Neuroscience

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.

General Education Requirements for the Major

To complete the general education and major requirements in a directed way, students who wish to major in Neuroscience should declare the major in their second year.

Students majoring in Neuroscience have three options for fulfilling the general education requirement in the biological sciences. The first and recommended path is to begin with BIOS 20186 Fundamentals of Cell and Molecular Biology and take one of the following: BIOS 20153 (formerly BIOS 20150), BIOS 20151, BIOS 20152, BIOS 20187, BIOS 20188, or BIOS 20191. (Note: The general education requirement in the biological sciences for the Neuroscience major 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).

Alternative paths to fulfilling the general education requirement in the biological sciences exist. Neuroscience majors may take the Pre-Med Sequence for Non–Biological Sciences Majors. In this case, BIOS 20170 Microbial and Human Cell Biology and BIOS 20171 Human Genetics and Developmental Biology will satisfy the general education requirement in the biological sciences. Or, the final option is a score of 4 or 5 on the Advanced Placement Biology exam, which allows students to enter the Advanced Biology sequence in the Autumn Quarter 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 that satisfy the general education requirement in the biological sciences.

GENERAL EDUCATION

One of the following BIOS sequences:* 200
BIOS 20186 Fundamentals of Cell and Molecular Biology

Plus one of the following:

BIOS 20153 Fundamentals of Ecology and Evolutionary Biology
or 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 Microbial and Human Cell Biology
& BIOS 20171 Human Genetics and Developmental Biology #

OR

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

One of the following two-course MATH sequences: 200
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: 200
CHEM 10100 Introductory General Chemistry I
& CHEM 10200 and Introductory General Chemistry II
CHEM 11100-11200 Comprehensive General Chemistry I-II
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 (or related) electives in addition to the required major curriculum. Elective courses can be tailored for a broad exposure to the many aspects of neuroscience or for depth in a particular area, such as cognitive neuroscience or machine learning.

Bachelor of Arts Degree in Neuroscience

The basic degree in Neuroscience is the bachelor of arts. To qualify for a BA, students must take 700 units of elective courses as described in the table below.

### MAJOR: BACHELOR OF ARTS REQUIRED COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<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>
<tr>
<td>PHYS 12100-12200</td>
<td>General Physics I-II (or higher) *</td>
<td>200</td>
</tr>
<tr>
<td>STAT 22000</td>
<td>Statistical Methods and Applications *</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20100</td>
<td>Neuroscience Laboratory</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20111</td>
<td>Cellular Neurophysiology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20121</td>
<td>Structure of the Nervous System</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>At least five Neuroscience electives ***</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>No more than two related electives ^</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

Total Units 1600

* Credit may be granted by examination.
^ May also include additional neuroscience electives
*** While students may register for multiple quarters of NSCI 29700 Reading and Research in Neuroscience, only one may be counted toward major requirements.

Students interested in double majoring in Neuroscience and Biological Sciences must meet with the NSCI advisors to discuss restrictions on double counting courses.

Bachelor of Science Degree in Neuroscience

Students can earn a bachelor of science in Neuroscience by completing three quarters of neuroscience electives over and above the BA requirements, which must include one to three quarters of faculty-supervised research (scholarly or experimental) that results in a written thesis (NSCI 29100 Neuroscience Thesis Research, NSCI 29101 Neuroscience Thesis Research, NSCI 29102 Neuroscience Thesis Research). Note that Neuroscience Thesis Research (NSCI 29100, NSCI 29101, NSCI 29102) must be completed prior to the final quarter of the student’s graduating year to allow sufficient preparation time for the written document and presentation. The additional neuroscience electives and the thesis work require approval by the office of the director of undergraduate studies and the thesis advisor.

### MAJOR: BACHELOR OF SCIENCE REQUIRED COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CHEM 11300</td>
<td>Comprehensive General Chemistry III *</td>
<td>100</td>
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<tr>
<td>or CHEM 12300</td>
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<td>STAT 22000</td>
<td>Statistical Methods and Applications *</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 20100</td>
<td>Neuroscience Laboratory</td>
<td>100</td>
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<tr>
<td>NSCI 20111</td>
<td>Cellular Neurophysiology</td>
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<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>
</tbody>
</table>

Total Units 1600

* Credit may be granted by examination.
^ May also include additional neuroscience electives

Students interested in double majoring in Neuroscience and Biological Sciences must meet with the NSCI advisors to discuss restrictions on double counting courses.
At least eight Neuroscience electives ** 800
No more than two related electives ^ 200
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

Electives

NEUROSCIENCE ELECTIVES (no fewer than five)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSCI 20500</td>
<td>Neuroanatomy</td>
<td>100</td>
</tr>
<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>NSCI 21100</td>
<td>Photons to Consciousness: Cellular and Integrative Brain Functions</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21300</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 21600</td>
<td>Attention and Working Memory in the Mind and Brain</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21800</td>
<td>Perspectives in Drug Abuse</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 21900</td>
<td>Neuropharmacology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22000</td>
<td>Gazing into the Black Box: Neocortex</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22100</td>
<td>Molecular Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22300</td>
<td>Molecular Principles of Nervous System Development</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22400</td>
<td>Neuroscience of Seeing</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 22500</td>
<td>Neuroscience of Communication</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23400</td>
<td>Synaptic Physiology</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23500</td>
<td>Survey of Systems Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23600</td>
<td>Computational Approaches to Cognitive Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23700</td>
<td>Methods in Computational Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 23800</td>
<td>Neurons and Glia: Advanced Cellular and Molecular Topics</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>
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<tr>
<td>NSCI 29101</td>
<td>Neuroscience Thesis Research</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29102</td>
<td>Neuroscience Thesis Research</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</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29202</td>
<td>Neuroscience Honors Thesis Research</td>
<td>100</td>
</tr>
<tr>
<td>NSCI 29700</td>
<td>Reading and Research in Neuroscience</td>
<td>100</td>
</tr>
<tr>
<td>BIOS 24217</td>
<td>Conquest of Pain</td>
<td>100</td>
</tr>
<tr>
<td>BIOS 27721</td>
<td>Observing Proteins in Action: How to Design and Build Your Own Instruments</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 25050</td>
<td>Computer Vision</td>
<td>100</td>
</tr>
<tr>
<td>CMSC 25400</td>
<td>Machine Learning</td>
<td>100</td>
</tr>
<tr>
<td>LING 27010</td>
<td>Psycholinguistics</td>
<td>100</td>
</tr>
<tr>
<td>PSYC 20300</td>
<td>Biological Psychology</td>
<td>100</td>
</tr>
<tr>
<td>PSYC 20400</td>
<td>Cognitive Psychology</td>
<td>100</td>
</tr>
<tr>
<td>PSYC 23800</td>
<td>Introduction to Learning and Memory</td>
<td>100</td>
</tr>
<tr>
<td>PSYC 25750</td>
<td>The Psychology and Neurobiology of Stress</td>
<td>100</td>
</tr>
</tbody>
</table>

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

RELATED ELECTIVES (no more than two)

No more than two of the following BIOS courses: 200

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</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>
</tr>
</tbody>
</table>
**Neuroscience**

<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>

**CMSC 12100-12200**  Computer Science with Applications I-II  200

**CMSC 15100-15200**  Introduction to Computer Science I-II  200

**CMSC 16100-16200**  Honors Introduction to Computer Science I-II  200

**BIOS 20200**  Introduction to Biochemistry  100

**BIOS 26210**  Mathematical Methods for Biological Sciences I  100

**BIOS 26211**  Mathematical Methods for Biological Sciences II  100

**CMSC 15400**  Introduction to Computer Systems  100

**PHYS 12300**  General Physics III  100

**or PHYS 13300**  Waves, Optics, and Heat  100

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**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 GPA of 2.0 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.

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**Honors in Neuroscience**

To obtain honors in Neuroscience, students must have a minimum GPA of 3.5 in the major and an overall cumulative GPA of 3.25 at the point of entering the honors track, no later than the end of the third year. Only students who receive a BS will be eligible for honors. Entry into the honors track must be approved by the director of undergraduate studies. Students must do full-time paid experimental research over the summer between their third and fourth years (students accepted into the honors program will receive funding from the department). Students continue with part-time research effort for three quarters throughout their fourth year (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.

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**Minor in Neuroscience**

The minor in Neuroscience is intended to provide neuroscientific literacy for students whose primary interest lies in other fields. Students must meet the general education requirements in the biological and physical sciences before entering the program. Two BIOS courses at the 10000-level or above plus MATH 13100-13200 Elementary Functions and Calculus I-II are the minimum general education requirements for the minor. Students interested in completing the minor are encouraged to take BIOS 20186 Fundamentals of Cell and Molecular Biology and BIOS 20188 Fundamentals of Physiology to complete their general education requirement in the biological sciences. (Note that students in these courses will be expected to be familiar with the concepts introduced in BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced)).

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**Summary of Requirements for the Minor in Neuroscience**

**REQUIRED COURSES FOR THE MINOR IN NEUROSCIENCE**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSCI 20111</td>
<td>Cellular Neurophysiology</td>
</tr>
<tr>
<td>NSCI 20121</td>
<td>Structure of the Nervous System</td>
</tr>
<tr>
<td>NSCI 20130</td>
<td>Systems Neuroscience</td>
</tr>
</tbody>
</table>

Four electives  400

Total Units  700

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 minor can be double counted with the student’s major(s) or with other minors, nor can it be counted toward general education requirements.
ELECTIVES FOR THE MINOR IN NEUROSCIENCE

NSCI 20140 Sensation and Perception 100
NSCI 20500 Neuroanatomy 100
NSCI 20510 Evolution and the Nervous System 100
NSCI 21000 Social Neuroscience 100
NSCI 21100 Photons to Consciousness: Cellular and Integrative Brain Functions 100
NSCI 21400 Biological Clocks and Behavior 100
NSCI 21600 Attention and Working Memory in the Mind and Brain 100
NSCI 21800 Perspectives in Drug Abuse 100
NSCI 21900 Neuropharmacology 100
NSCI 22000 Gazing into the Black Box: Neocortex 100
NSCI 22100 Molecular Neuroscience 100
NSCI 22300 Molecular Principles of Nervous System Development 100
NSCI 22400 Neuroscience of Seeing 100
NSCI 22500 Neuroscience of Communication 100
NSCI 23400 Synaptic Physiology 100
NSCI 23500 Survey of Systems Neuroscience 100
NSCI 23600 Computational Approaches to Cognitive Neuroscience 100
NSCI 23700 Methods in Computational Neuroscience 100
NSCI 23800 Neurons and Glia: Advanced Cellular and Molecular Topics 100
NSCI 24000 Modeling and Signal Analysis for Neuroscientists 100
BIOS 24217 Conquest of Pain 100
BIOS 27721 Observing Proteins in Action: How to Design and Build Your Own Instruments 100
CMSC 25025 Machine Learning and Large-Scale Data Analysis 100
CMSC 25050 Computer Vision 100
CMSC 25400 Machine Learning 100
LING 27010 Psycholinguistics 100
PSYC 20300 Biological Psychology 100
PSYC 20400 Cognitive Psychology 100
PSYC 23800 Introduction to Learning and Memory 100
PSYC 25750 The Psychology and Neurobiology of Stress 100
STAT 22000 Statistical Methods and Applications 100

Neuroscience Courses

NSCI 00292. Neuroscience Honors Thesis Research. 000 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; M. McNulty Terms Offered: Winter
Prerequisite(s): NSCI 20111. Must be a Neuroscience Major

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: Autumn
Prerequisite(s): At least one quarter of Biological Sciences instruction, AND MATH 13100, or MATH 15100, or MATH 16100. Or consent of instructor
Equivalent Course(s): BIOS 24111
NSCI 20121. Structure of the Nervous System. 100 Units.
The anatomy and circuit physiology of the vertebrate brain will be presented in depth. We will introduce the molecular genetics of neuronal cell biology, the evolution and development of nervous systems, and the organization of the chemical senses. The laboratory component of this course will include brain dissections and the clinical presentation of individuals with neurological disorders.
Instructor(s): P. Mason, C. Ragsdale Terms Offered: Winter
Prerequisite(s): NSCI 20111
Equivalent Course(s): BIOS 24121

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 Terms Offered: Spring
Prerequisite(s): NSCI 20111, NSCI 20121 or consent of instructors
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: Spring
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 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): PSYC 22350, BIOS 24137, CHDV 22350, ECON 21830, HLTH 22350

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 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 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. Awh, E. Vogel Terms Offered: Winter
Prerequisite(s): PQ: NSCI 20110 (Fundamental Neuroscience) is required for Neuroscience majors only.
Equivalent Course(s): PSYC 23820

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 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 Terms Offered: Autumn Spring. Autumn Quarter: Adm to Aut Paris Study Abroad Program
Prerequisite(s): NSCI 20111, NSCI 20121
Equivalent Course(s): BIOS 24140

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. This course will not be taught in Autumn 2019. Course will resume in Autumn 2020.
Prerequisite(s): NSCI 20111, 20121, 20130 or consent of instructor. For Biology majors: Three quarters of a Biological Sciences Fundamentals sequence.
Equivalent Course(s): CPNS 34200, BIOS 24226

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 20111, NSCI 20121 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. Neuroscience major undergrads need to have completed the Fundamentals of Neuroscience sequence.
Instructor(s): E. Grove, P. Kratsios Terms Offered: Winter
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): DVBI 32300, NURB 32300, CPNS 32300
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): PSYC 34133, BIOS 24133, PSYC 24133, CPNS 34133, NURB 34133

NSCI 22500. Neuroscience of Communication. 100 Units.
We will read and discuss communication and how various kinds of communication are mediated by neural systems. The course will cover theories, methods, and empirical findings in communication neuroscience. Topics will include speech and language, emotional information, face perception, gesture, and music.
Instructor(s): H. Nusbaum Terms Offered: Spring
Equivalent Course(s): PSYC 21510, PSYC 31510

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: Spring
Prerequisite(s): Upper undergrads by consent of instructor
Equivalent Course(s): NURB 32400

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): S. Bensmaia Terms Offered: Autumn
Prerequisite(s): NSCI 20130. For Biological Sciences majors: Three quarters of a Biological Sciences fundamentals sequence
Equivalent Course(s): NURB 31600, ORGB 32500, BIOS 24208, CPNS 30116

NSCI 23600. Computational Approaches to Cognitive Neuroscience. 100 Units.
This course is concerned with the relationship of the nervous system to higher order behaviors (e.g., perception, object recognition, action, attention, learning, memory, and decision making). Psychophysical, functional imaging, and electrophysiological methods are introduced. Mathematical and statistical methods (e.g. neural networks and algorithms for studying neural encoding in individual neurons and decoding in populations of neurons) are discussed. Weekly lab sections allow students to program cognitive neuroscientific experiments and simulations.
Instructor(s): N. Hatsopoulos Terms Offered: Winter
Prerequisite(s): For Neuroscience Majors: NSCI 20110, NSCI 20130, BIOS 26210, and knowledge using Matlab, or consent of instructor.
Equivalent Course(s): PSYC 34410, CPNS 33200, BIOS 24232, ORGB 34650

NSCI 23700. Methods in Computational Neuroscience. 100 Units.
Topics include (but are not limited to): Hodgkin-Huxley equations, Cable theory, Single neuron models, Information theory, Signal Detection theory, Reverse correlation, Relating neural responses to behavior, and Rate vs. temporal codes.
Instructor(s): S. Bensmaia 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 23800. Neurons and Glia: Advanced Cellular and Molecular Topics. 100 Units.
This is not a survey course and will provide in-depth analysis of topics in the areas of molecular and cell biology of the nervous system selected by the faculty. The topics to be covered this year are: 1) structure and function of neuronal proteins 2) cell biology of neurons and synapses, 3) neurochemistry and metabolism of neurons, and 4) cell biology of glia. Each topic will be covered as a unit that will start with the main techniques used in that area of research followed by central concepts. Each week will usually consist of two faculty lectures where key papers on that specific topic are assigned and analyzed. In the third session, there will be assigned papers on specific topics from the faculty lectures that will be presented and discussions led by the students.
Instructor(s): W. Green; R. Carrillo Terms Offered: Winter
Prerequisite(s): Required: NSCI 20111, NSCI 20121, NSCI 20130 or consent of Instructor Recommended: BIOS 20200 Equivalent Course(s): NURB 34800, BIOS 24141

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. 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 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. 100 Units.
NSCI 29200, and consent of instructor, and approval of major director. Open to Neuroscience majors who are candidates for honors in Neuroscience.
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 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.
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.