NEUROSCIENCE (BI-CO)

Department Website: https://www.haverford.edu/neuroscience

The desire to understand human and animal behavior in terms of nervous system structure and function is longstanding. Historically, researchers and scholars have approached this task from a variety of disciplines, including medicine, biology, psychology, philosophy, and physiology. The field of neuroscience emerged as an interdisciplinary approach, combining techniques and perspectives from these disciplines, as well as emerging fields such as computation and cognitive science, to yield new insights into the workings of the nervous system and behavior.

The Major and Minor in Neuroscience advance two overlapping but distinct sets of learning goals, which are explained in turn below.

Learning Goals

Neuroscience Major

The major in Neuroscience allows students to pursue an in-depth study of the nervous system and behavior across disciplines. Students should consult with the Neuroscience Director or any member of the faculty advisory committee in order to declare the major.

The goals of the major include enabling students to gain:

• Training in cognate disciplines that are fundamental to the study of neuroscience
• An in-depth understanding of the organization of the nervous system and its relation to categories of behavior such as motor control, sensation and perception, motivational states, and higher cognition.
• Fluency with the many levels at which the nervous system can be studied, including molecular, cellular, systems, behavioral and cognitive neuroscience levels.
• An ability to closely examine and critically evaluate primary research on specialized, advanced neuroscience topics.
• An appreciation of the interdisciplinary nature of neuroscience and the allied disciplines that inform the study of mind, brain, and behavior.
• Experience with neuroscience laboratory skills and the design and analysis of neuroscience experiments.

Neuroscience Minor

The minor in Neuroscience allows students with any major to pursue interests in behavior and the nervous system across disciplines. Students should consult with the Neuroscience Director or any member of the faculty advisory committee in order to declare the minor.

The goals of the minor include enabling students to gain:

• a basic understanding of the organization of the nervous system and its relation to categories of behavior such as motor control, sensation and perception, motivational states, and higher cognition.
• An appreciation of and fluency with the many levels at which the nervous system can be studied, including molecular, cellular, systems, behavioral and cognitive neuroscience levels.
• An appreciation of the interdisciplinary nature of neuroscience and the allied disciplines that inform the study of mind, brain, and behavior.
• An ability to closely examine and critically evaluate primary research on specialized, advanced neuroscience topics.

Haverford’s Institutional Learning Goals are available on the President’s website, at http://hav.to/learninggoals.

Major Requirements

• Introduction to Neuroscience (1 credit)
  • NEUR H100
• Foundational Science Courses (4 credits)
  • 1 semester of General Chemistry (CHEM H111, CHEM H113, CHEM H115, CHEM B103)
  • 1 semester of Introductory Biology (BIOL H200, BIOL H201 with instructor approval, BIOL B110 or BIOL B111)
  • 1 semester of Introductory Psychology (PSYC H100 or PSYC B105)
  • 1 semester of Statistics (PSYC H200, PSYC B205; MATH H103 or MATH H203, MATH B104, or ECON H203)
• Upper-level Neuroscience Courses with Breadth Requirement (4 credits)
  • Students must take 4 credits of upper-level neuroscience courses
  • Upper-level Neuroscience courses are divided into three categories: Cellular/Molecular, Behavioral/Systems, and Cognitive. Students must take courses from at least two of the three categories to fulfill the breadth requirement.
  • A list of approved courses and their categories is linked from the Neuroscience website.
• Laboratory Coursework in Neuroscience (1 credit)
  • In order to gain hands-on experience with some of the tools, methods, and paradigms of Neuroscience, majors are required to take 1 credit of neuroscience laboratory coursework. This can be accomplished in several ways (e.g., 2 half-credit psych labs, 1 full-credit psych lab, 1 full-credit neuroscience SuperLab).
  • A list of approved laboratory courses is linked from the Neuroscience website.

• Thesis or Capstone in Neuroscience (1 credit)
  • To culminate their experience as a Neuroscience major, students are required to complete one course of thesis or capstone work. This may take the form of a 2-semester laboratory thesis project or a 1-semester capstone course.

Minor Requirements
• One approved “gateway” course:
  • HC NEUR H100 (Introduction to Neuroscience),
  • HC PSYC H217 (Behavioral Neuroscience) or BMC PSYC B218 (Behavioral Neuroscience)
  • BIOL B202 (Neurobiology).
• Five credits from the list of approved courses, with these constraints:
  • The five credits must sample from three different disciplines.
  • At least three of the five credits must come from List A: Primary Neuroscience courses
  • At least one of the credits must be at the 300-level or higher.
  • One of the five credits may come from supervised senior research in neuroscience.
  • No more than two of the six minor credits may come from institutions outside of the Bi-Co.

A current list of approved courses, divided into List A: Primary Neuroscience and List B: Allied Disciplines, is linked from the Neuroscience Minor website.

Faculty at Haverford
Laura Been
Assistant Professor of Psychology
Rebecca Compton
Professor of Psychology and Director of Neuroscience
Robert Fairman
Professor of Biology
Roshan Jain
Assistant Professor of Biology
Mary Ellen Kelly
Visiting Assistant Professor of Psychology
Patrese Robinson-Drummer
Assistant Professor of Neuroscience
Seol Hee Im
Visiting Assistant Professor of Biology

Faculty at Bryn Mawr
Dustin Albert
Assistant Professor of Psychology
Peter Brodfuehrer
Eleanor A. Bliss Emeritus Professor of Biology
Andrew Gargiulo
Bucher Jackson Post-Doctoral Fellow in Psychology
Laura Grafe
Assistant Professor of Psychology, Coordinator of Neuroscience
Karen Greif
Professor of Biology
Anjali Thapar
Professor and Chair of Psychology
Earl Thomas
Professor Emeritus of Psychology

NEUR H100 INTRODUCTION TO NEUROSCIENCE (1.0 Credit)
Patrese Robinson-Drummer
Division: Natural Science
Domain(s): C: Physical and Natural Processes
Neuroscience is an interdisciplinary field that seeks to understand the structure and functions of nervous system. Topics include evolution and development of the nervous system, neuroimaging and anatomy, neurophysiological basis of learning and memory, cognitive-behavioral development, and sensation and perception. Prerequisite(s): This course is not open to students who have previously taken HC Psych 217, HC Psych 260, or BMC Psych 218
(Offered: Fall 2021, Spring 2022; typically offered: Every other Year)

CHEM H111 CHEMICAL STRUCTURE AND BONDING (1.0 Credit)
Kelly Matz, Kristina Streu
Division: Natural Science; Quantitative
Domain(s): C: Physical and Natural Processes
Structure and bonding in molecules starting from nuclear and electronic structure of atoms. This course introduces the theories of chemical bonding that rationalize and predict the structures and bulk properties of molecules and materials. It also introduces modern instrumental and computational methods used to study chemical structure and bonding. Three lectures and one lab period per week required.
(Offered: Fall 2021; typically offered: Every Fall)

CHEM H113 INTENSIVE: CHEMICAL STRUCTURE AND BONDING (1.0 Credit)
Frances Rose Blase, Kelly Matz, Staff
Division: Natural Science; Quantitative
Domain(s): C: Physical and Natural Processes
Structure and bonding in molecules starting from nuclear and electronic structure of atoms. This course introduces the theories of chemical bonding that rationalize and predict the structures and bulk properties of molecules and materials. It also introduces modern instrumental and computational methods used to study chemical structure and bonding. This is a more intensive offering of CHEM 113 designed for students with little or no experience in chemistry. Prerequisite(s): Placement by the Chemistry Department.
(Offered: Fall 2021; typically offered: Every Fall)

CHEM H115 CHEMICAL STRUCTURE AND BONDING WITH INQUIRY LAB (1.0 Credit)
Kristina Streu, Robert Scarrow
Division: Natural Science
Domain(s): C: Physical and Natural Processes
Structure and bonding in molecules starting from nuclear and electronic structure of atoms. This course introduces the theories of chemical bonding that rationalize and predict the structures and bulk properties of molecules and materials. In the lab, students will become acquainted with modern methods of chemical structure analysis as they discover the identity of unknown compounds via self-proposed experiments. Three lectures, one lab period, and one laboratory planning meeting each week. Prerequisite(s): Placement by the Chemistry Department
(Typically offered: Every Fall)

BIOL H200 EVOLUTION, GENETICS & GENOMICS (1.0 Credit)
Danielle De Leo, Eric Miller, Foen Peng, Rachel Hoang, Seol Hee Im, Shirley Lang
Division: Natural Science
Domain(s): C: Physical and Natural Processes
Three hours of lecture and one laboratory period per week. A one-year course in cellular and molecular biology, Biology 200 considers the cell as a unit of biological activity. Biology 200A is an introduction to the major macromolecules of the cell, which includes a discussion of their synthesis and breakdown and leads into a discussion of cellular structures. The laboratory introduces the student to cell and molecular biology and biochemistry. Enrollment per lab section is limited to 28. Preference for a specific lab section will be given to students preregistering for that lab section; students who do not preregister will be assigned on a space available basis. When two sections of the lecture component are offered one lecture section will be limited to 50. Prerequisite(s): The prerequisite for Biology 200A is successful completion, with a grade of 2.0 or higher, of a one credit Natural Science course (which includes a laboratory experience) at Haverford, Bryn Mawr or Swarthmore, or instructor consent
(Offered: Fall 2021; typically offered: Every Fall)

BIOL H201 MOLECULES, CELLS, & ORGANISMS (1.0 Credit)
Amy Cooke, Robert Fairman, Seol Hee Im, Shirley Lang
Division: Natural Science
Domain(s): C: Physical and Natural Processes
Three hours of lecture and one laboratory period per week. A one-year course in cellular and molecular biology, Biology 200 considers the cell as a unit of biological activity. Biology 200B is an introduction to the major macromolecules of the cell, which includes a discussion of their synthesis and breakdown and leads into a discussion of cellular structures. The laboratory introduces the student to cell and molecular biology and biochemistry. Enrollment per lab section is limited to 28. Preference for a specific lab section will be given to students preregistering for that lab section; students who do not preregister will be assigned on a space available basis. When two sections of the lecture component are offered one lecture section will be limited to 50. Prerequisite(s): BIOL H200 with a grade of 2.0 or higher, or instructor consent
(Offered: Spring 2022; typically offered: Every Spring)

BIOL B202 NEUROBIOLOGY (1.0 Credit)
Cynthia Hsu
Division: Natural Science
Domain(s): C: Physical and Natural Processes
An introduction to the nervous system and its broad contributions to function. The class will explore fundamentals of neural anatomy and signaling, sensory and motor processing and control, nervous system development and examples of complex brain functions. Lecture three hours a week. Prerequisite: One semester of BIOL 110-111 or permission of instructor.
(Offered: Fall 2021; typically offered: Every Fall)

MATH H103 INTRODUCTION TO PROBABILITY AND STATISTICS (1.0 Credit)
Division: Natural Science; Quantitative
Domain(s): C: Physical and Natural Processes
Basic concepts and methods of elementary probability and quantitative reasoning, with practical applications. Topics include: sample average and
standard deviation, normal curves, regression, expected value and standard error, confidence intervals and hypothesis tests. Crosslisted: Mathematics, Statistics Prerequisite(s): Not open to students who have (a) placed into 121 or higher, (b) taken 118 or higher, (c) taken any other introductory statistics class at Haverford or Bryn Mawr, (d) received a score of 4 or 5 on the AP Statistics exam (Typically offered: Every Year)

MATH H203 STATISTICAL METHODS AND THEIR APPLICATIONS (1.0 Credit)
Weiwen Miao
Division: Natural Science; Quantitative
Domain(s): C: Physical and Natural Processes
An introduction to statistical methods used to analyze data in the natural and social sciences. It covers descriptive statistics, the binomial and normal distributions, expected value and variance, confidence intervals and hypothesis testing, comparison of two samples, regression, and analysis of variance. A required computer lab, using R, is taught alongside this course. Crosslisted: Mathematics, Statistics Prerequisite(s): MATH 118 or higher, placement into MATH 121 or higher, or instructor consent. Students who have taken another introductory statistics course at Haverford or Bryn Mawr may only enroll in STAT 203 with instructor consent (Offered: Fall 2021; typically offered: Every Semester)

ECON H203 STATISTICAL METHODS IN ECONOMICS (1.0 Credit)
Richard Ball
Division: Quantitative; Social Science
Domain(s): B: Analysis of the Social World
Foundations of statistical inference and data analysis. Three class hours and two lab hours. Prerequisite(s): ECON 104, 105, or 106; Completion of Math 105 or Math 118 at Haverford College (or a comparable course in calculus at another college), or placement into Math 121 or higher. (Offered: Fall 2021; typically offered: Every Year)

PSYC H100 FOUNDATIONS OF PSYCHOLOGY (1.0 Credit)
Jennifer Lilgendahl, Marilyn Boltz, Mary Ellen Kelly, Shu-wen Wang
Division: Social Science
Domain(s): B: Analysis of the Social World
An introduction to the study of mind and behavior. Topics include biological, cognitive, personality, abnormal, and social psychology, as well as a general consideration of the empirical approach to the study of behavior. This course is a prerequisite for most other 200 and 300 level psychology courses. However, in most cases, this prerequisite may be met with an AP Psychology score of 4 or 5 or IB Psychology credit. Prerequisite(s): Not available to students with AP Psychology (score of 4 or 5) or IB Psychology credit, as noted on transcript. Enrollment Limit: 35 Lottery Preference(s): 25 spaces reserved for incoming freshmen. Then priority as follows: freshmen, sophomores, juniors, seniors, An introduction to the study of mind and behavior. Topics include biological, cognitive, personality, abnormal, and social psychology, as well as a general consideration of the empirical approach to the study of behavior. This course is a prerequisite for most other 200 and 300 level psychology courses. However, in most cases, this prerequisite may be met with an AP Psychology score of 4 or 5 or IB Psychology credit. Prerequisite(s): Not available to students with AP Psychology (score of 4 or 5) or IB Psychology credit, as noted on transcript. (Offered: Fall 2021, Spring 2022; typically offered: Every Semester)

PSYC H200 RESEARCH METHODS AND STATISTICS (1.0 Credit)
Benjamin Le, Laura Been, Mary Ellen Kelly
Division: Quantitative; Social Science
Domain(s): B: Analysis of the Social World; B: Analysis of the Social World; C: Physical and Natural Processes
A general overview of the research methods used in psychological science along with training in the statistical methods used in the field. Activities focus on designing research studies, collecting data, data analysis, and presenting results through written assignments. Prerequisite(s): PSYC 100 or PSYC B105 or Psychology AP Score of 4 or instructor consent Enrollment Limit: 20 Lottery preference(s): (1) Psychology majors, (2) sophomores, (3) seniors [non-psychology majors], (4) juniors [non-psychology majors], (5) first-year students, A general overview of the experimental method and its use in the psychological study of behavior, coupled with in-depth treatment of statistics as applied to psychology research. Lab exercises focus on designing experiments, collecting data, applying statistical methods (using a data analysis software package), and presenting data through written assignments. 90 minutes of lab per week required in addition to lecture. Prerequisite(s): PSYC 100 or PSYC B105 or Psychology AP Score of 4 or instructor consent. (Offered: Fall 2021, Spring 2022; typically offered: Every Year)

PSYC B205 RESEARCH METHODS AND STATISTICS (1.0 Credit)
Anjali Thapar
Division: Quantitative; Social Science
Domain(s): B: Analysis of the Social World
An introduction to research design, general research methodology, and the analysis and interpretation of data. Emphasis will be placed on issues involved with conducting psychological research. Topics include descriptive and inferential statistics, research design and validity, analysis of variance, and correlation and regression. Each statistical method will also be executed using computers. Lecture three hours, laboratory 90 minutes a week.

(Offered: Fall 2021, Spring 2022; typically offered: Every Spring)

**PSYC H217 BEHAVIORAL NEUROSCIENCE (1.0 Credit)**

*Laura Been*

**Division:** Natural Science

**Domain(s):** B: Analysis of the Social World; C: Physical and Natural Processes

Interrelations between brain, behavior, and subjective experience. The course introduces students to physiological psychology through consideration of current knowledge about the mechanisms of mind and behavior. Crosslisted: Psychology, Biology Prerequisite(s): Any one of the following or instructor consent: PSYC 100, PSYC B105, BIOL H123, BIOL H124, BIOL H128, BIOL H129, Psychology AP Score 4 Enrollment Limit: 35 Lottery Preference(s): Priority to senior psychology or neuroscience majors, followed by junior psychology or neuroscience majors, followed by psychology or neuroscience minors.

Interrelations between brain, behavior, and subjective experience. The course introduces students to physiological psychology through consideration of current knowledge about the mechanisms of mind and behavior. Crosslisted: Psychology, Biology Prerequisite(s): Any one of the following or instructor consent: PSYC 100, PSYC B105, BIOL H123, BIOL H124, BIOL H128, BIOL H129, Psychology AP Score 4

(Offered: Fall 2021; typically offered: Every Semester)