away would count toward the major or concentration and then learned they wouldn’t:
    - Some students (rarely) have failed to discuss the course in advance of their study abroad experiences. They may also have assumed that approval of a course by another department (e.g., Biology or Psychology) would necessarily mean that they would receive Neuroscience credit for the course. This is not necessarily the case.

NSCI 201 (F) Neuroscience

Crosslistings: PSYC212 / BIOL212 / NSCI201

Primary Crosslisting
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 only with permission of instructor

**Enrollment Limit:** 72

**Enrollment Preferences:** sophomores and Biology and Psychology majors

**Expected Class Size:** 72

**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3)

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

**Attributes:** COGS Interdepartmental Electives; NSCI Required Courses; PSYC 200-level Courses

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Make 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:** not available for the fifth course option

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

**Enrollment Limit:** 32

**Enrollment Preferences:** Biology majors and Neuroscience concentrators

**Expected Class Size:** 32

**Department Notes:** satisfies the distribution requirement in the Biology major

**Distributions:** (D3)

**Attributes:** COGS Interdepartmental Electives; NSCI Group A Electives

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Spring 2019
NSCI 310 (F) Neural Development and Plasticity

Crosslistings: NSCI310 / BIOL310

Secondary Crosslisting

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 Limit: 24

Enrollment Preferences: Biology majors; Neuroscience concentrators; Psych majors

Expected Class Size: 24

Department Notes: does not satisfy the distribution requirement in the Biology major

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives; NSCI Group A Electives

Not offered current academic year

NSCI 311 (F) Neural Systems and Circuits

Crosslistings: NSCI311 / BIOL311

Secondary Crosslisting

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 Limit: 24

Enrollment Preferences: Biology majors and Neuroscience concentrators

Expected Class Size: 24

Department Notes: does not satisfy the distribution requirement in Biology

Distributions: (D3)

Attributes: NSCI Group A Electives
NSCI 314 (S) Drug Addiction and Obesity: Tales of a Disordered Brain
Crosslistings: NSCI314 / PSYC314
Secondary Crosslisting
Drug addiction and obesity are two of the biggest health problems facing our world today. Although obesity and drug addiction are two qualitatively different disorders, recent literature suggests that they share similar neural substrates. The first third of this class will discuss the behavioral and neural underpinnings of drug addiction, the second third of this class will discuss the behavioral and neural underpinnings of obesity, and the last third of the class will discuss their interaction in many different facets. In so doing, students will learn about the animal models used to study drug addiction and obesity (i.e., intravenous self-administration, intracranial self-stimulation, conditioned place preference, conditioned taste avoidance, and locomotor sensitization) and the neurobiological techniques used to understand their underlying mechanisms (i.e., DREADDs, optogenetics, and immunohistochemistry). Utilizing these tools, students will design and conduct an empirical laboratory experiment to study these dysregulated behaviors.
Class Format: seminar
Requirements/Evaluation: presentations and participation in discussions; written assignments; 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 Limit: 16
Enrollment Preferences: Psychology majors and Neuroscience concentrators
Expected Class Size: 16
Distributions: (D2)
Attributes: NSCI Group B Electives; PSYC Area 1 - Behavioral Neuroscience; PSYC Empirical Lab Course

Spring 2019
SEM Section: 01 TR 9:55 am - 11:10 am Matthew M. Clasen
LAB Section: 02 R 1:00 pm - 4:00 pm Matthew M. Clasen

NSCI 315 (F) Hormones and Behavior
Crosslistings: NSCI315 / PSYC315
Secondary Crosslisting
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 Limit: 16
Enrollment Preferences: Psychology majors and Neuroscience concentrators
Expected Class Size: 16
Distributions: (D3)
Distribution Notes:  meets Division 3 requirement if registration is under PSYC
Attributes:  NSCI Group B Electives;  PSYC Area 1 - Behavioral Neuroscience;  PSYC Empirical Lab Course

Fall 2018
LEC Section: 01  MWF 8:30 am - 9:45 am  Noah J. Sandstrom
LAB Section: 02  T 1:00 pm - 4:00 pm  Noah J. Sandstrom

NSCI 317 (S)  Nature via Nurture: Topics in Developmental Psychobiology
Crosslistings: PSYC317 / NSCI317
Secondary Crosslisting
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 Limit:  10
Enrollment Preferences:  Neuroscience concentrators and Psychology majors
Expected Class Size:  10
Distributions: (D3)
Distribution Notes:  meets Division 3 requirement if registration is under PSYC
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

Spring 2019
TUT Section: T1  TBA  Betty Zimmerman
LAB Section: T2  R 1:00 pm - 4:00 pm  Betty Zimmerman

NSCI 318 (S)  Image, Imaging, and Imagining: The Brain and Visual Arts
Crosslistings: NSCI318 / INTR223 / PSYC318
Secondary Crosslisting
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

Extra Info 2: 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 Limit: 12

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

Expected Class Size: 12

Distributions: (D3)

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

Attributes: FMST Related Courses; NSCI Group B Electives; PSYC Area 1 - Behavioral Neuroscience; PSYC Empirical Lab Course

Not offered current academic year

**NSCI 319 (S) Neuroethics**

Crosslistings: PSYC319 / NSCI319

Secondary Crosslisting

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 Limit: 10

Enrollment Preferences: Psychology majors and Neuroscience concentrators

Expected Class Size: 10

Distributions: (D2) (WI)

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

Attributes: NSCI Group B Electives; PSYC Area 1 - Behavioral Neuroscience;

Not offered current academic year

**NSCI 342 (S) Neural and Hormonal Basis of Hunger**

Crosslistings: NSCI342 / BIOL412

Secondary Crosslisting

Hunger and satiety are highly regulated behavioral states that maintain energy homeostasis in animals. This course will focus on readings from the primary literature to track numerous recent advances in how the brain and endocrine systems regulate appetite. Topics include how organ systems communicate with the brain to regulate appetite, how different populations of neurons in the brain interact to regulate appetite, how brain systems that regulate appetite affect other behaviors, and how the neural and hormonal basis of hunger compare with brain systems that regulate other homeostatic systems such as thirst. By tracing the advances in appetite regulation within the past decade, we will also trace the advent of cutting-edge molecular, genetic, and optical-based tools that are transforming multiple fields within physiology and neuroscience. Students in this class will have the opportunity to improve skills in written and oral scientific presentation.

Class Format: seminar
NSCI 347 (S)  Neurobiology of Emotion
Crosslistings: NSCI347 / BIOL407

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 Limit: 12
Enrollment Preferences: senior Biology majors who have not taken a 400-level Biology course; then to eligible NSCI concentrators
Expected Class Size: 12
Department Notes: does not satisfy the distribution requirement in the Biology major
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives; NSCI Group A Electives

Not offered current academic year

NSCI 397 (F)  Independent Study: Neuroscience
Independent study.
Class Format: independent study
Distributions: (D3)

Fall 2018
IND Section: 01  TBA  Noah J. Sandstrom

NSCI 398 (S)  Independent Study: Neuroscience
Independent study.
Class Format: independent study
Distributions: (D3)

Spring 2019
IND Section: 01  TBA  Noah J. Sandstrom
**NSCI 401 (F) 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

**Department Notes:** required of all senior students in the Neuroscience program

**Distributions:** (D3)

**Attributes:** NSCI Required Courses

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**Fall 2018**

**SEM Section:** 01  M 7:00 pm - 9:40 pm  Heather Williams

**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)

**Distributions:** (D3)

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**Fall 2018**

**HON Section:** 01  TBA  Noah J. Sandstrom

**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)

**Distributions:** (D3)

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**Spring 2019**

**HON Section:** 01  TBA  Noah J. Sandstrom