

# NEUROSCIENCE (CONCENTRATION)

## Program Guidelines & Mission

**Neuroscience** is the study of the nervous system, seeking to understand not only the biology of the brain and nervous system, but also how chemical and cellular functions relate to the cognitive processes and behavior of organisms. Thus, neuroscience is founded on the tenet that an understanding of the brain and nervous system is only possible when approached from an interdisciplinary perspective.

The **Neuroscience Concentration** at Denison is designed to offer students an interdisciplinary perspective on the nervous system and behavior via courses in Biology, Computer Science or Data Analytics, Philosophy, and Psychology. This design is rooted in the liberal arts, providing a study with breadth and depth of study as students build connections across courses. The courses are intended to complement, and potentially overlap with, the student's major and general education requirements. Through these courses, many of which have labs, students will cultivate their understanding of the scientific method, as well as various research designs and the corresponding data-analysis techniques. They will also be introduced to different ways of thinking about and conceptualizing problems through courses in philosophy and either computer science or data analytics. As they continue through advanced course work in biology and psychology, students will develop depth in the concentration by learning more detailed and advanced topics. They will also refine their "hands on" laboratory skills, including experimental design, data collection, analysis and scientific writing. Additionally, the students participate in a neuroscience seminar in which they dive into recent neuroscience literature, applying knowledge from other courses to current questions in the field, and practicing their skills in verbal and written communication.

## Faculty

Heather Rhodes (Biology), Neuroscience Program Director

Faculty: Seth Chin-Parker (Psychology), Barbara Fultner (Philosophy), Franne Kamhi (Psychology), Susan Kennedy (Psychology), Matthew Kretchmar (Computer Science), Nestor Matthews (Psychology / Data Analytics), Heather Rhodes (Biology)

View faculty profiles and contact information (<https://denison.edu/academics/neuroscience/contacts/>)

## Neuroscience Concentration

Neuroscience Concentration requires students to complete the ten 4-credit courses listed below, and the zero-credit NEUR 401 - Neuroscience Assessment.

### Four Foundational Courses in Biology and Psychology

Students may begin these courses as early as the first semester at Denison. It is recommended that they be completed in the first 2 years, as they are prerequisites for other courses in the concentration. Note that the two biology courses must be taken in order; both courses are offered all semesters. Likewise, the two psychology courses must be taken in order; both courses are offered all semesters.

Code	Title
BIOL 210	Molecular Biology and Unicellular Life
BIOL 220	Multicellular Life
PSYC 100	Introduction to Psychology
PSYC 200	Research Methods and Statistics

### One Upper-Level Neuroscience Seminar

Note this course is offered once a year and can be taken anytime after prerequisites are completed. In this course students will delve into current research topics from across the field of neuroscience by reading and discussing recent scientific literature.

NEUR 312 - Current Topics in Neuroscience (Bio 210, 220, Psych 100, 100 are prerequisites)

### One Computational Course

Because computational modeling, computational research methods, and analyses of large datasets are fundamental aspects of modern neuroscience, students must take either an introductory Computer Science or Data Analytics course as part of the concentration. **We recommend CS 111 - Discovering Computer Science: Scientific Data and Dynamics or DA 101 - Introduction to Data Analytics**, but other introductory CS courses will also fulfill the requirement. These courses are offered frequently; this requirement can be fulfilled at any time.

Code	Title
CS 111	Discovering Computer Science: Scientific Data and Dynamics
or DA 101	Introduction to Data Analytics
or CS 109	Discovering Computer Science
or CS 112	Discovering Computer Science: Markets, Polls, and Social Networks

### One Philosophy Course Related to Neuroscience

Neuroscience is an interdisciplinary field that seeks to interrogate how humans (and other animals) perceive, think, and behave. The ideas neuroscientists wrestle with therefore overlap with the work of philosophers, and philosophy can inform the work of neuroscientists. Students will take one philosophy course as part of the concentration. This requirement can be fulfilled at any time. These courses are offered periodically and it is recommended that students check offerings with the philosophy department. Note that PHIL 210 - Philosophy of Science has no prerequisites when taken by a junior or senior science major; similarly, PHIL 280 - Philosophy of Mind has no prerequisites for neuroscience concentrators, and PHIL 285 - Biomedical Ethics has no prerequisites.

Code	Title
PHIL 210	Philosophy of Science
or PHIL 280	Philosophy of Mind
or PHIL 285	Biomedical Ethics

### Three Advanced Courses in Biology and Psychology

These courses may be taken in any order, except that PSYC 350 - Biological Psychology and PSYC 351 - Research in Biological Psychology must be taken concurrently. BIOL 349 - Neurophysiology is recommended over BIOL 334 - Comparative Physiology: Human and non-human animals, but BIOL 349 - Neurophysiology is typically offered every other year, so BIOL 334 - Comparative Physiology: Human and non-human animals is an alternative if needed for scheduling. PSYC 350 - Biological

Psychology/PSYC 351 - Research in Biological Psychology is typically offered every year. Note that all of these courses have prerequisites, but they are fulfilled by the foundational courses in the concentration.

Code	Title
BIOL 349 or BIOL 334	Neurophysiology Comparative Physiology: Human and non-human animals
PSYC 350	Biological Psychology
PSYC 351	Research in Biological Psychology

(In place of PSYC 351, students may take one of the following course pairings: PSYC 310 & PSYC 311, PSYC 330 & PSYC 331, PSYC 340 & PSYC 341. Note that PSYC 350 is still required, and thus this substitution increases the total number of courses for the concentration by one.)

## Neuroscience Assessment

Satisfactory completion of NEUR 401 - Neuroscience Assessment is required of all senior Neuroscience concentrators during the semester prior to graduation. NEUR 401 - Neuroscience Assessment is a zero credit course graded S/U.

## Courses

### NEUR 299 - Introductory Topics in Neuroscience (1-4 Credit Hours)

A general category used only the evaluation of transfer credit.

### NEUR 312 - Current Topics in Neuroscience (4 Credit Hours)

In this seminar-style course, students will learn about and explore current areas of research in the field of neuroscience. Topical areas may vary but typically include perspectives from cellular & molecular neuroscience, neural systems & circuits, neural development / plasticity / repair, behavioral & cognitive neuroscience, and the neurobiology of disease. Students will read a variety of sources, from popular press to scientific journal articles, and develop oral and writing skills for communicating neuroscience research to different audiences.

**Prerequisite(s):** BIOL 210, BIOL 220, PSYC 100, PSYC 200.

### NEUR 361 - Directed Study (1-4 Credit Hours)

### NEUR 362 - Directed Study (1-4 Credit Hours)

### NEUR 363 - Independent Study (1-4 Credit Hours)

### NEUR 364 - Independent Study (1-4 Credit Hours)

### NEUR 401 - Neuroscience Assessment (0 Credit Hours)

Satisfactory completion of NEUR 401 is required of all senior neuroscience concentrators. NEUR 401 is a zero credit course.

### NEUR 451 - Senior Research (4 Credit Hours)

Research in selected topics in Neuroscience.

### NEUR 452 - Senior Research (4 Credit Hours)

Research in selected topics in Neuroscience.

### NEUR 499 - Advanced Topics in Neuroscience (1-4 Credit Hours)

A general category used only in the evaluation of transfer credit.

### BIOL 210 - Molecular Biology and Unicellular Life (4 Credit Hours)

This course, the first of the three-course biology majors core sequence, is designed to introduce students to principles of molecular and cellular biology, with an examination of both prokaryotic and eukaryotic unicellular species. Major themes that will be covered include molecular origins of life, bioenergetics, the molecular basis of genetic expression, and cellular reproduction. Coursework will be designed to train students in the scientific method; finding, reading, and understanding scientific literature; analyzing data; and communicating scientific research in written and oral formats. A weekly laboratory period will allow students to learn cellular and molecular biology techniques and carry out independent group research projects. Three class periods and one lab session per week. Offered Fall and Spring semesters. This course satisfies the Quantitative Reasoning GE requirement.

**Corequisite(s):** CHEM 131 is recommended (but is not required).

### BIOL 349 - Neurophysiology (4 Credit Hours)

We will use neurophysiology and neuroanatomy to understand the links between molecules, cells, systems, and ultimately behavior. The course will start with an exploration of neurons and signaling within and among cells. We will then examine some sensory and motor systems. The last portion of the course will examine the whole animal in a neurophysiological context. The classroom portion of the course consists of lectures, discussion of the text and of research articles, problem sets, analysis of case studies, and other activities. The laboratory component will involve a mixture of behavioral, anatomical, and physiological studies on vertebrate and invertebrate animals, electronic modeling of nerve circuits, and computer simulations of nerve activity. The labs are designed to introduce students to some fundamental neurophysiological techniques and to a variety of study organisms, and to strengthen experimental design and analysis skills.

**Prerequisite(s):** Biology Core, and CHEM 131 or consent, or CHEM majors - BIOL 210, BIOL 220, and CHEM 300 (or concurrently), or NEURO concentrators- BIOL 210, BIOL 220, and CHEM 131 and PSYC 200.

### CS 111 - Discovering Computer Science: Scientific Data and Dynamics (4 Credit Hours)

This course is an introduction to computational problem solving. Students will develop their abilities to abstract (or model) otherwise complex problems and generate elegant and efficient solutions. Students will practice these skills by developing computer programs that solve problems motivated by research in the sciences. Additional topics may include Monte Carlo methods, data analysis, population dynamics, computational biology, genetic algorithms, cellular automata, networks, data mining, and fractals. Students may earn credit for at most one of CS 109, CS 110, CS 111, and CS 112. Absolutely no prior experience is necessary.

**PSYC 100 - Introduction to Psychology (4 Credit Hours)**

A laboratory course that provides an introduction to the scientific study of behavior and mental processes. Topics include the biological bases of psychological processes and behavior, sensation, perception, learning, cognition, development, social processes, personality, abnormal psychology, and possibly others. The course emphasizes current knowledge and research in the field and its application. The laboratory component of this course examines the strengths and limitations of correlational, experimental, and observational research methods, and enhances understanding of course concepts and principles. Laboratory experiences include development of research questions, design of studies, data collection in classroom laboratories and field settings, data analysis and interpretation. Laboratory assignments involve written reports and demonstration of critical thinking skills about psychological concepts and scientific research. This course has a research participation (or equivalent activity) requirement. PSYC 100 is a prerequisite for all other courses in the department.

**PSYC 200 - Research Methods and Statistics (4 Credit Hours)**

This course examines the primary research methods and data analysis procedures used by psychologists to describe, predict, interpret and/or explain psychological phenomena and behavior. Observational, experimental, and quasi-experimental methods are studied along with principles of research design, control, validity, reliability, and ethical practice. Throughout the course, methodological procedures are considered in conjunction with principles and methods of data analysis, presentation, and interpretation. The logic and procedures of descriptive and inferential statistics are emphasized. This course prepares students to design, conduct, analyze and evaluate psychological research and is a prerequisite for all psychology research courses at the 200 and 300-level. To promote research ethics, all PSYC 200 students must successfully complete the Citi Program's Research Ethics & Compliance training.

**Prerequisite(s):** PSYC 100 or PSYC 199.

**PSYC 310 - Psychology of Learning (4 Credit Hours)**

An intensive survey of experimental research on fundamental emotional cognitive processes of learning and memory, with a focus on how those processes manifest themselves in, influence, and determine behavior. The learning processes of instrumental and Pavlovian conditioning, and the interactions of those learning processes, comprise the main focus of the course. Theory, research, implications and applications pertaining to the basic principles of behavior are emphasized. The course, and learning/conditioning research traditionally, is valuable because of the use of models to understand learning about biologically and emotionally significant experiences. Unconscious learning and seemingly irrational reactions are considered in depth. Much of the course content is relevant to applied topics such as behavior modification, substance abuse problems, anxiety, depression, other behavior disorders, education and parenting practices. This course does not cover techniques for improving academic learning skills for students.

**Prerequisite(s):** PSYC 100 or PSYC 199.

**PSYC 311 - Research in Psychology of Learning (4 Credit Hours)**

Offers the student experience conducting research in and/or out of the learning laboratory, using a variety of methods. Research requires time outside of class. Some work with live animals is usually involved. Effective Fall 2022 all 300-level Psychology Research courses will no longer offer a GE "W".

**Prerequisite(s):** PSYC 100 or PSYC 199, PSYC 200, and one 200-level research course combination.

**Corequisite(s):** PSYC 310.

**PSYC 330 - Cognitive Psychology (4 Credit Hours)**

This course examines how people acquire, remember, and use knowledge. Topics covered include memory, attention, perception, imagery, and cognitive neuroscience. Applications to contexts such as learning and teaching, social behaviors, and individual behavior and performance will be considered.

**Prerequisite(s):** PSYC 100 or PSYC 199.

**PSYC 331 - Research in Cognitive Psychology (4 Credit Hours)**

Provides the student with research experience on problems of current interest in cognitive psychology. Effective Fall 2022 all 300-level Psychology Research courses will no longer offer a GE "W".

**Prerequisite(s):** PSYC 100 or PSYC 199, PSYC 200, and one 200-level research course combination.

**Corequisite(s):** PSYC 330.

**PSYC 340 - Sensation and Perception (4 Credit Hours)**

This course explores sensory and perceptual systems. Discussions on these topics will reflect biological, ecological and evolutionary perspectives. Topics include sensitivity to light and sound; color perception; depth and form perception; perceptual illusions; music perception, and speech perception. Power and justice issues associated with sensory disabilities (e.g., blindness and deafness) will be emphasized. This course fulfills the Power and Justice (P) GE requirement.

**Prerequisite(s):** PSYC 100 or PSYC 199.

**PSYC 341 - Research in Sensation and Perception (4 Credit Hours)**

This course offers experience in conducting research on sensory processes and perception. Students are exposed to different research techniques and investigate problems relating to the various sensory modalities. Effective Fall 2022 all 300-level Psychology Research courses will no longer offer a GE "W".

**Prerequisite(s):** PSYC 100 or PSYC 199, PSYC 200, and one 200-level research course combination.

**Corequisite(s):** PSYC 340.

**PSYC 350 - Biological Psychology (4 Credit Hours)**

This course explores the relationships between the brain and nervous system and behavior, and includes topics ranging from neuroanatomy and pharmacology of the nervous system to the biological bases of mental illness. The interactions among the nervous and endocrine systems are emphasized in an attempt to understand how basic physiological principles can serve in the understanding of complex phenomena, including emotion, learning, sleep and arousal and sexual behavior. Required for students pursuing the neuroscience concentration.

**Prerequisite(s):** PSYC 100 or PSYC 199.

**PSYC 351 - Research in Biological Psychology (4 Credit Hours)**

This course focuses on basic research methodologies and techniques that are commonly used to examine the biological bases of behavior. Students are given "hands on" experience in the design and execution of several research projects. Effective Fall 2022 all 300-level Psychology Research courses will no longer offer a GE "W".

**Prerequisite(s):** PSYC 100 or PSYC 199, PSYC 200, and one 200-level research course combination.

**Corequisite(s):** PSYC 350.