Neuroscience

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

Program of Study

Neuroscience is concerned with the function of nervous systems. The sheer scope of neuroscience necessitates numerous scientific approaches to achieve understanding of sensation, perception, cognition, and behavior. Consequently, students in the major are provided with access to a wealth of scientific variety, including biology, psychology, physics, chemistry, computer science, engineering, mathematics, statistics, 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.

The bachelor of arts (BA), bachelor of science (BS), and BS with honors degrees in neuroscience provide a broad foundation in understanding neural function from the perspective of molecules, cells, circuits, systems, organisms, and species. The BA degree provides thorough study in the field of neuroscience while allowing flexibility in elective choice. The BS and BS honors degrees offer a more intensive program of study that includes individual research. Students who wish to incorporate neuroscientific literacy into their degree but have primary interest in other fields can choose to obtain a minor in neuroscience.

Summary of Requirements for the Major in Neuroscience

The major curriculum includes nine required neuroscience courses, which provide a comprehensive overview of the field. Students must also take neuroscience electives, which may include up to two neuroscience-related electives. Neuroscience electives increase a student’s knowledge of neural systems, while neuroscience-related electives are included to provide students with tools or context to enhance understanding of neural systems. Elective courses can be selected either to achieve breadth, i.e., broad exposure to many topics, or for depth in a particular area of neuroscience. Students who wish to major in neuroscience are strongly encouraged to declare the major in their second year.

Program Requirements: BA – Nine required neuroscience courses beyond the general education requirement (which should begin in the first year), plus a minimum of seven electives are required for a BA.

Program Requirements: BS – Nine required neuroscience courses beyond the general education requirement (which should begin in the first year), plus a minimum of 10 electives. Enrollment in faculty-supervised research for elective credit culminating in a poster presentation and thesis submission are also required for a BS.

Program Requirements for BS with Honors – The honors program expands on the program requirements for the BS by requiring a minimum GPA, a summer of full-time research, and three quarters of faculty-supervised research for elective credit in the student’s fourth year. In the Spring Quarter of their fourth year, BS with Honors students will submit a thesis and present their research in a public forum. Interested majors must apply for admittance into the honors program in their third year.

Grading

All courses used to satisfy prerequisites and requirements must be taken for quality grades. Students must pass each course in the Fundamental Neuroscience Sequence (NSCI 20100–20140) with a C or higher. Students are also required to pass general education courses with an average GPA of 2.0 or higher to continue in the program.

General Education Requirements for the Major

To satisfy the general education requirements, students must take 200 units of Biological Sciences, 200 units of Mathematics, and 200 units of Chemistry from the selected list of general education courses for the neuroscience major (see General Education Table).

Bachelor of Arts Degree in Neuroscience

The basic degree in neuroscience is the BA. To qualify for a BA, students must minimally satisfy the general education requirements and complete the neuroscience required courses (900 units), 500 units of neuroscience elective courses, and 200 units of neuroscience or neuroscience-related elective courses as listed in the table below.

Major: Bachelor of Arts Required Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSCI 20101</td>
<td>Foundations of Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20111</td>
<td>Cellular Neurophysiology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20130</td>
<td>Systems Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20140</td>
<td>Sensation and Perception</td>
<td>100</td>
</tr>
<tr>
<td>PHYS 12100-12200</td>
<td>General Physics I-II (or higher) *</td>
<td>200</td>
</tr>
<tr>
<td>NSCI 20100</td>
<td>Neuroscience Laboratory</td>
<td>100</td>
</tr>
</tbody>
</table>
INDIVIDUAL MAJOR

By their third year, students majoring in neuroscience are strongly encouraged to participate in research with a faculty member. This can take many forms, including internships, fellowships, and research for elective credit. See also BS and Honors in Neuroscience. For more information on research opportunities, visit the undergraduate major website.

BACHELOR OF SCIENCE DEGREE IN NEUROSCIENCE

Students graduate with a bachelor of science in neuroscience by completing the neuroscience required courses (900 units), 200 units of neuroscience or related elective courses, and 800 units of neuroscience elective courses, which must include one to three quarters of faculty-supervised NSCI 29100 Neuroscience Thesis Research culminating in a written thesis and poster presentation. When enrolled in the neuroscience thesis elective, BS students will be required to attend a minimum of one BS student mentoring meeting each quarter. The thesis and poster will be evaluated by faculty in addition to the faculty thesis supervisor. Neuroscience Thesis Research (NSCI 29100) must be completed before the final quarter of the student’s graduating year to allow sufficient time to prepare the written document and presentation. The additional neuroscience electives and thesis work require approval by the office of the director of undergraduate studies and the thesis adviser. Note that if a student wishes to carry out thesis work with a non-Neuroscience Institute-listed faculty member, the student must contact the director of undergraduate studies for approval in the quarter prior to submitting the thesis proposal.

MAJOR: BACHELOR OF SCIENCE REQUIRED COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSCI 20101</td>
<td>Foundations of Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20111</td>
<td>Cellular Neurophysiology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20130</td>
<td>Systems Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20140</td>
<td>Sensation and Perception</td>
<td>100</td>
</tr>
<tr>
<td>PHYS 12100-12200</td>
<td>General Physics I-II (or higher) *</td>
<td>200</td>
</tr>
<tr>
<td>NSCI 20100</td>
<td>Neuroscience Laboratory</td>
<td>100</td>
</tr>
<tr>
<td>STAT 22000</td>
<td>Statistical Methods and Applications</td>
<td>100</td>
</tr>
<tr>
<td>CHEM 11300</td>
<td>Comprehensive General Chemistry III</td>
<td>100</td>
</tr>
<tr>
<td>or CHEM 12300</td>
<td>Honors General Chemistry III</td>
<td></td>
</tr>
</tbody>
</table>

At least eight Neuroscience electives **

No more than two Neuroscience-related electives ^

Total Units: 1900

* Credit may be granted by examination.

** Must include one to three courses of NSCI 29100, NSCI 29101, NSCI 29102 Neuroscience Thesis Research or NSCI 29200, NSCI 29201, NSCI 29202 Neuroscience Honors Thesis Research

^ May also include additional neuroscience electives

HONORS IN NEUROSCIENCE

The BS with honors is an extension of the BS and is targeted toward students with a particularly strong interest in research. To apply for the neuroscience honors program, students must have a minimum GPA of 3.5 in the major and a cumulative GPA of 3.25. This level of achievement must then be maintained throughout the academic year corresponding to the thesis submission. Applications for the honors program will be reviewed by a faculty examining committee. A Neuroscience Institute–listed faculty sponsor and approved topic must be identified before applying.

The honors program begins with 10 weeks of full-time research during the Summer Quarter between the student’s third and fourth years. A stipend is provided during the summer research component of the honors program. Honors students will continue their research as a graded elective research course (NSCI 29200, NSCI
Neuroscience

29201, and NSCI 29202 Neuroscience Honors Thesis Research) during Autumn, Winter, and Spring Quarters of the fourth year, which culminates in a public talk and a written thesis. The thesis and public talk will be evaluated by a faculty thesis committee. As part of the research course work, honors students participate in weekly classes 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 IN NEUROSCIENCE

The minor in neuroscience is intended to provide neuroscientific literacy for students whose primary interest lies in other fields. Students graduate with a minor in neuroscience by completing NSCI 20101 Foundations of Neuroscience, NSCI 20111 Cellular Neurophysiology, and NSCI 20130 Systems Neuroscience, as well as four neuroscience electives. The minor also requires that students meet the general education requirements in the biological or physical sciences plus MATH 13100-13200 Elementary Functions and Calculus I-II (or higher). Students are strongly encouraged to take STAT 22000 Statistical Methods and Applications (or higher) and NSCI 20140 Sensation and Perception for two of the four electives, if these courses have not already been taken to fulfill major requirements. No course in the neuroscience minor can count toward the student’s major(s) or other minors, nor can it count toward general education requirements.

REQUIRED COURSES FOR THE MINOR IN NEUROSCIENCE

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSCI 20101</td>
<td>Foundations of Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20111</td>
<td>Cellular Neurophysiology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20130</td>
<td>Systems Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>Four Neuroscience electives*</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td>700</td>
<td></td>
</tr>
</tbody>
</table>

* Neuroscience-related electives do not count.

MINOR IN COMPUTATIONAL NEUROSCIENCE

This minor is intended to provide literacy in computational neuroscience and is for students who are interested in mathematical approaches applied to neural systems. The minor requires that students meet the general education requirements in the biological or physical sciences plus MATH 13100-13200 Elementary Functions and Calculus I-II (or higher). No course in the computational neuroscience minor can count toward the student’s major(s) or other minors, nor can it count toward general education requirements.

Summary of Requirements for the Minor in Computational Neuroscience

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 26210-26211</td>
<td>Mathematical Methods for Biological Sciences I-II</td>
<td>200</td>
</tr>
<tr>
<td>NSCI 20101</td>
<td>Foundations of Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23700</td>
<td>Methods in Computational Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 24000</td>
<td>Modeling and Signal Analysis for Neuroscientists</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td></td>
<td>500</td>
</tr>
</tbody>
</table>

* Neuroscience majors must meet with the NSCI advisors to discuss an appropriate course equivalent.

DOUBLE MAJORS

Students interested in double majoring in neuroscience and biological sciences, psychology, or cognitive science must meet with the NSCI advisors to discuss restrictions, as there is a limit of seven courses that can be double counted. Please email neuromajor@uchicago.edu to receive information on restrictions for double counting courses.

SAMPLE PROGRAM

Neuroscience is a unique and broad field that allows students to plan their undergraduate career in a variety of ways. Below is a sample plan for when to take NSCI required courses:

- **Year 1:** Biological Sciences, Chemistry, and Mathematics General Education Courses
- **Year 2:** NSCI 20101, NSCI 20111, NSCI 20130, PHYS 12100-12200 General Physics I-II
- **Year 3:** NSCI 20100 and/or NSCI 20140, Electives, Research Opportunities, STAT 22000
- **Year 4:** NSCI 20100 and/or NSCI 20140, Electives, Research Opportunities, STAT 22000

ELECTIVES

NEUROSCIENCE ELECTIVES (no fewer than five)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSCI 20510</td>
<td>Evolution and the Nervous System</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21000</td>
<td>Social Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>NSCI 21015</td>
<td>Biological Psychology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21100</td>
<td>Photons to Consciousness: Cellular and Integrative Brain Functions</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21200</td>
<td>Animal Models in the Study of Cognition</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21400</td>
<td>Biological Clocks and Behavior</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21500</td>
<td>Fundamentals of Synapses</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21520</td>
<td>A Deep Dive into the Cell and Molecular Biology of the Brain</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21530</td>
<td>DYNAMIC CAMOUFLAGE: Behavior, Visual Perception and Neural Skin Patterning in Cephalopods</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21600</td>
<td>Attention and Working Memory in the Mind and Brain</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21610</td>
<td>Neuroanatomy of Cranial Nerves and Nuclei</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21625</td>
<td>Cognitive Neuroscience in Humans and Rodents</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21750</td>
<td>Ethics through a Neurobiological Lens</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21800</td>
<td>Perspectives in Drug Abuse</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21810</td>
<td>Principles of Cellular Neural Development</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21900</td>
<td>Neuropharmacology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22010</td>
<td>Neuroscience of Consciousness</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22015</td>
<td>Cognitive Psychology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22110</td>
<td>Molecular and Translational Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22130</td>
<td>Psychoactive drugs, the Brain and Behavior</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22200</td>
<td>Molecular Principles of Nervous System Development</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22235</td>
<td>Observing Proteins in Action: How to Design and Build Your Own Instruments</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22400</td>
<td>Neuroscience of Seeing</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22415</td>
<td>Introduction to Learning and Memory</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22450</td>
<td>Conquest of Pain</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22460</td>
<td>Anatomy of Selected Brain Circuits</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22500</td>
<td>Neuroscience of Communication</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22535</td>
<td>The Psychology and Neurobiology of Stress</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22870</td>
<td>Neural Interfaces for Restoration and Augmentation</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23400</td>
<td>Synaptic Physiology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23480</td>
<td>Neurogenetics</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23500</td>
<td>Survey of Systems Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23700</td>
<td>Methods in Computational Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23810</td>
<td>Neurons and Glia: A cellular and molecular perspective</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 24000</td>
<td>Modeling and Signal Analysis for Neuroscientists</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29100</td>
<td>Neuroscience Thesis Research</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29101</td>
<td>Neuroscience Thesis Research II</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29102</td>
<td>Neuroscience Thesis Research III</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29200</td>
<td>Neuroscience Honors Thesis Research</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29201</td>
<td>Neuroscience Honors Thesis Research II</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29202</td>
<td>Neuroscience Honors Thesis Research III</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29700</td>
<td>Reading and Research in Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>CMSC 25025</td>
<td>Machine Learning and Large-Scale Data Analysis</td>
<td>100</td>
</tr>
<tr>
<td>CMSC 25400</td>
<td>Machine Learning</td>
<td>100</td>
</tr>
</tbody>
</table>

* Non-NSCI courses listed here require prior approval from the department. Inquiries and petitions may be submitted to neuromajor@uchicago.edu. (neuromajor@uchicago.edu)

RELATED ELECTIVES (no more than two)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 20172</td>
<td>Mathematical Modeling for Pre-Med Students</td>
<td>100</td>
</tr>
<tr>
<td>BIOS 20173</td>
<td>Perspectives of Human Physiology</td>
<td>100</td>
</tr>
<tr>
<td>BIOS 20175</td>
<td>Biochemistry and Metabolism</td>
<td>100</td>
</tr>
<tr>
<td>BIOS 20187</td>
<td>Fundamentals of Genetics</td>
<td>100</td>
</tr>
<tr>
<td>BIOS 20188</td>
<td>Fundamentals of Physiology</td>
<td>100</td>
</tr>
<tr>
<td>or BIOS 20191</td>
<td>Integrative Physiology</td>
<td>100</td>
</tr>
</tbody>
</table>
### GENERAL EDUCATION TABLE

**GENERAL EDUCATION**

One of the following BIOS sequences:

<table>
<thead>
<tr>
<th>BIOS 20186</th>
<th>Fundamentals of Cell and Molecular Biology</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 20153</td>
<td>Fundamentals of Ecology and Evolutionary Biology</td>
<td></td>
</tr>
<tr>
<td>BIOS 20151</td>
<td>Introduction to Quantitative Modeling in Biology (Basic)</td>
<td></td>
</tr>
<tr>
<td>BIOS 20152</td>
<td>Introduction to Quantitative Modeling in Biology (Advanced)</td>
<td></td>
</tr>
<tr>
<td>BIOS 20187</td>
<td>Fundamentals of Genetics</td>
<td></td>
</tr>
<tr>
<td>BIOS 20188</td>
<td>Fundamentals of Physiology</td>
<td></td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>BIOS 20170</th>
<th>Microbial and Human Cell Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp; BIOS 20171</td>
<td>Human Genetics and Developmental Biology</td>
</tr>
</tbody>
</table>

OR

| BIOS 20234-20235-20236 | Molecular Biology of the Cell; Biological Systems; Biological Dynamics |

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 | Introductory General Chemistry I |
| & CHEM 10200 | and Introductory General Chemistry II |
| CHEM 11100-11200 | Comprehensive General Chemistry I-II |
| CHEM 12100 | Honors General Chemistry I |
| & CHEM 12200 | and Honors General Chemistry II |

| **Total Units** | **600** |

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† The neuroscience major general education requirement in the biological sciences can be fulfilled by courses in the Biological Sciences Fundamentals Sequences (BIOS 20186 to 20190) without the Biological Sciences prerequisites (BIOS 20153-20151/20152) unless a student pursues a double major in Biological Sciences. However, all students in the sequence will be expected to possess the mathematical modeling competencies and basic coding in R covered in BIOS 20151/BIOS 20152 and BIOS 20153.

* Credit may be granted by examination.

‡ BIOS 20171 must be taken concurrently with BIOS 20172.
Neuroscience

** Students with a score of 4 or 5 on the Advanced Placement Biology exam may use their AP credit to meet the general education requirement in the biological sciences if the first three quarters of the Advanced Biology sequence are completed.

NEUROSCIENCE COURSES

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; M. McNulty Terms Offered: Winter
Prerequisite(s): Neuroscience Fundamentals sequence (NSCI 20101-NSCI 20130), Must be a Neuroscience Major

NSCI 20101. Foundations of Neuroscience. 100 Units.
This course is an introduction to the broad field of neuroscience. This is a lecture-based course that aims to introduce undergraduate students to concepts and principles that explain how the nervous system is built and how it functions. Examples of thematic areas covered in lectures include: (a) cellular anatomy of the nervous system, (b) development and evolution of the nervous system, (c) sensory systems, (d) motor systems, (e) cognition and behavior.
Instructor(s): D. Freedman, P. Kratsios, M. Sheffield Terms Offered: Autumn
Equivalent Course(s): BIOS 24101, PSYC 24450

NSCI 20111. Cellular Neurophysiology. 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): M. Sheffield, W. Wei Terms Offered: Winter
Prerequisite(s): NSCI 20101, and MATH 13100, or MATH 15100, or MATH 16100. Or consent of instructor Equivalent Course(s): BIOS 24111

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): J. MacLean Terms Offered: Spring
Prerequisite(s): NSCI 20101, NSCI 20111 or consent of instructors Equivalent Course(s): BIOS 24130, PSYC 24010

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: Winter
Prerequisite(s): NSCI 20101 and NSCI 20130, or consent of instructor Equivalent Course(s): ORGB 30510
NSCI 21000. Social Neuroscience. 100 Units.
Social species, by definition, create emergent organizations beyond the individual - structures ranging from dyads and families to groups and cultures. Social neuroscience is the interdisciplinary field devoted to the study of neural, hormonal, cellular, and genetic mechanisms, and to the study of the associations and influences between social and biological levels of organization. The course provides a valuable interdisciplinary framework for students in psychology, neuroscience, behavioral economics, and comparative human development. Many aspects of social cognition will be examined, including but not limited to attachment, attraction, altruism, contagion, cooperation, competition, dominance, empathy, isolation, morality, and social decision-making.
Instructor(s): J. Decety Terms Offered: Autumn
Equivalent Course(s): BIOS 24137, ECON 21830, HLTH 22350, PSYC 22350, CHDV 22350

NSCI 21015. Biological Psychology. 100 Units.
What are the relations between mind and brain? How do brains regulate mental, behavioral, and hormonal processes; and how do these influence brain organization and activity? This course introduces the anatomy, physiology, and chemistry of the brain; their changes in response to the experiential and sociocultural environment; and their relation to perception, attention, behavioral action, motivation, and emotion.
Instructor(s): S. London, J. Yu Terms Offered: Winter
Prerequisite(s): Some background in biology and psychology.
Note(s): This course does not meet requirements for the Biological Sciences Major.
Equivalent Course(s): CHDV 20300, PSYC 20300, BIOS 29300

NSCI 21100. Photons to Consciousness: Cellular and Integrative Brain Functions. 100 Units.
This course uses the visual system as a model to explore how the brain works. We begin by considering the physical properties of light. We then proceed to consider the mechanism of sensory transduction, cellular mechanisms of neuron to neuron communication, the operation of small neural networks, strategies of signal detection in neuron networks, and the hierarchical organization of cortical function. We conclude with visually guided behavior and consciousness.
Instructor(s): E. Schwartz Terms Offered: Winter
Prerequisite(s): NSCI 20111
Equivalent Course(s): BIOS 24136

NSCI 21300. Animal Models in the Study of Cognition. 100 Units.
This course will be a combination of lecture and seminar. In the first half of the course we will read and discuss seminal literature in the study of cognitive questions using animal models (primarily rodents). In the second half of the course we will learn about study design and design two different types of studies in smaller groups. Evaluation will be through short weekly papers, class discussion and a final paper.
Instructor(s): L. Kay Terms Offered: Autumn
Prerequisite(s): Completion of PSYC 20300 Biological Psychology or equivalent background in neuroscience and/or biological psychology.
Equivalent Course(s): PSYC 28910

NSCI 21400. Biological Clocks and Behavior. 100 Units.
This course will address physiological and molecular biological aspects of circadian and seasonal rhythms in biology and behavior. The course will primarily emphasize biological and molecular mechanisms of CNS function, and will be taught at a molecular level of analysis from the beginning of the quarter. Those students without a strong biology background are unlikely to resonate with the course material.
Instructor(s): B. Prendergast Terms Offered: Autumn
Prerequisite(s): A quality grade in PSYC 20300 Introduction to Biological Psychology. Additional biology courses are desirable. Completion of Core biology will not suffice as a prerequisite.
Equivalent Course(s): BIOS 24248, HLTH 21750, PSYC 21750

NSCI 21500. Fundamentals of Synapses. 100 Units.
In this course, students will learn about the fundamentals of synapses, from molecular analysis to structure and function. Marine and aquatic models have historically provided a unique opportunity to investigate synaptic function due to the large size of their neurons, including the synaptic connections. Today, these synapse models are used to study basic principles of neuron-to-neuron communication (synaptic transmission), as well as disease mechanisms. In addition to lectures and discussions of key literature, this course will feature hands-on laboratory-based exercises in molecular genetics, imaging and physiology of synapses, as well as independent “discovery” projects to explore new topics in synapse biology.
Instructor(s): J. Morgan, J. Rosenthal Terms Offered: Spring
Prerequisite(s): Acceptance into the MBL Neuroscience Spring Quarter Program

NSCI 21520. A Deep Dive into the Cell and Molecular Biology of the Brain. 100 Units.
This course will be an interactive analysis of the cell biology of neurons and glia. Central questions include how do the unique morphologies of neurons and glia shape their cell biology and how do we use different techniques to examine these cells. Other topics include: structure and function of neuronal proteins, membrane excitability, the functions of different glia types, and signaling pathways in synapse formation and development. The course will span three weeks at the Marine Biological Laboratory. Mornings will consist of lectures and critical reading/discussion of the primary literature. In the afternoon, students will perform hands-on experiments on different lab projects that put into practice the concepts and techniques discussed in class.
Instructor(s): W. Green, R. Carrillo Terms Offered: Spring
Prerequisite(s): Acceptance into the MBL Neuroscience Spring Quarter Program

NSCI 21530. DYNAMIC CAMOUFLAGE: Behavior, Visual Perception and Neural Skin Patterning in Cephalopods. 100 Units.
This course takes an integrative approach to understanding a neurally controlled system of dynamic defense against visual predators. Camouflage is a widespread form of defense throughout the animal kingdom in every known habitat - land or sea. In the oceans, cephalopods (cuttlefish, octopus, squid) have evolved a sophisticated sensorimotor system called Rapid Adaptive Coloration, which can instantaneously change their total body appearance within a fraction of a second to range from highly camouflaged to startlingly conspicuous for a wide range of behaviors. The forms and functions of this dynamic system will be teased apart in integrative fashion in a top-down approach from ecology to organismal biology to organs, tissues and cells. The course touches on neural anatomy, sensation, visual perception (including psychophysics) and animal behavior. There are also applied biology aspects of this system that will be presented as well.

Instructor(s): R. Hanlon Terms Offered: Spring
Prerequisite(s): Acceptance into the MBL Neuroscience Spring Quarter Program

NSCI 21600. Attention and Working Memory in the Mind and Brain. 100 Units.
This course will provide a broad overview of current work in psychology and neuroscience related to attention and working memory. We will discuss evidence for sharp capacity limits in an individual's ability to actively monitor and maintain information in an 'online' mental state. Readings will be primarily based on original source articles from peer-reviewed journals, with a focus on behavioral and neural approaches for measuring and understanding these basic cognitive processes.

Instructor(s): E. Vogel, E. Awh Terms Offered: Winter
Prerequisite(s): PQ: NSCI 20101 (Foundations of Neuroscience) is required for Neuroscience majors only.
Equivalent Course(s): PSYC 33830, PSYC 23820

NSCI 21610. Neuroanatomy of Cranial Nerves and Nuclei. 100 Units.
This hands-on laboratory course will cover the cranial nerves and their associated nuclei. The logic of cranial nerves, cranial nuclei, suprabulbar control, and thalamic projections will be described. The logic of predicting symptoms associated with lesions in these pathways will be explained. Students will learn how to understand and predict the clinical consequences of interruptions along cranial nerve pathways. Classes will consist of short lectures interspersed with examination and drawing of slides of stained brain sections using projection microscopes. There will be two field trips to local collections of brains and anatomical specimens.

Instructor(s): P. Mason Terms Offered: Autumn
Prerequisite(s): Enrollment into the Paris Study Abroad Program

NSCI 21750. Ethics through a Neurobiological Lens. 100 Units.
This class surveys a range of ethical dilemmas as viewed from a neurobiological perspective. Using their working knowledge of functional neuroanatomy, students will be expected to understand and articulate the reasoning behind multiple viewpoints for each topic. Then, students will be asked to discuss a particular case study that revolves around the week's topic, and write a one-page summary of what they learned from the week's discussion. For a final project, students will study one of the dilemmas presented or one of their own choosing.

Instructor(s): P. Mason Terms Offered: Spring
Prerequisite(s): At least one course in the Neuroscience Major Fundamental Sequence (NSCI 20101, OR NSCI 20111, OR NSCI 20130)
Equivalent Course(s): BIOS 28105

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.
Equivalent Course(s): NURB 32900, BIOS 24135

NSCI 21810. Principles of Cellular Neural Development. 100 Units.
This course describes fundamental principles of how brains grow up from the perspective of the basic organizational unit of brains, the cell. We will detail development from the very earliest events in zygotes to postnatal refinement of synaptic connections years after birth. We will endeavor to understand how principles of neural development were discovered, abandoned, and re-discovered using the lens of history and biography. We will accomplish these goals with readings of primary literature, discussions of the tools used to discover these principles, and debates on the tenacity of declaring that these principles exist.

Instructor(s): B. Kasthuri Terms Offered: Autumn
Prerequisite(s): NSCI 20101, NSCI 20111, or consent of instructor

NSCI 21900. Neuropharmacology. 100 Units.
This is a one quarter course that will explore neuronal pharmacology. Both the autonomic and central nervous system will be examined. The course has a clinical orientation. The course starts with an overview of the nervous system. In this section, we will explore the cellular aspects of neurons and their basic membrane and
electrophysiological properties as will cellular and molecular aspects of synaptic transmission. The majority of the course will explore different neurotransmitter systems and drugs that interact with these systems.  
Instructor(s): A. Fox  
Prerequisite(s): NSCI 20101, NSCI 20111  
Equivalent Course(s): BIOS 24140

**NSCI 22110. Neuroscience of Consciousness. 100 Units.**
Consciousness has been considered one of great mysteries in human existence. In this course, we will begin by trying to define the term and consider the so-called "hard" and "easy" problems of consciousness. A brief history of ancient civilizations' views on mental experience will be discussed. We will then go over basic neuroscientific concepts and methods that are being used to study the neural correlates of consciousness. We will explore different states of consciousness and disruptions of consciousness in human patients. We will touch on the related problems of intentionality and free will. Finally, we will discuss prevailing scientific theories of consciousness.  
Instructor(s): Hatsopoulos, Nicholas Terms Offered: Autumn  
Prerequisite(s): NSCI 20101

**NSCI 22130. Psychoactive drugs, the Brain and Behavior. 100 Units.**
The goal of this course is for the students to understand how psychoactive drugs affect the brain and behavior. Understanding how these drugs work will provide students a window in the relationship between the brain and behavior. Understanding how drugs affect the brain and behavior will also enhance the students understanding of the relationship between psychoactive drugs/medications and society.  
Instructor(s): H. de Wit, R. Lee, M. Xu, X. Zhuang Terms Offered: Winter  
Prerequisite(s): For UG: NSCI 20101, NSCI 20111 and NSCI 20130  
Equivalent Course(s): NURB 32130

**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. Neuroscience major undergrads need to have completed the Fundamentals of Neuroscience sequence.  
Instructor(s): E. Grove, P. Kratsios Terms Offered: Spring  
Prerequisite(s): For undergrads: NSCI 20110, 20120, 20130 and a basic understanding of Genetics, or "BIOS 20187" (Fundamentals of Genetics) is recommended, but not required.  
Equivalent Course(s): CPNS 32300, NURB 32300, DVBI 32300

**NSCI 22355. Observing Proteins in Action: How to Design and Build Your Own Instruments. 100 Units.**
New insights into cell function are now possible using technologies that resolve single molecules. However, as devices become more complicated, we are often faced with three questions: What is it that our instruments actually measure; how can we change the instrument to see a new behavior; and, how do we analyze the data to get the greatest insight? We will learn how to answer these questions by designing, building, and using our own electrical and optical instruments, making measurements, and then analyzing the results. Membrane proteins play an essential role in the behavior of all cells. We will study membrane protein channels in synthetic membranes, host cells, and giant axons from squid collected in the waters surrounding the MBL. The movement of electrical charge produced by conformational changes will be correlated with both the current passing through single channels and structural information obtained from light and electron microscopy. The course will proceed from simple measurements to student-designed projects.  
Instructor(s): E. Schwartz, F. Bezanilla, E. Perozo Terms Offered: Autumn. L. September term.  
Note(s): This course will be given at Marine Biological Laboratory, Woods Hole, Massachusetts
NSCI 22400. Neuroscience of Seeing. 100 Units.
This course focuses on the neural basis of vision, in the context of the following two questions: 1. How does the brain transform visual stimuli into neuronal responses? 2. How does the brain use visual information to guide behavior? The course covers signal transformation throughout the visual pathway, from retina to thalamus to cortex, and includes biophysical, anatomical, and computational studies of the visual system, psychophysics, and quantitative models of visual processing. This course is designed as an advanced neuroscience course for undergraduate and graduate students. The students are expected to have a general background in neurophysiology and neuroanatomy.
Instructor(s): W. Wei, J. Maunsell, M. Sherman, S. Shevell Terms Offered: Autumn
Prerequisite(s): NSCI 20111 or BIOS 24110 or consent of instructor
Equivalent Course(s): BIOS 24133, CPNS 34133, PSYC 24133, NURB 34133, PSYC 34133

NSCI 22415. Introduction to Learning and Memory. 100 Units.
This course examines basic questions in learning and memory. We discuss the historical separation and division of these two areas as well as the paradigmatic differences in studying learning and memory. We also discuss basic research methods for investigating learning and memory and survey established and recent research findings, as well as consider several different kinds of models and theories of learning and memory. Topics include skill acquisition, perceptual learning, statistical learning, working memory, implicit memory, semantic vs. episodic memory, and memory disorders.
Instructor(s): A. Bakkour Terms Offered: Spring
Equivalent Course(s): PSYC 23800, EDSO 23800

NSCI 22460. Anatomy of Selected Brain Circuits. 100 Units.
The course will provide an introduction to the anatomy and function of specific brain circuits. Students will participate in the dissection of human and sheep brains to uncover and describe gross-anatomical connectivity patterns of brain areas involved in cognition, learning, emotion, and movement control. We will use histological and microscopic techniques to visualize and describe circuits and specific types of neurons within these circuits. The course will further introduce students to the latest EM/histological reconstruction techniques.
Instructor(s): C. Hansel, B. Kasthuri Terms Offered: Spring
Prerequisite(s): NSCI 20101, NSCI 20130 or consent of instructor

NSCI 22535. The Psychology and Neurobiology of Stress. 100 Units.
This course explores the topic of stress and its influence on behavior and neurobiology. Specifically, the course will discuss how factors such as age, gender, and social context interact to influence how we respond to stressors both physiologically and behaviorally. The course will also explore how stress influences mental and physical health.
Instructor(s): G. Norman Terms Offered: Autumn
Note(s): This course does not meet the requirements for the Biological Sciences Major.
Equivalent Course(s): BIOS 29271, CHDV 25750, PSYC 25750

NSCI 22870. Neural Interfaces for Restoration and Augmentation. 100 Units.
The objective of this course is to survey the science and engineering that underlie Brain-Machine Interfaces (BMIs). This course will discuss a variety of neural interfaces to restore sensory or motor function. I will describe the neural systems and the hardware and algorithms involved, and explore the general principles that guide attempts to read signals directly from the nervous system to drive extra-corporeal devices, bypassing the muscles, and write signals back in to restore sensation, bypassing native sensory transduction. I will leverage BMI experiments taking place in Chicagoland (including UChicago) for live demonstrations of BMIs in action.
Instructor(s): S. Bensmaia Terms Offered: Autumn
Prerequisite(s): NSCI 20101
Equivalent Course(s): CPNS 32870, NURB 32870

NSCI 23400. Synaptic Physiology. 100 Units.
This course covers the basic principles of synaptic transmission and plasticity using a combination of lecture and discussion of primary literature. Lecture topics cover membrane electrical phenomena that lead to release of neurotransmitter presynaptically, as well as the physiological consequences of postsynaptic receptor activation. Paper discussions, which make up ~ 2/3 of the course, are centered on two major topics: 1) The molecular machinery controlling synaptic vesicle exocytosis and recycling, and 2) Synaptic plasticity covering LTP, LTD,
Metaplasticity, Spike-timing dependent plasticity and Homeostatic plasticity. There is significant emphasis on the connections between the various forms of synaptic modification and behavior.

Instructor(s): D. McGehee Terms Offered: Autumn
Prerequisite(s): Upper undergrads by consent of instructor
Equivalent Course(s): NURB 32400

NSCI 23480. Neurogenetics. 100 Units.
This course introduces human and mouse genetics through the lens of neurological disorders. It starts with genetic concepts and the principles of genetic approaches, followed by human genetic studies of neocortex development and original findings in repeat expansion diseases. We will discuss concurrent concepts in genetic diagnosis and therapeutic strategies. This course is open to graduate and upper-level undergraduate students. It combines lectures and discussion sections.
Instructor(s): X. Zhang Terms Offered: Spring
Prerequisite(s): BIOS 20187, NSCI 20101, or consent of instructor
Equivalent Course(s): HGEN 33480, NURB 33480

NSCI 23500. Survey of Systems Neuroscience. 100 Units.
This lab-centered course teaches students the fundamental principles of vertebrate nervous system organization. Students learn the major structures and the basic circuitry of the brain, spinal cord and peripheral nervous system. Somatic, visual, auditory, vestibular and olfactory sensory systems are presented in particular depth. A highlight of this course is that students become practiced at recognizing the nuclear organization and cellular architecture of many regions of brain in rodents, cats and primates.
Instructor(s): Oswald, A. M. Terms Offered: Autumn
Prerequisite(s): Neuroscience Majors: NSCI 20130, Biological Sciences Majors: NSCI 20101-20130, or three quarters of a Biological Sciences fundamentals sequence
Note(s): Undergrads by consent only
Equivalent Course(s): NURB 31600, ORGB 32500, CPNS 30116

NSCI 23700. Methods in Computational Neuroscience. 100 Units.
Topics include (but are not limited to): relating neural data to behavior, Signal Detection theory, models of vision and artificial neural networks, Information Theory, Generalized Linear Models, dimensionality reduction, classification, and clustering.
Instructor(s): M. Kaufman Terms Offered: Winter. L.
Prerequisite(s): For Neuroscience Majors: NSCI 20130, BIOS 26210 and BIOS 26211 which must be taken concurrently, or consent of instructor.
Equivalent Course(s): CPNS 34231, PSYC 24231, BIOS 24231

NSCI 23810. Neurons and Glia: A cellular and molecular perspective. 100 Units.
This course will be an interactive, in-depth analysis of the cell biology of neurons and glia. We will learn and discuss the latest techniques used, for example, to study the structure and function of neuronal proteins. In this way we will illuminate the central concepts that define our understanding of the cell and molecular biology of neurons and glia. The course will consist of lectures and critical reading of contemporary literature.
Instructor(s): R. Carrillo; W. Green Terms Offered: Spring
Prerequisite(s): Neuroscience Majors: NSCI 20101-20130 (Fundamental Neuroscience Sequence) Biological Sciences Majors: NSCI 20101-20130, or three quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): NURB 34810, BIOS 24251

NSCI 24000. Modeling and Signal Analysis for Neuroscientists. 100 Units.
The course provides an introduction into signal analysis and modeling for neuroscientists. We cover linear and nonlinear techniques and model both single neurons and neuronal networks. The goal is to provide students with the mathematical background to understand the literature in this field, the principles of analysis and simulation software, and allow them to construct their own tools. Several of the 90-minute lectures include demonstrations and/or exercises in Matlab.
Instructor(s): W. van Drongelen Terms Offered: Spring, L.
Prerequisite(s): Undergraduates: Biology Major - BIOS 26210 and 26211, or consent of instructor. Neuroscience Major - NSCI 20130, BIOS 26210 and 26211, or consent of instructor.
Equivalent Course(s): BIOS 24408, CPNS 32111

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 II. 100 Units.
Second quarter of scholarly or research thesis that follows NSCI 29100
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 III. 100 Units.
Third quarter of scholarly or research thesis for BS students
Instructor(s): Staff Terms Offered: Autumn Spring Summer Winter
Prerequisite(s): NSCI 29101, and consent of instructor, and approval of major director.

**NSCI 29200. Neuroscience Honors 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. Open to Neuroscience majors who are candidates for honors in Neuroscience.

**NSCI 29201. Neuroscience Honors Thesis Research II. 100 Units.**
Second quarter of BS Honors student thesis research
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 III. 100 Units.**
Third quarter of BS Honors student thesis research
Instructor(s): Staff
Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): NSCI 29201, and consent of instructor, and approval of major director. Open to Neuroscience majors who are candidates for honors in Neuroscience.

**NSCI 29700. Reading and Research in Neuroscience. 100 Units.**
BA Students can do reading and research in an area of neuroscience under the guidance of a faculty member. A written report is required at the end of the quarter.
Instructor(s): Staff
Terms Offered: Autumn, Spring, Summer, Winter
Prerequisite(s): By consent of instructor and approval of NSCI Undergraduate Director.
Note(s): Must be a Bachelor of Arts student. Students are required to submit the College Reading & Research form.