Neuroscience

Department Website: http://neuroscience.uchicago.edu/undergraduate

Program of Study

Neuroscience is the study of neurons and neural systems and their outputs: sensation, perception, homeostasis, and behavior. Neural function is investigated at the levels of molecules, cells, circuits, organisms, and species, making neuroscience inherently multidisciplinary. In addition to established neuroscience career paths in academia, medicine, and the pharmaceutical industry, new careers for students of neuroscience are emerging in economics, software development, and other fields requiring "big data" analysis or a mechanistic understanding of how humans think. The course of study in the undergraduate major in neuroscience provides students with the background and skills appropriate for these diverse careers.

The University of Chicago offers a bachelor of arts (BA) degree and a bachelor of science (BS) degree in Neuroscience. The Neuroscience major is designed to accommodate students with the range of scientific variety that one finds at the professional level of neuroscience, including physics, chemistry, computer science, engineering, mathematics, biology, psychology, and medicine. Neuroscience faculty at the University of Chicago have expertise in all of these areas and are distributed across the Biological Sciences, Social Sciences, and Physical Sciences Divisions. Majoring students have the opportunity to take a broad range of courses or to specialize in a particular area.

Declaring the Major

Students who wish to major in Neuroscience should declare the major in their second year. (Because the Neuroscience major was introduced in the 2016–17 academic year, the Class of 2020 and subsequent classes can design a plan of study in Neuroscience from their first year. Students in the Classes of 2018 and 2019 may also be able to major in Neuroscience, depending on the courses they have already taken, although there is no way to guarantee this. Students in these classes should consult with their College advisers to see if majoring in Neuroscience is feasible.)

General Education

Students majoring in Neuroscience typically begin their general education requirement in the Biological Sciences with BIOS 20186 Fundamentals of Cell and Molecular Biology. Attaining a proper grounding in cell biology is essential before delving into neuroscience as a discipline. To complete the requirement, students may choose to take one of the following: BIOS 20150 How Can We Understand the Biosphere?, BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic), BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced), BIOS 20187 Fundamentals of Genetics, BIOS 20188 Fundamentals of Physiology, or BIOS 20191 Integrative Physiology. (Note: The general education requirement for the NSCI major can be fulfilled by courses in the Biology Fundamentals Sequences [20186-20190] without the Biological Sciences prerequisites [BIOS 20150-20151/20152] unless a student pursues a double major in Biological Sciences. Students who choose this path will be expected to possess the competency in mathematical modeling of biological phenomena covered in BIOS 20151 or BIOS 20152.)

Two alternative paths to fulfilling the General Education requirements exist. 1) Neuroscience majors may take the Pre-Med Sequence for Non-Biology majors. In this case, BIOS 20170 Microbial and Human Cell Biology and BIOS 20171 Human Genetics and Developmental Biology will satisfy the core. (Note that BIOS 20171 must be taken concurrently with BIOS 20172 Mathematical Modeling for Pre-Med Students.) 2) A score of 4 or 5 on the AP Biology exam allows students to enter the Advanced Biology sequence in the Autumn of their first year. This three-quarter, lab-intensive sequence is for students with a strong background in research. Upon completion of the sequence students are awarded two credits, which satisfy the general education requirement in Biological Sciences.

The Major

The basic degree in Neuroscience is the BA, for which requirements are described below. A BS is awarded to students who complete an additional three quarters of Neuroscience electives, which must include one to three quarters of faculty-supervised research (scholarly or experimental) resulting in a written thesis (see Requirements for the Bachelor of Science Degree in Neuroscience below).

The major curriculum includes nine required Neuroscience courses, which provide a comprehensive overview of the field. The BA requires another 700 units of elective courses, which must be selected from the list below. Electives can be chosen for a broad exposure or tailored for depth in a particular area, such as cellular/molecular, systems, cognitive, and computational neuroscience and machine learning.

Students must have their program of elective courses approved by the office of the director of undergraduate studies. The Student Elective Approval Form (http://neuroscience.uchicago.edu/wp-content/uploads/2017/01/Student-Approval-Form-.pdf) should be filled out by the end of the third year and submitted to the Neuroscience major director of undergraduate studies for approval at neuromajor@uchicago.edu.

ELECTIVES

No more than three of the following BIOS courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 20172</td>
<td>Mathematical Modeling for Pre-Med Students</td>
</tr>
<tr>
<td>BIOS 20173</td>
<td>Perspectives of Human Physiology</td>
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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 20175</td>
<td>Biochemistry and Metabolism</td>
</tr>
<tr>
<td>BIOS 20187</td>
<td>Fundamentals of Genetics</td>
</tr>
<tr>
<td>BIOS 20188</td>
<td>Fundamentals of Physiology</td>
</tr>
<tr>
<td>or BIOS 20191</td>
<td>Integrative Physiology</td>
</tr>
<tr>
<td>BIOS 20189</td>
<td>Fundamentals of Developmental Biology</td>
</tr>
<tr>
<td>or BIOS 20190</td>
<td>Principles of Developmental Biology</td>
</tr>
<tr>
<td>BIOS 20234</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>BIOS 20235</td>
<td>Biological Systems</td>
</tr>
<tr>
<td>BIOS 20236</td>
<td>Biological Dynamics</td>
</tr>
<tr>
<td>BIOS 20242</td>
<td>Principles of Physiology</td>
</tr>
</tbody>
</table>

No more than one of the following two-course CMSC sequences:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CMSC 12100-12200</td>
<td>Computer Science with Applications I-II</td>
</tr>
<tr>
<td>CMSC 15100-15200</td>
<td>Introduction to Computer Science I-II</td>
</tr>
<tr>
<td>CMSC 16100-16200</td>
<td>Honors Introduction to Computer Science I-II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOS 20200</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>BIOS 24206</td>
<td>Peering Inside the Black Box: Neocortex</td>
</tr>
<tr>
<td>BIOS 24208</td>
<td>Survey of Systems Neuroscience</td>
</tr>
<tr>
<td>BIOS 24217</td>
<td>Conquest of Pain</td>
</tr>
<tr>
<td>BIOS 24231</td>
<td>Methods in Computational Neuroscience</td>
</tr>
<tr>
<td>BIOS 24232</td>
<td>Computational Approaches to Cognitive Neuroscience</td>
</tr>
<tr>
<td>BIOS 24408</td>
<td>Modeling and Signal Analysis for Neuroscientists</td>
</tr>
<tr>
<td>BIOS 26210</td>
<td>Mathematical Methods for Biological Sciences I</td>
</tr>
<tr>
<td>BIOS 26211</td>
<td>Mathematical Methods for Biological Sciences II</td>
</tr>
<tr>
<td>BIOS 27721</td>
<td>Observing Proteins in Action: How to Design and Build Your Own</td>
</tr>
<tr>
<td>LING 27010</td>
<td>Psycholinguistics</td>
</tr>
<tr>
<td>NURB 32400</td>
<td>Synaptic Physiology</td>
</tr>
<tr>
<td>PSYC 20300</td>
<td>Biological Psychology</td>
</tr>
<tr>
<td>PSYC 20400</td>
<td>Cognitive Psychology</td>
</tr>
<tr>
<td>PSYC 23800</td>
<td>Introduction to Learning and Memory</td>
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<tr>
<td>PSYC 25560</td>
<td>Body &amp; Mind: How our bodies reveal &amp; change emotion &amp; thought</td>
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<tr>
<td>PSYC 25750</td>
<td>The Psychology and Neurobiology of Stress</td>
</tr>
<tr>
<td>PSYC 26660</td>
<td>Genes and Behavior</td>
</tr>
<tr>
<td>CMSC 15400</td>
<td>Introduction to Computer Systems</td>
</tr>
<tr>
<td>CMSC 25020</td>
<td>Computational Linguistics</td>
</tr>
<tr>
<td>CMSC 25025</td>
<td>Machine Learning and Large-Scale Data Analysis</td>
</tr>
<tr>
<td>CMSC 25050</td>
<td>Computer Vision</td>
</tr>
<tr>
<td>CMSC 25400</td>
<td>Machine Learning</td>
</tr>
<tr>
<td>PHYS 12300</td>
<td>General Physics III</td>
</tr>
<tr>
<td>or PHYS 13300</td>
<td>Waves, Optics, and Heat</td>
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<tr>
<td>NSCI 29100</td>
<td>Neuroscience Thesis Research</td>
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<tr>
<td>NSCI 29101</td>
<td>Neuroscience Thesis Research</td>
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<tr>
<td>NSCI 29102</td>
<td>Neuroscience Thesis Research</td>
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<tr>
<td>NSCI 29200</td>
<td>Neuroscience Honors Thesis Research</td>
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<tr>
<td>NSCI 29201</td>
<td>Neuroscience Honors Thesis Research</td>
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<tr>
<td>NSCI 29202</td>
<td>Neuroscience Honors Thesis Research</td>
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</table>

While it is possible to complete a double major in Neuroscience and another program, this is not encouraged. Neuroscience majors are generally better suited to achieving breadth through a combination of courses that provides the desired expertise in neuroscience and carefully selected courses outside of neuroscience.

Requirements for the Bachelor of Science Degree in Neuroscience

Students can earn a BS in Neuroscience by completing three quarters of Neuroscience elective courses over and above the BA requirements, which must include one to three quarters of faculty-supervised research that results in a written thesis (NSCI 29100, NSCI 29101, NSCI 29102 Neuroscience Thesis Research). The additional courses and the thesis work require approval by the office of the director of undergraduate studies and the thesis advisor. The thesis may be either research-based or literature-based.
Grading

All courses used to satisfy prerequisites and requirements must be taken for quality grades. Students must pass all required courses with an average GPA of 2.0 or higher to continue in the program.

Summary of Requirements for the Major in Neuroscience

**GENERAL EDUCATION**

One of the following BIOS sequences:*  
BIOS 20186 Fundamentals of Cell and Molecular Biology  
Plus one of the following  
BIOS 20150 How Can We Understand the Biosphere?  
BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic)  
BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced)  
BIOS 20187 Fundamentals of Genetics  
BIOS 20188 Fundamentals of Physiology  
BIOS 20191 Integrative Physiology  
OR  
BIOS 20170 & BIOS 20171 Microbial and Human Cell Biology  
and Human Genetics and Developmental Biology #

One of the following two-course MATH sequences:  
MATH 13100-13200 Elementary Functions and Calculus I-II  
MATH 15100-15200 Calculus I-II *  
MATH 16100-16200 Honors Calculus I-II

One of the following two-course CHEM sequences:  
CHEM 10100 & CHEM 10200 Introductory General Chemistry I  
and Introductory General Chemistry II  
CHEM 11100-11200 Comprehensive General Chemistry I-II *  
CHEM 12100-12200 Honors General Chemistry I-II

Total Units 600

**MAJOR: BACHELOR OF ARTS**

CHEM 11300 Comprehensive General Chemistry III *  
or CHEM 12300 Honors General Chemistry III  
PHYS 12100-12200 General Physics I-II (or higher) *  
STAT 22000 Statistical Methods and Applications *  
NSCI 20110 Fundamental Neuroscience  
NSCI 20120 Cellular Neuroscience  
NSCI 20130 Systems Neuroscience  
NSCI 20140 Sensation and Perception  
NSCI 20100 Neuroscience Laboratory  
Seven electives 700

Total Units 1600

**MAJOR: BACHELOR OF SCIENCE**

CHEM 11300 Comprehensive General Chemistry III *  
or CHEM 12300 Honors General Chemistry III  
PHYS 12100-12200 General Physics I-II (or higher) *  
STAT 22000 Statistical Methods and Applications *  
NSCI 20110 Fundamental Neuroscience  
NSCI 20120 Cellular Neuroscience  
NSCI 20130 Systems Neuroscience  
NSCI 20140 Sensation and Perception  
NSCI 20100 Neuroscience Laboratory  
Seven electives 700  
Three additional electives ** 300

Total Units 1900
* Credit may be granted by examination.
# BIOS 20171 must be taken concurrently with BIOS 20172.
** Must include one to three courses of NSCI 29100, 29101, 29102 Neuroscience Thesis Research or NSCI 29200, 29201, 29202 Neuroscience Honors Thesis Research

Honors

To obtain honors in Neuroscience, students must have a minimum cumulative GPA (3.25) at the point of entering the honors track, no later than the end of the third year. Entry into the honors track must be approved by the director of undergraduate studies. Students must do experimental research for three quarters and submit a thesis (NSCI 29200, NSCI 29201, NSCI 29202 Neuroscience Honors Thesis Research). As part of the research course work, honors students participate in regular group meetings in which they share their research with each other and supervising faculty, and receive guidance on formulating testable hypotheses, experimental design, report writing, and oral presentations. They also receive training in the responsible conduct of research. Experimental research may not be credited toward honors in more than one major.

Minor Options

A minor in Neuroscience is not offered. The College offers a minor program in Computational Neuroscience, and students majoring in Biological Sciences have the option of completing a Specialization in Neuroscience.

Neuroscience Courses

**NSCI 00292. Neuroscience Honors Thesis Research. 100 Units.**
Research Thesis and Seminar
Instructor(s): Elizabeth Grove Terms Offered: Summer
Prerequisite(s): Acceptance into the Neuroscience Honors Program

**NSCI 20100. Neuroscience Laboratory. 100 Units.**
This course has three components in series, representing (1) molecular neuroscience, (2) cellular electrophysiology, and (3) computation and psychophysics. The course meets one afternoon each week for four hours of laboratory time, including a didactic introduction. Students will be graded on their laboratory reports.
Instructor(s): J. Maunsell; E. Heckscher; C. Hansel; M. McNulty Terms Offered: Winter
Prerequisite(s): NSCI 20110; must be a Neuroscience major.
Note(s):

**NSCI 20110. Fundamental Neuroscience. 100 Units.**
This course is a rigorous introduction to the study of neurons, nervous systems and brains. The systems anatomy and physiology of the vertebrate brain will be covered in depth. Common features of neural circuits, such as those subserving the stretch reflex, will be examined. The biology of brain evolution and development will be introduced. A highlight of this course will be student dissections of sheep brains and the laboratory presentation of human brain dissections by the instructors.
Instructor(s): C. Ragsdale, P. Mason Terms Offered: Autumn
Prerequisite(s): At least two quarters of Biological Sciences instruction (including courses taken concurrently) or consent of instructor
Equivalent Course(s): BIOS 24110

**NSCI 20120. Cellular Neuroscience. 100 Units.**
This course describes the cellular and subcellular properties of neurons, including passive and active electrophysiological properties, and their synaptic interactions. Readings are assigned from a general neuroscience textbook.
Instructor(s): R. A. Eatock, W. Wei, Staff Terms Offered: Winter
Prerequisite(s): NSCI 20110, along with completion of MATH 13100, or MATH 15100, or MATH 16100
Equivalent Course(s): BIOS 24120

**NSCI 20130. Systems Neuroscience. 100 Units.**
This course covers vertebrate and invertebrate systems neuroscience with a focus on the anatomy, physiology, and development of sensory and motor control systems. The neural bases of form and motion perception, locomotion, memory, and other forms of neural plasticity are examined in detail. We also discuss clinical aspects of neurological disorders.
Instructor(s): D. Freedman, Staff Terms Offered: Spring
Prerequisite(s): NSCI 20110, and NSCI 20120 or consent of instructor
Equivalent Course(s): BIOS 24130

**NSCI 20140. Sensation and Perception. 100 Units.**
What we see and hear depends on energy that enters the eyes and ears, but what we actually experience—perception—follows from human neural responses. This course focuses on visual and auditory phenomena, including basic percepts (for example, acuity, brightness, color, loudness, pitch) and also more complex percepts such as movement and object recognition. Biological underpinnings of perception are an integral part of the course.
Instructor(s): K. Ledoux Terms Offered: Winter
Equivalent Course(s): PSYC 20700
NSCI 20500. Neuroanatomy. 100 Units.
This course is part of the Study Abroad Neuroscience program in Paris, France. In this course, we will use an understanding of development in order to understand the neuroanatomy of the adult vertebrate nervous system. This understanding will be solidified by dissections of mammalian, fish and bird brains as well as a trip to see myriad brains at the Muséum national d’histoire naturelle. In the second half of the course, neuroanatomical adaptations specific to particular animals will be examined in the context of critical environmental and ecological factors. Examples include postural control in sloths, vision in marine animals and raptors, and the control of muscles of facial expression across mammalian species.
Instructor(s): P. Mason Terms Offered: TBD. Paris Study Abroad Neuroscience Program
Prerequisite(s): Enrollment into the Paris Study Abroad Program

NSCI 20510. Evolution and the Nervous System. 100 Units.
Evolutionary neuroscience has traditionally focused on the neural bases of animal behavior (neuroethology) and employed the methods of comparative anatomy, cellular neurophysiology and behavioral neuropsychology. This course will approach neuroethology from a modern evolutionary perspective, one that integrates findings from genomics, molecular developmental biology and paleontology with insights from neuroethology. Our exploration will include the controversies over the evolutionary origin of neurons and centralized brains, the independent solutions across taxa to processing ecologically important sensory information, and recent insights into the evolution of the neocortex.
Instructor(s): C. Ragsdale Terms Offered: TBD. Paris Study Abroad Neuroscience Program
Prerequisite(s): Enrollment into the Paris Study Abroad Program

NSCI 21800. Perspectives in Drug Abuse. 100 Units.
It is a broad overview course about drug abuse, that is appropriate for graduate students as well as undergraduates. It includes lectures on epidemiology, genetics, neurobiology, experimental methods, policy and treatment, as well as lectures on several specific drug classes. Lectures are by Dr. de Wit and by other invited faculty members, and students are required to present and discuss recent published papers during classes.
Instructor(s): H. de Wit Terms Offered: Spring
Equivalent Course(s): BIOS 24135, NURB 32900

NSCI 22000. Gazing into the Black Box: Neocortex. 100 Units.
The neocortex is the multilayered outermost structure of the mammalian brain. It is the site of higher brain functions including reasoning and creativity. However, the complexity of the neocortex—it is comprised of ~20 billion neurons which have 0.15 quadrillion connections between them—seems to preclude any hope of achieving a fundamental understanding of the system. Recent technological innovations have opened novel avenues of investigation making realization of the neocortex an increasingly tractable problem. This course will place particular emphasis on how to critically read scientific papers as we evaluate and discuss current experimental approaches to the neocortex. Integral to this evaluation will be the detailed discussion of the latest technological approaches.
Instructor(s): J. MacLean Terms Offered: Autumn
Prerequisite(s): NSCI 20110, 20120, 20130 or consent of instructor. For Biology majors: Three quarters of a Biological Sciences Fundamentals sequence.

NSCI 22100. Molecular Neuroscience. 100 Units.
This lecture/seminar course explores the application of modern cellular and molecular techniques to clarify basic questions in neurobiology. Topics include mechanisms of synaptic transmission, protein trafficking, exo- and endo-cytosis, and development and mechanisms of neurological diseases.
Instructor(s): S. Sisodia Terms Offered: Spring
Prerequisite(s): NSCI 20110, NSCI 20120 and BIOS 20200, or consent of instructor
Equivalent Course(s): BIOS 24131

NSCI 22300. Molecular Principles of Nervous System Development. 100 Units.
This elective course provides an overview of the fundamental questions in developmental neurobiology. It is based on primary research papers and highlights key discoveries in vertebrate and invertebrate animals that advanced our understanding of nervous system development. Topics covered, among others, will include neural stem cells, neuronal specification and terminal differentiation, and circuit assembly. Dogmas and current debates in developmental neurobiology will be discussed, aiming to promote critical thinking about the field. This advanced-level course is open to upper level undergraduate and graduate students and combines lectures, student presentations, and discussion sections.
Instructor(s): E. Grove, P. Kratsios Terms Offered: Winter
Prerequisite(s): NSCI 20110, NSCI 20120, NSCI 20130, BIOS 20187 or consent of instructor
Equivalent Course(s): NURB 32300

NSCI 29100. Neuroscience Thesis Research. 100 Units.
Scholar or Research Thesis.
Instructor(s): Staff Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): By consent of instructor and approval of major director.

NSCI 29101. Neuroscience Thesis Research. 100 Units.
Scholar or Research Thesis.
Instructor(s): Staff Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): NSCI 29100, and consent of instructor, and approval of major director.
NSCI 29102. Neuroscience Thesis Research. 100 Units.
Scholar or Research Thesis.
Instructor(s): Staff
Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): NSCI 29100, and consent of instructor, and approval of major director.

NSCI 29200. Neuroscience Honors Thesis Research. 100 Units.
Research Thesis and Seminar.
Instructor(s): Staff
Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): By consent of instructor and approval of major director. Open to Neuroscience majors who are candidates for honors in Neuroscience.

NSCI 29201. Neuroscience Honors Thesis Research. 100 Units.
Research Thesis and Seminar.
Instructor(s): Staff
Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): NSCI 29200, and consent of instructor, and approval of major director. Open to Neuroscience majors who are candidates for honors in Neuroscience.

NSCI 29202. Neuroscience Honors Thesis Research. 100 Units.
Research Thesis and Seminar.
Instructor(s): Staff
Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): NSCI 20201, and consent of instructor, and approval of major director. Open to Neuroscience majors who are candidates for honors in Neuroscience.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

- Times was used instead of Trajan.
- Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.