NEUROSCIENCE

Overview & Learning Goals

Learning Goals

Students will:

1. Understand and be able to use the scientific method to arrive at conclusions based upon appropriate evidence:
   a. Hypothesis development
   b. Experimental design
   c. Analytical reasoning and quantitative data analysis
2. Know and understand fundamental concepts (e.g., in biology, psychology, chemistry) that are the underpinnings for the study of the brain and behavior.
3. Become familiar with fields related to neuroscience, in particular those that neuroscience seeks to explain and those that provide tools or principles that help explain neural functioning.
4. Demonstrate a broad intellectual foundation in neuroscience, including molecular, cellular, cognitive, and behavioral perspectives; and understand how these perspectives are interrelated.
5. Become proficient in multiple techniques used in neuroscience research; be able to evaluate the strengths and weaknesses of each.
6. Apply the scientific method to questions relevant to neuroscience; design and conduct experiments to increase understanding of fundamental questions in neuroscience.
7. Learn to critically assess neuroscience literature.
8. Learn to communicate scientific concepts both orally and in writing.
9. Be exposed to the ethical implications of neuroscience research and the use of neuroscience in society.

Department/Program Website (https://www.bowdoin.edu/neuroscience/)

Faculty

Patsy S. Dickinson, *Program Director*
Mary Keenan, *Program Coordinator*

Professors: Manuel Diaz-Rios (Biology), Patsy S. Dickinson (Biology), Hadley Wilson Horch (Biology)
Assistant Professors: Jennifer Honeycutt (Psychology), Erika M. Nyhus (Psychology)
Visiting Faculty: Thomas W. Small (Psychology)
Lab Instructors: Anja Forche, Tina Rioux
Contributing Faculty: Amy S. Johnson‡, Mary Lou Zeeman

Faculty/Staff Website (https://www.bowdoin.edu/neuroscience/faculty-and-staff/)

Requirements

Neuroscience Major

The major consists of thirteen courses, including ten core courses and three electives from the lists to follow.

Note: The information provided below is a listing of required and elective courses for the major in neuroscience. These courses are offered by other departments and programs within the College. Normally up to two courses transferred from other institutions can be used toward the completion of the major. Please refer to bowdoin.edu/classfinder (https://classfinder.bowdoin.edu/classfinder/) and the Departments of Biology, Chemistry, Computer Science, Mathematics, Physics, and Psychology for further information, including course descriptions, instructors, and semesters when these courses are offered.

Core Courses

Code	Title	Credits
Introductory Level and General Courses		
BIOL 1102	Biological Principles II	1
or BIOL 1109	Scientific Reasoning in Biology	
Select one of the following:		1
CHEM 1092	Introductory Chemistry and Quantitative Reasoning II	
CHEM 1102	Introductory Chemistry II	
CHEM 1109	General Chemistry	
CHEM 2250	Organic Chemistry I	1
PSYC 1101	Introduction to Psychology	1
Select one of the following:		1
PSYC 2520	Data Analysis	
MATH 1300	Biostatistics	
MATH 1400	Statistics in the Sciences	
Introductory Neuroscience Course		
BIOL 2135	Neurobiology	1
or PSYC 2050	Physiological Psychology	
Mid-level Neuroscience Courses		
Select three of the following:		3
BIOL 2553	Neurophysiology	
BIOL 2566	Molecular Neurobiology	
BIOL 2510	Neuropharmacology	
PSYC 2750	Behavioral Neuroscience Laboratory: Affective Neuroscience	
PSYC 2775	Laboratory in Cognitive Neuroscience	
Advanced Neuroscience Courses		
Select one of the following:		1
BIOL 3311	Motor Systems Neurobiology	
BIOL 3325	Topics in Neuroscience	
BIOL 3329	Neuronal Regeneration	
BIOL 3388	Neurobiology of the Synapse	
PSYC 3050	Hormones and Behavior	
PSYC 3055	Cognitive Neuroscience of Memory	

Electives

Code	Title	Credits
Electives		
Select three electives from the courses listed above (but not already taken), or below:		3
BIOL 1101	Biological Principles I	
BIOL 2112	Genetics and Molecular Biology	
BIOL 2124	Biochemistry and Cell Biology	
BIOL 2175	Developmental Biology	
BIOL 2214	Comparative Animal and Human Physiology	
BIOL 2423	Biochemistry of Cellular Processes	
CHEM 2320	Biochemistry	
CSCI 1101	Introduction to Computer Science	

PHYS 1140	Introductory Physics II
PSYC 2010	Infant and Child Development
PSYC 2025	Abnormal Psychology
PSYC 2030	Social Psychology
PSYC 2040	Cognitive Psychology
PSYC 2060	Cognitive Neuroscience
PSYC 2510	Research Design in Psychology

Only one semester of independent study (2970–2999 or 4000–4049) or honors projects (4050 or higher) at any level can count toward the major.

Additional Information

Additional Information and Program Policies

- Only one semester of independent study or honors at any level can count toward the major. Independent study in neuroscience may be used to fulfill one of the three elective credits.
- Advanced placement credits may not be used to fulfill any of the course requirements for the major except Introductory Chemistry. In order to receive credit for advanced placement work, students must have their scores officially reported to the Office of the Registrar by the end of their sophomore year at Bowdoin.
- If students place out of PSYC 1101 Introduction to Psychology or BIOL 1109 Scientific Reasoning in Biology, thirteen courses related to neuroscience must still be completed.
- Courses that count toward the major must be taken for regular letter grades (not Credit/D/Fail).
- Students must earn a C- or better for a course to count toward the major.
- Only courses that are required for the neuroscience major and a second major may double-count.
- Neuroscience majors cannot also major in chemistry with a neurochemical concentration; they can, however, major in chemistry with a different concentration.

Courses

NEUR 1099 (a, INS) Brains in Motion: Exploring the Interface between Mind and Body
Manuel Diaz-Rios.
Every Fall. Fall 2020. Enrollment limit: 24.

This course is an introductory exploration of the nervous system as it relates to bodily functions. It explores neurons as the basic building blocks of brain and behavior. Through lectures and classroom experiments, students would learn how electrochemical nerve signals control body movement, cardiovascular function, reflexes, and brain activity. Further, students explore how the nervous system can interact with machine interfaces, including prosthetics. (Same as: BIOL 1099)

NEUR 2050 (a) Physiological Psychology
Every Other Year. Enrollment limit: 35.

An introductory survey of biological influences on behavior. The primary emphasis is on the physiological regulation of behavior in humans and other vertebrate animals, focusing on genetic, developmental, hormonal, and neuronal mechanisms. Additionally, the evolution of these regulatory systems is considered. Topics discussed include perception, cognition, sleep, eating, sexual and aggressive behaviors, and mental disorders. (Same as: PSYC 2050)

Prerequisites: PSYC 1101 or BIOL 1102 or BIOL 1109 or Placement in above PSYC 1101 or Placement in BIOL 2000 level.

Previous terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017.

NEUR 2060 (a) Cognitive Neuroscience
Erika Nyhus.
Every Other Year. Fall 2020. Enrollment limit: 35.

An introduction to the neuroscientific study of cognition. Topics surveyed in the course include the neural bases of perception, attention, memory, language, executive function, and decision making. In covering these topics, the course will draw on evidence from brain imaging (fMRI, EEG, MEG), transcranial magnetic stimulation, electrophysiology, and neuropsychology. Also considers how knowledge about the brain constrains our understanding of the mind. (Same as: PSYC 2060)

Prerequisites: PSYC 1101 or Placement in above PSYC 1101.

Previous terms offered: Fall 2018, Fall 2016.

NEUR 2099 (a) Brain, Behavior, and Evolution
Thomas Small.
Non-Standard Rotation. Fall 2020. Enrollment limit: 35.

A comparative and evolutionary approach to animal behavioral neuroscience. The primary focus is on the evolution of the brain and behavior in vertebrate systems, including humans, but invertebrates are also discussed. Topics include the evolution and diversity of sensory systems, reproductive behaviors, parental care, learning and memory, social behaviors, intelligence, and cognition. (Same as: PSYC 2099)

Prerequisites: PSYC 1101 or BIOL 1102 or BIOL 1109 or Placement in above PSYC 1101 or Placement in BIOL 2000 level.

NEUR 2135 (a, INS, MCSR) Neurobiology
Hadley Horch.
Every Fall. Fall 2020. Enrollment limit: 35.

Examines fundamental concepts in neurobiology from the molecular to the systems level. Topics include neuronal communication, gene regulation, morphology, neuronal development, axon guidance, mechanisms of neuronal plasticity, sensory systems, and the molecular basis of behavior and disease. Weekly lab sessions introduce a wide range of methods used to examine neurons and neuronal systems. (Same as: BIOL 2135)

Prerequisites: BIOL 1102 or BIOL 1109 or Placement in BIOL 2000 level.

Previous terms offered: Fall 2019, Fall 2018, Fall 2017, Fall 2016.

NEUR 2510 (a, INS) Neuropharmacology
Every Spring. Enrollment limit: 24.

This course will discuss drug-induced changes in the functioning of the nervous system. The specific focus will be to provide a description of the cellular and molecular actions of drugs (natural or artificial) on the communication between neurons (known as synaptic transmission) and on the production of behaviors such as walking, breathing, heart function, and learning/memory, among others. This course will also refer to specific diseases of the nervous system and their treatment, in addition to giving an overview of the techniques used for the study of neuropharmacology. (Same as: BIOL 2510)

Prerequisites: Two of: either BIOL 1102 or BIOL 1109 and either BIOL 2135 (same as NEUR 2135) or BIOL 2214 (same as NEUR 2214) or PSYC 2050 (same as NEUR 2050).

Previous terms offered: Spring 2020.

NEUR 2553 (a, INS) Neurophysiology
Patsy Dickinson.
Every Fall. Fall 2020. Enrollment limit: 20.

A comparative study of the function of the nervous system in invertebrate and vertebrate animals. Topics include the mechanism that underlie both action potentials and patterns of spontaneous activity in individual nerve cells, interactions between neurons, and the organization of neurons into larger functional units. Lectures and four hours of laboratory work per week. (Same as: BIOL 2553)

Prerequisites: Two of: either BIOL 1102 or BIOL 1109 and either BIOL 2135 or BIOL 2214 or PSYC 2050.

Previous terms offered: Fall 2019, Fall 2018, Fall 2017, Fall 2016.

NEUR 2566 (a, INS) Molecular Neurobiology
Every Spring. Enrollment limit: 24.

Examination of the molecular control of neuronal structure and function. Topics include the molecular basis of neuronal excitability, the factors involved in chemical and contact-mediated neuronal communication, and the complex molecular control of developing and regenerating nervous systems. Laboratory sessions are devoted to exploring the molecular basis of compensatory plasticity in the cricket auditory system. (Same as: BIOL 2566)

Prerequisites: Two of: either BIOL 1102 or BIOL 1109 or Placement in BIOL 2000 level and either BIOL 2112 or BIOL 2124 (same as BIOC 2124) or BIOL 2135 (same as NEUR 2135) or BIOL 2553 (same as NEUR 2553) or PSYC 2050 (same as NEUR 2050).

Previous terms offered: Spring 2020, Spring 2019, Spring 2017.

NEUR 2750 (a, INS) Behavioral Neuroscience Laboratory: Affective Neuroscience
Jennifer Honeycutt.
Every Year. Fall 2020. Enrollment limit: 20.

A laboratory course that exposes students to modern techniques in neuroscience that can be applied to the study of affective behavior, broadly. Underlying concepts associated with various behavioral, molecular, neuroanatomical, pharmacological, and translational methods will be discussed in a lecture format. Students will apply these concepts and techniques in discussions and laboratory preparations demonstrating how affective processes are organized within the central nervous system of vertebrates. This course will explore using experimental examples how the brain influences behavior, thereby illuminating our understanding of human neuropsychological functioning. (Same as: PSYC 2750)

Prerequisites: Three of: either PSYC 2050 (same as NEUR 2050) or BIOL 2135 (same as NEUR 2135) or PSYC 2060 (same as NEUR 2060) and PSYC 2510 or either BIOL 1102 or BIOL 1109 and PSYC 2520 or either MATH 1300 or MATH 1400.

Previous terms offered: Fall 2019, Fall 2018, Fall 2017, Fall 2016.

NEUR 2775 (a, INS, MCSR) Laboratory in Cognitive Neuroscience
Every Year. Enrollment limit: 20.

A laboratory course that exposes students to multiple techniques in cognitive neuroscience that can be applied to the study of human cognition. Introduces human neuroimaging methods including electroencephalography (EEG) and functional magnetic resonance imaging (fMRI). Students will then use these methods to study aspects of human cognition including perception, attention, memory, language, problem solving, reasoning, and decision making. (Same as: PSYC 2775)

Prerequisites: Three of: PSYC 2040 or either PSYC 2050 (same as NEUR 2050) or PSYC 2060 (same as NEUR 2060) or BIOL 2135 (same as NEUR 2135) and PSYC 2510 or either BIOL 1102 or BIOL 1109 or Placement in BIOL 2000 level and PSYC 2520 or either MATH 1300 or MATH 1400.

Previous terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017.

NEUR 3050 (a) Hormones and Behavior
Thomas Small.
Every Fall. Fall 2020. Enrollment limit: 16.

An advanced discussion of concepts in behavioral neuroendocrinology. Topics include descriptions of the major classes of hormones, their roles in the regulation of development and adult behavioral expression, and the cellular and molecular mechanisms responsible for their behavioral effects. Hormonal influences on reproductive, aggressive, and parental behaviors, as well as on cognitive processes are considered. (Same as: PSYC 3050)

Prerequisites: Three of: either PSYC 2050 (same as NEUR 2050) or BIOL 2135 (same as NEUR 2135) or PSYC 2060 (same as NEUR 2060) and PSYC 2510 or either BIOL 1102 or BIOL 1109 or Placement in BIOL 2000 level and PSYC 2520 or either MATH 1300 or MATH 1400.

Previous terms offered: Spring 2020, Spring 2019, Fall 2017, Fall 2016.

NEUR 3055 (a) Cognitive Neuroscience of Memory
Erika Nyhus.
Every Spring. Fall 2020. Enrollment limit: 16.

An advanced discussion of recent empirical and theoretical approaches to understanding the cognitive neuroscience of memory. Readings and discussions address empirical studies using neuroimaging methods. Topics include hippocampal and cortical contributions to memory encoding and retrieval and the effect of genetic variability, drugs, emotions, and sleep on memory. (Same as: PSYC 3055)

Prerequisites: Three of: either PSYC 2040 or PSYC 2050 (same as NEUR 2050) or PSYC 2060 (same as NEUR 2060) or BIOL 2135 (same as NEUR 2135) and Placement in BIOL 2000 level or PSYC 2510 or either BIOL 1102 or BIOL 1109 and PSYC 2520 or either MATH 1300 or MATH 1400.

Previous terms offered: Fall 2018.

NEUR 3056 (a) Computational Modelling in Cognitive Neuroscience
Non-Standard Rotation. Enrollment limit: 14.

A survey of cognitive neuroscience literature in which researchers have used computational models to formalize their theories. Topics include executive function, learning, attention, and decisionmaking. (Same as: PSYC 3056)

Prerequisites: Three of: either PSYC 2050 (same as NEUR 2050) or BIOL 2135 (same as NEUR 2135) or PSYC 2060 (same as NEUR 2060) and PSYC 2510 or either BIOL 1102 or BIOL 1109 or Placement in BIOL 2000 level and PSYC 2520 or MATH 1300.

Previous terms offered: Spring 2017.

NEUR 3057 (a) Seminar in Behavioral Neuroscience
Non-Standard Rotation. Enrollment limit: 14.

An advanced seminar covering brain mechanisms that affect behavior in humans and other animals. Topics may include the neural circuits that regulate normal social interactions, learning and memory processes, and/or higher cognitive functions, as well as the relationship between disrupted neural functions and mental disorders. The major emphasis of the course will be on reading and discussing primary research articles in the field of behavioral neuroscience. (Same as: PSYC 3057)

Prerequisites: Three of: either PSYC 2050 (same as NEUR 2050) or PSYC 2060 (same as NEUR 2060) or BIOL 2135 (same as NEUR 2135) and PSYC 2510 or either BIOL 1102 or BIOL 1109 and PSYC 2520 or either MATH 1300 or MATH 1400.

Previous terms offered: Fall 2019.

NEUR 3311 (a) Motor Systems Neurobiology
Manuel Diaz-Rios.
Non-Standard Rotation. Fall 2020. Enrollment limit: 16.

In this course you will learn about the main animal models used in the study of how the nervous system controls motor behavior as animals, including humans, interact with the environment. The course will cover the principal motor systems (including those for walking, flying, swimming, breathing, and others), focusing in particular on bridging the gap between molecular/cellular neuroscience and higher-level perception and behavior. Topics to be covered include neuroanatomy, neurophysiology and functions of the most studied animal behaviors, and the groups of interconnected neurons (termed neural circuits) that control them. Students will read, interpret, analyze, and discuss seminal (classical) and recent scientific papers from influential motor systems neurobiology laboratories. The course will also discuss the relevance of these neuronal motor systems to human diseases. (Same as: BIOL 3311)

Prerequisites: BIOL 2112 or BIOL 2124 (same as BIOC 2124) or BIOL 2135 (same as NEUR 2135) or BIOL 2175 or BIOL 2553 (same as NEUR 2553) or BIOL 2566 (same as NEUR 2566) or PSYC 2750 (same as NEUR 2750) or PSYC 2751.

Previous terms offered: Fall 2019.

NEUR 3325 (a, INS) Topics in Neuroscience
Non-Standard Rotation. Enrollment limit: 15.

An advanced seminar focusing on one or more aspects of neuroscience, such as neuronal regeneration and development, modulation of neuronal activity, or the neural basis of behavior. Students read and discuss original papers from the literature. (Same as: BIOL 3325)

Prerequisites: BIOL 2135 (same as NEUR 2135) or BIOL 2553 (same as NEUR 2553) or BIOL 2566 (same as NEUR 2566) or BIOL 2588 (same as NEUR 2588) or PSYC 2750 (same as NEUR 2750)- 2751 or PSYC 2775 (same as NEUR 2775).

Previous terms offered: Spring 2020, Spring 2019, Spring 2017.

NEUR 3329 (a, INS) Neuronal Regeneration
Every Fall. Enrollment limit: 15.

The consequences of neuronal damage in humans, especially in the brain and spinal cord, are frequently devastating and permanent. Invertebrates, on the other hand, are often capable of complete functional regeneration. Examines the varied responses to neuronal injury in a range of species. Topics include neuronal regeneration in planaria, insects, amphibians, and mammals. Students read and discuss original papers from the literature in an attempt to understand the basis of the radically different regenerative responses mounted by a variety of neuronal systems. (Same as: BIOL 3329)

Prerequisites: BIOL 2112 or BIOL 2124 or BIOL 2135 or BIOL 2175 or BIOL 2553 or BIOL 2566 or PSYC 2750 or PSYC 2751.

Previous terms offered: Fall 2017.

NEUR 3388 (a, INS) Neurobiology of the Synapse
Non-Standard Rotation. Enrollment limit: 14.

A seminar-style class exploring primary scientific literature focused on the synapse as the fundamental signaling unit of the brain. Focuses on the cell biology, physiology, plasticity, and signal integration of inter-neuronal communication. Topics will also include recent methodological advances in the study of synaptic function. Following short introductory lectures, students will present selected papers and lead discussions. (Same as: BIOL 3388)

Prerequisites: BIOL 2124 (same as BIOC 2124) or BIOL 2135 (same as NEUR 2135) or BIOL 2175 or BIOL 2214 (same as NEUR 2214) or BIOL 2553 (same as NEUR 2553) or PSYC 2750 (same as NEUR 2750).

Previous terms offered: Spring 2018.