NEUROSCIENCE

Department Overview

Neuroscience is the scientific community's effort to understand the mechanisms that give rise to thoughts, motives, and behavior. The central mechanism of behavior is the brain, and exploring it is a fascinating odyssey in natural science. Neuroscientists investigate the connections between events that occur at the subcellular level and the behavior of the whole organism. Addressing the fundamental questions of neuroscience requires the collaboration of specialists in diverse fields. Thus, although neuroscientists specialize in one particular discipline, they need to be cognizant of many related areas. The neuroscience major is cross-disciplinary and taught primarily by professors in the biology and psychology departments; however, students desiring to do advanced work may choose to work with faculty from a wide variety of departments.

As neuroscience majors, students will engage in broadly based study of the nervous system. This study will be multidisciplinary, integrating the perspectives of biology, psychology, and related sciences. Students will develop a foundation in concepts, issues, discoveries, and methodological approaches to the interdisciplinary endeavor of neuroscience. Students will discover how approaches from various neuroscience subdisciplines complement one another and how the findings can be integrated to provide a more global understanding of the functioning of the nervous system. Students will gather, analyze, and interpret scientific data and summarize and communicate empirical results; this process will enhance their familiarity and facility with scientific methodology. Students will develop their verbal, quantitative, and writing skills. Students may focus in a subfield of neuroscience and may conduct research with faculty members. Students will gain experience in integrating and synthesizing data, develop a broad background in the sciences and humanities, and acquire skills adaptable to a wide variety of areas and interests. The major will prepare students for career paths that include graduate school, the health professions, research, and clinical work.

Nu Rho Psi

Nu Rho Psi is the national honor society in neuroscience, founded in 2006 for the purpose of encouraging professional interest and excellence in scholarship in neuroscience. Eligibility requirements include declaration of a major in neuroscience, completion of at least three semesters of courses towards the neuroscience major, a grade-point average of 3.5 or higher in courses required for the neuroscience major, and a grade-point average of 3.4 in all college courses.

Director of the Neuroscience Program: Christopher Vecsey

Associate Director of the Neuroscience Program: Hassan Lopez

Associate Professor: Sarita Lagalwar, Christopher Vecsey

Visiting Assistant Professor: Tatiana Schnieder

Administrative Assistant: Carolyn Lundy

Affiliated Faculty

Biology: Jennifer Bonner, Jason Breves, David Domozych, Corey Freeman-Gallant, Bernard Possidente, Monica Raveret-Richter

Computer Science: Tom O'Connell

Mathematics: Lucy Oremland

Psychology: Denise Evert*; Susan Kettering Williamson '59 Chair in Neuroscience*, Rebecca Johnson, Hassan Lopez, Dominique Vuvan

Neuroscience B.A.

To fulfill the major, students must complete the following:

Code	Title	Hours
Core Courses		
NS 101	Introduction to Neuroscience	4
NS 201	Cellular and Molecular Neuroscience	4
or NS 202	Neurophysiology	
BI 107	Molecular and Cellular Foundations of Life	4
BI 108	Organismal Biology	4
CH 125	Principles of Chemistry	4
PS 202	Statistics and Research Methods I	4
Advanced Research Methods Requirement		
Select one class of the following: [1]		4-5
BI 346	Cannabis sativa	
PS 303	Research Methods 2: Intermediate Statistics	
PS 304	Research Methods 2: Physiological Psychology	
PS 312	Adv Sem Major Issues (when topic is appropriate for NS majors)	
PS 314	Research Methods 2: Psychology of Reading	
PS 325	Research Methods 2: Perception	
NS 201	Cellular and Molecular Neuroscience	
NS 202	Neurophysiology (when not taken as a core course)	
NS 314	Mapping the Cerebellum: Structure, Connectivity & Bioinformatics	
BI 242	Molecular Cell Biology	
BI 245	Principles of Genetics	
BI 247	Cell Biology	
BI 311	Biological Electron Microscopy	
BI 341	Neurodevelopment	
BI 344	Biological Clocks	
BI 352	Topics in Biology with Lab (when topic is appropriate for NS majors)	
BI 368	Advanced Light Microscopy	
CH 341	Biochemistry: Macromolecular Structure and Function with Lab	
Integrative Course		
NS 277	Integrative Seminar in Neuroscience Research [2,4]	
or NS 377	Senior Coda in Neuroscience	
Elective Courses		
100 and 200-Level Electives		
Select any three courses of the following:		9-13
CS 106	Introduction to Computer Science I	
or CS 107	An Introduction to Computer Science with Animations and 2D Games	
or CS 209	Data Structures and Mathematical Foundations	
or CS 226	Software Design	

NS 201	Cellular and Molecular Neuroscience (if either is not taken as Advanced Research Methods or as a core course)	
or NS 202	Neurophysiology	
NS 212	Topics in Neuroscience	
BI 242	Molecular Cell Biology	
BI 244	Comparative Vertebrate Physiology	
BI 245	Principles of Genetics	
BI 247	Cell Biology	
PS 218	Cognition	
PS 213	Hormones and Behavior	
PS 221	Clinical Psychopharmacology	
PS 225	Perception	
PS 231	Neuropsychology	
PS 232	Introduction to Cognitive Science	
PS 233	Cognitive Neuroscience	
CH 221	Organic Chemistry I	
PY 130	Introductory Physics I with Laboratory: Forces and Energy	
300-Level Electives		
Select any four courses of the following:		12-17
NS 304	From Molecules to Memory	
NS 305	Sleep: A Neurobiological Perspective	
NS 312	Advanced Topics in Neuroscience	
NS 314	Mapping the Cerebellum: Structure, Connectivity & Bioinformatics	
NS 315	Mechanisms of Alzheimer's Disease	
NS 316	Neurobiology of Disease	
BI 311	Biological Electron Microscopy	
BI 316	Animal Behavior	
BI 341	Neurodevelopment	
BI 342	Frontiers in Molecular Neuroscience	
BI 343	Endocrinology	
BI 344	Biological Clocks	
BI 345	Human Genetics	
BI 346	Cannabis sativa	
BI 352	Topics in Biology with Lab (when topic is appropriate for NS majors)	
BI 368	Advanced Light Microscopy	
PS 304	Research Methods 2: Physiological Psychology	
PS 314	Research Methods 2: Psychology of Reading	
PS 323	Psycholinguistics	
PS 325	Research Methods 2: Perception	
PS 336	Music Cognition	
PS 341	Seminar in Cognitive Neuroscience: Left Brain/ Right Brain	
CH 341	Biochemistry: Macromolecular Structure and Function with Lab	
CS 322	Artificial Intelligence	
Optional Independent Research Courses [3]		
200-Level Research		
NS 275	Introduction to Neuroscience Research	1
300-Level Research		
NS 371	Research Experience in Neuroscience	1-3
NS 375H	Senior Research Project I (fall semester only)	4
NS 376	Senior Research Project II	4
Total Hours		**59-71**

1. If a course is taken to satisfy the Advanced Research Methods requirement, it cannot also be used to fulfill one of the elective requirements listed below, or as a core course.
2. With the exception of NS 277 Integrative Seminar in Neuroscience Research, none of the courses that count toward the major may be taken on a Satisfactory/Unsatisfactory basis.
3. With approval of faculty member
4. NS 277 Integrative Seminar in Neuroscience Research is effective for students who entered Skidmore in Fall 2019 and prior. NS 377 Senior Coda in Neuroscience is effective for students who entered Skidmore in Fall 2020 and beyond.

Recommendations and Advice

Senior Coda

Students wishing to complete the Senior Coda requirement by enrolling in a Neuroscience course should take NS 377 Senior Coda in Neuroscience during the fall semester of their senior year.

Tutorial Project

Students are strongly encouraged to enroll in Introduction to Neuroscience Research (NS 275 Introduction to Neuroscience Research) and Research Experience in Neuroscience (NS 371 Research Experience in Neuroscience) prior to completion of the neuroscience major. These courses allow students to obtain valuable research experience by working directly with neuroscience faculty. Highly motivated students may wish to pursue a senior tutorial project (NS 376 Senior Research Project II), which is a yearlong, intensive research thesis conducted in collaboration with a neuroscience faculty member. Generally speaking, majors should consider taking NS 275 Introduction to Neuroscience Research in their sophomore and/or junior year, and NS 371 Research Experience in Neuroscience in their junior year as a prelude to senior research.

Advice on Choosing Electives

Students' choices of electives (both within and beyond the requirements specified by the neuroscience major) may be guided by interests as well as professional goals. For example, in the core course Principles of Chemistry (CH 125 Principles of Chemistry), students are introduced to fundamental concepts of chemistry that are necessary for understanding basic mechanisms in the neurosciences; students wishing to deepen this understanding are encouraged to take additional courses in chemistry, including organic chemistry and biochemistry. Examples of projected paths through the major are intended as illustrations of groupings of electives informed by different kinds of interests and goals. For each illustration, suggestions are offered for electives within and beyond the major.

Core Courses

Students are strongly encouraged to complete the six lab-based core courses by the end of their sophomore year in preparation for their upper level courses.

Code	Title	Hours
NS 101	Introduction to Neuroscience	4
NS 201	Cellular and Molecular Neuroscience	4
BI 107	Molecular and Cellular Foundations of Life	4

BI 108	Organismal Biology	4
CH 125	Principles of Chemistry	4
PS 202	Statistics and Research Methods I	4

Projected Paths Through the Major

Path 1: A Biobehavioral Neuroscience Focus

Within Major

Code	Title	Hours
Consider these electives:		
BI 245	Principles of Genetics	4
BI 316	Animal Behavior	4
BI 341	Neurodevelopment	4
BI 344	Biological Clocks	4
PS 213	Hormones and Behavior	4
PS 304	Research Methods 2: Physiological Psychology	4
NS 304	From Molecules to Memory	3
NS 305	Sleep: A Neurobiological Perspective	3

Beyond Major

Additional electives from psychology (e.g., PS 223 Evolutionary Psychology) and biology (e.g.,BI 302 Behavioral Ecology, BI 324 Evolution, BI 370 Computer Modeling of Biological Systems).

Path 2: A Cellular/Molecular Focus

Within Major

Code	Title	Hours
Consider these electives:		
BI 242	Molecular Cell Biology	4
BI 245	Principles of Genetics	4
BI 247	Cell Biology	4
BI 342	Frontiers in Molecular Neuroscience	3
CH 221	Organic Chemistry I	5
CH 341	Biochemistry: Macromolecular Structure and Function with Lab	5
NS 201	Cellular and Molecular Neuroscience	4
NS 202	Neurophysiology (when not taken as a core course)	4
or NS 201	Cellular and Molecular Neuroscience	
NS 304	From Molecules to Memory	3
NS 305	Sleep: A Neurobiological Perspective	3
NS 314	Mapping the Cerebellum: Structure, Connectivity & Bioinformatics	3
NS 315	Mechanisms of Alzheimer's Disease	3
NS 316	Neurobiology of Disease	3

Beyond Major

Code	Title	Hours
Additional Courses from Biology		
BI 360	Genome Biology: Chromatin Structure, Function and Epigenetic Regulation	3
BI 363	RNA Metabolism	3
Additional Courses from Chemistry		
CH 222	Organic Chemistry II	5

Path 3: A Cognitive Neuroscience Focus

Within Major

Code	Title	Hours
Consider these electives:		
PS 231	Neuropsychology	4
PS 225	Perception	3
PS 314	Research Methods 2: Psychology of Reading	4
PS 323	Psycholinguistics	4
PS 341	Seminar in Cognitive Neuroscience: Left Brain/ Right Brain	3
BI 245	Principles of Genetics	4
CS 106	Introduction to Computer Science I	4
CS 107	An Introduction to Computer Science with Animations and 2D Games	4
CS 209	Data Structures and Mathematical Foundations	4
CS 226	Software Design	4

Beyond Major

Additional courses from computer science (e.g., CS 206 Introduction to Computer Science II).

Path 4: A Cognitive Science Focus

Within Major

Code	Title	Hours
Consider these electives:		
CS 106	Introduction to Computer Science I	4
PS 225	Perception	3
PS 232	Introduction to Cognitive Science	3

Beyond Major

Additional courses from computer science (e.g., CS 206 Introduction to Computer Science II, CS 306 Computability, Complexity, and Heuristics) and philosophy (e.g., PH 241 Philosophy of Mind Mind, Thought, and Consciousness).

Path 5: A Health Professions Focus

Within Major

Code	Title	Hours
Consider these electives:		
CH 221	Organic Chemistry I	5
CH 341	Biochemistry: Macromolecular Structure and Function with Lab	5
PS 231	Neuropsychology	4
BI 242	Molecular Cell Biology	4
BI 244	Comparative Vertebrate Physiology	4
BI 245	Principles of Genetics	4
BI 247	Cell Biology	4
NS 304	From Molecules to Memory	3
NS 305	Sleep: A Neurobiological Perspective	3
NS 315	Mechanisms of Alzheimer's Disease	3
NS 316	Neurobiology of Disease	3
PY 130	Introductory Physics I with Laboratory: Forces and Energy	4

Beyond Major

Code	Title	Hours
Additional Courses from Biology		
BI 306	Mammalian Physiology	4

Additional Courses from Chemistry		
CH 222	Organic Chemistry II	5
Additional Courses from Physics		
PY 140	Introductory Physics II with Laboratory: Electrodynamics	4
Additional Courses from Calculus		
MA 111	Calculus I	4
MA 113	Calculus II	4
Additional Courses		
Additional courses in sociology, anthropology, exercise science and English		

Notes:

- Those students interested in pre-med and other health professions should consult with the Health Professions Advisory Committee for guidance in selecting courses;
- None of the courses that count toward the major may be taken on a Satisfactory/Unsatisfactory basis.

Honors

To be eligible for honors in neuroscience, a student must meet the requisite grade-point average[1] and complete two semesters of 300-level research related to neuroscience (summer research conducted either at Skidmore or at another institution will be considered). Students must also complete an honors application by the withdrawal deadline of the spring semester of the senior year. Within this application, students must briefly describe their research experiences and explain why these experiences should qualify them for honors in neuroscience.

[1] *Note:* To be considered for honors, the College requires a GPA of 3.500 or higher for work in the major, and a GPA of 3.000 or higher based on all work taken at Skidmore.

Course Listing

NS 101 - Introduction to Neuroscience
Credits: 4
An interdisciplinary examination of the neurobiological bases of behavior and mental processing. Topics include the structure and functioning of the nervous system, brain-behavior relationships, and hormonal and genetic effects on behavior and mental processing. Laboratories develop students' understanding of functional neuroanatomy, neural transmission, and human psychophysiology.
Note(s): Fulfills Natural Sciences requirement; fulfills Scientific Inquiry requirement.

NS 201 - Cellular and Molecular Neuroscience
Credits: 4
An examination of complex cellular and molecular mechanisms underlying all neural processes. Students will learn the fundamentals of neuronal cell and molecular signaling, and apply that knowledge to expand their understanding of higher order processes including plasticity, neuroregeneration, and neural development. In the laboratory students will learn to culture cells, detect cellular proteins through western blotting and immunocytochemistry, and design and implement an independent research plan.
Prerequisites: *NS 101 and BI 106 or BI 107.*

NS 202 - Neurophysiology
Credits: 4
An intermediate-level examination of the nervous system from a biological perspective. "Neurophysiology" simply means the study of the function of neurons. Lectures will focus on the specialized electrical and chemical signaling that occurs within and between cells in the brain and explore the ways that those signals allow animals to perform behaviors ranging from the most simple (reflexes and rhythmic movements) to the most complex (learning to recognize an environment). Material will span the physics of electricity, genetics, biochemistry, animal and human behavior, and diseases of the nervous system. The lab focuses on neurophysiological approaches to studying the nervous system in invertebrate organisms such as fruit flies and crayfish.
Prerequisites: *BI 107 and NS 101.*

NS 212 - Topics in Neuroscience
Credits: 3,4
An opportunity to study topics in neuroscience that are not offered on a regular basis. The specific topics will vary each time the course is taught.
Prerequisites: *NS 101.*
Note(s): This course may be repeated for credit with focus on a different theme. When this course includes a lab, it will be listed for 4 credits.

NS 275 - Introduction to Neuroscience Research
Credits: 1
An introductory exploration of conducting research in neuroscience. The purpose of this learning experience is to provide students with an interactive research experience in the laboratory or field, in coordination with a faculty member. Students may be exposed to, and participate in, several aspects of the research process, including planning, designing, and implementing the research, as well as in data analysis and interpretation of the results. This experience will allow students at various stages of their careers to sample research questions/methodologies in particular subdisciplines of neuroscience, and will enhance the student's ability for more independent work.
Prerequisites: *NS 101 and permission of instructor.*
Note(s): This course can be repeated for credit up to 5 credits. Must be taken S/U.

NS 277 - Integrative Seminar in Neuroscience Research
Credits: 1
A study of selected areas of neuroscience research and techniques. Both primary source articles and first-person accounts by faculty in the biology and psychology departments are used to introduce the theoretical and practical aspects of neuroscience research. Emphasis will be placed on understanding the multiple levels (e.g., molecular to behavioral) at which research topics in neuroscience can be addressed and also the ways in which research techniques define the types of questions that can be asked at a given level of analysis.
Prerequisites: *This course should be taken upon completion of NS 101 and the completion of or current enrollment in at least one other core or elective course from the list of courses in the neuroscience major.*
Note(s): Must be taken S/U.

NS 304 - From Molecules to Memory
Credits: 3
An exploration of the current state of knowledge about the neurobiological basis of learning and memory. Through a combination of lectures and discussions of primary literature, students will explore the molecular and cellular basis of learning in invertebrates and vertebrates from a neural perspective.
Prerequisites: *NS 101 and NS 201 or NS 202 and PS 202 or BI 235.*

NS 305 - Sleep: A Neurobiological Perspective
Credits: 3
An examination of the neurobiology of sleep, an evolutionarily conserved behavioral state in which we spend almost a third of our lives and yet about which we know sparingly little. Specifically, students will study the characteristics of sleep, mechanisms of sleep regulation, disorders that influence sleep, and the many possible functions of sleep. Subject matter will span molecular biology, genetics, animal and human behavior, and medicine.
Prerequisites: *NS 101 and NS 201 or NS 202 and PS 202 or BI 235.*

NS 312 - Advanced Topics in Neuroscience
Credits: 3,4
A critical examination of fundamental areas of controversy in current theories, research findings, and applications of neuroscience with a psychological focus. Topics might include sensory processing, neurodegeneration, neuropharmacology, brain imaging, and brain plasticity.
Prerequisites: *NS 101 and PS 202.*

NS 314 - Mapping the Cerebellum: Structure, Connectivity & Bioinformatics
Credits: 3
Advanced study of the cerebellum at the behavioral, cellular, molecular and genetic levels. Students will map the cerebellum through anatomy and histology, investigate cerebellar behavior in humans and mice, analyze the cellular and molecular pathways that underlie cerebellar learning, examine the effects of cerebellar disease and examine the genetic networks of cerebellar neurons via bioinformatics.
Prerequisites: *NS 201 or BI 247.*

NS 315 - Mechanisms of Alzheimer's Disease
Credits: 3
In this course, through readings, discussions, and experimental proposal work, we will discuss the past, present and future of Alzheimer's disease (AD) research. Over half of the American population has been touched by AD either through a friend/family member/coworker, or due to having the disease themselves. The prevalence of AD has increased rapidly in all parts of the world, due to increased diagnoses and longer lifespans. The last four decades of cell and molecular research in the AD field have yielded a wealth of information on disease pathology and progression, genetic involvement, environmental contributors, and biochemical changes. However, safe yet potent therapies remain elusive.
Prerequisites: *NS 201.*

NS 316 - Neurobiology of Disease
Credits: 3
Exploration of multiple brain diseases and common modes of pathogenesis. Classes will include instructor-driven lecture, class discussions and student-led discussion and presentations. Students will help select the diseases and underlying mechanisms studied in the course. Additionally, students will have the opportunity to explore research on a disease of their choice in detail through the eyes of a renowned scientist in the field.
Prerequisites: *NS 201 or NS 202*

NS 371 - Research Experience in Neuroscience
Credits: 1-3
Directed study providing students with the opportunity for an intensive research experience in a particular laboratory or field setting. The emphasis is on the further development of students' research skills within a particular area of neuroscience inquiry. Each student will work with an individual faculty member on various aspects of the research process, including the design and implementation of a research project, data analyses and interpretation, and scientific writing.
Prerequisites: *NS 101 and permission of instructor.*
Note(s): May be repeated for credit. Must be taken S/U.

NS 375H - Senior Research Project I
Credits: 4
The first semester of a yearlong research project or thesis to be followed by NS 376 in the following semester. Students will work with an individual faculty member to develop a major research project, including conceptualization of a topic, review of the scientific literature, learning of any necessary research techniques, execution of any preliminary research, and submission of a research proposal to the faculty supervisor.
Prerequisites: *Previous research experience (e.g., NS 275, NS 371, PS 275, PS 371, BI 275, BI 371 A-C, summer research, etc.) and permission of instructor.*

NS 376 - Senior Research Project II
Credits: 4
The second semester of a yearlong research project (thesis). The student will work with an individual faculty member to complete a major research project, and be required to submit a final project.
Prerequisites: *NS 375H.*

NS 377 - Senior Coda in Neuroscience
Credits: 1
Provides students with an opportunity to reflect on their liberal arts education and to prepare them for their future careers. The seminar will meet weekly and will consist of networking with alumni, professional development, post-graduation planning and a reflection of their college experience. The course will also allow neuroscience students to engage with and learn from each other. Must be taken in the senior year.
Prerequisites: *NS 201 or NS 202.*
Note(s): Fulfills Senior Coda requirement.

Code	Title	Hours
Biology		
BI 107	Molecular and Cellular Foundations of Life	4
BI 108	Organismal Biology	4
BI 242	Molecular Cell Biology	4
BI 244	Comparative Vertebrate Physiology	4
BI 245	Principles of Genetics	4
BI 247	Cell Biology	4
BI 251	Topics in Biology	3
BI 252	Topics in Biology with Lab	4
BI 306	Mammalian Physiology	4
BI 311	Biological Electron Microscopy	4
BI 316	Animal Behavior	4
BI 341	Neurodevelopment	4
BI 342	Frontiers in Molecular Neuroscience	3
BI 343	Endocrinology	3
BI 344	Biological Clocks	4
BI 345	Human Genetics	4

BI 346	Cannabis sativa	4
BI 351	Topics in Biology	3
BI 352	Topics in Biology with Lab	4
BI 368	Advanced Light Microscopy	4
Chemistry		
CH 125	Principles of Chemistry	4
CH 221	Organic Chemistry I	5
CH 222	Organic Chemistry II	5
CH 341	Biochemistry: Macromolecular Structure and Function with Lab	5
Computer Science		
CS 106	Introduction to Computer Science I	4
CS 107	An Introduction to Computer Science with Animations and 2D Games	4
CS 322	Artificial Intelligence	4
Psychology		
PS 202	Statistics and Research Methods I	4
PS 218	Cognition	4
PS 213	Hormones and Behavior	4
PS 221	Clinical Psychopharmacology	3
PS 225	Perception	3
PS 231	Neuropsychology	4
PS 232	Introduction to Cognitive Science	3
PS 233	Cognitive Neuroscience	4
PS 303	Research Methods 2: Intermediate Statistics	4
PS 304	Research Methods 2: Physiological Psychology	4
PS 314	Research Methods 2: Psychology of Reading	4
PS 318H	Advanced Statistics in Psychology	4
PS 323	Psycholinguistics	4
PS 325	Research Methods 2: Perception	4
PS 341	Seminar in Cognitive Neuroscience: Left Brain/ Right Brain	3
PS 336	Music Cognition	4
Physics		
PY 130	Introductory Physics I with Laboratory: Forces and Energy	4