NEUROSCIENCE

Director: Annemarie Shibata, Ph.D.

Department Office: Biology Department, Hixson-Lied Science Building, Room 422

The Neuroscience Program, housed within the Biology department, is a multidisciplinary program designed to provide an integrated, comprehensive, and investigatory learning experience that imparts a broad and strong understanding of the fundamental concepts and research principles that form the neurosciences.

Neuroscience is the study of 1) how the nervous system controls and responds to bodily functions and directs behavior; 2) how nervous system structure and function are determined by genes and the environment; and 3) how the brain serves as the foundation of the mind, awareness and thought. The Bachelor of Science with a major in Neuroscience is intended for students interested in pursuing careers in a variety of health professions and graduate programs, scientific research in academia and industry, or related life science careers.

The mission of the Neuroscience major is to deliver a comprehensive curriculum in neuroscience providing students with thorough understanding of neuroscience principles and modern application. This program will provide technical and intellectual skills for neuroscience and neuroscience related careers. Our role is also to work with colleagues across disciplines in the College of Arts and Sciences and Health and Professional Schools to develop students who understand what science contributes and what methodologies it necessitates. Our program will explain and reinforce how neuroscience contributes to our understanding of human behavior and will join with the Magis Core curriculum at Creighton to shape well-informed students/citizens.

Participating Departments and Faculty

Various faculty from the following departments participate in our multidisciplinary major: Biology, Psychology, Physics, Computer Science, Mathematics, Chemistry, Philosophy, and Pharmacology and Neuroscience.

Specific Requirements for Admission to the Neuroscience Major

- Admission to the B.S., Major in Neuroscience program requires sophomore standing, completion of General Biology lecture and laboratory series, General Chemistry lecture and laboratory series, and Introduction to Psychology courses, with a minimum GPA of 3.0 in those pre-requisites.

Course requirements (71 credits)

Pre-requisites and Support courses (31 credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIO 201</td>
<td>General Biology: Organismal and Population</td>
<td>3</td>
</tr>
<tr>
<td>BIO 205</td>
<td>General Biology: Cellular and Molecular Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>BIO 206</td>
<td>General Biology: Organismal and Population Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>BIO 362</td>
<td>Cell Structure and Function</td>
<td>3</td>
</tr>
<tr>
<td>CHM 203</td>
<td>General Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHM 204</td>
<td>General Chemistry I Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CHM 205</td>
<td>General Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>or CHM 285</td>
<td>Advanced General Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHM 206</td>
<td>General Chemistry II Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>or CHM 286</td>
<td>Chemical and Statistical Analysis Laboratory</td>
<td>1</td>
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</tbody>
</table>

Support courses

Chemistry support

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CHM 321</td>
<td>Organic Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHM 322</td>
<td>Organic Chemistry I Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

Physics support

Choose 1 of the Physics course sequences below:

Option 1 (recommended for pre-medical, pre-health and pre-graduate program students)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>PHY 201</td>
<td>General Physics for the Life Sciences</td>
<td>3</td>
</tr>
<tr>
<td>PHY 205</td>
<td>General Physics Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>PHY 202</td>
<td>General Physics for the Life Sciences II</td>
<td>3</td>
</tr>
<tr>
<td>PHY 206</td>
<td>General Physics Laboratory II</td>
<td>1</td>
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</tbody>
</table>

Option 2 (recommended for students interested in electives requiring calculus-based physics)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 213</td>
<td>General Physics for the Physical Sciences I</td>
<td>3</td>
</tr>
<tr>
<td>PHY 205</td>
<td>General Physics Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>PHY 214</td>
<td>General Physics for the Physical Sciences II</td>
<td>3</td>
</tr>
<tr>
<td>PHY 206</td>
<td>General Physics Laboratory II</td>
<td>1</td>
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</table>

Option 3 (given approval from the Physics Department)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>PHY 221</td>
<td>Advanced General Physics I:Modeling the Physical World</td>
<td>3</td>
</tr>
<tr>
<td>PHY 223</td>
<td>Project Physics Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>PHY 222</td>
<td>Advanced General Physics II:Modeling the Physical World</td>
<td>3</td>
</tr>
</tbody>
</table>

Neuroscience Core Requirements (28 credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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</tr>
</thead>
<tbody>
<tr>
<td>PSY 437</td>
<td>Behavioral Neuroscience</td>
<td>3</td>
</tr>
<tr>
<td>BIO 462</td>
<td>Neurobiology</td>
<td>3</td>
</tr>
<tr>
<td>BIO 463</td>
<td>Neurobiology Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>PHL 350</td>
<td>Introduction to Neuropharmacology</td>
<td>3</td>
</tr>
<tr>
<td>PHL 424</td>
<td>Philosophy of Mind</td>
<td>3</td>
</tr>
<tr>
<td>NES 510</td>
<td>Neurophysiology Lab</td>
<td>2</td>
</tr>
<tr>
<td>NES 592</td>
<td>Neuroscience Senior Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

Select one of the following: 3 credits

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<tr>
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<tbody>
<tr>
<td>BIO 467</td>
<td>Developmental Biology</td>
<td>3</td>
</tr>
<tr>
<td>NES/BIO 464</td>
<td>Neurobiology of Disease</td>
<td>3</td>
</tr>
<tr>
<td>PHL 404</td>
<td>Bioethics and Society</td>
<td>2</td>
</tr>
<tr>
<td>PHL 425</td>
<td>Sciences, Ethics &amp; Society</td>
<td>2</td>
</tr>
<tr>
<td>PHL 457</td>
<td>Biomedical Ethics: Philosophical and Theological Approaches</td>
<td>3</td>
</tr>
</tbody>
</table>

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<tbody>
<tr>
<td>BIO 449</td>
<td>Physiology</td>
<td>3</td>
</tr>
<tr>
<td>PHA 404</td>
<td>Human Physiology (Follows Pharmacy School Schedule)</td>
<td>3</td>
</tr>
</tbody>
</table>

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<tr>
<td>BIO 362</td>
<td>Cell Structure and Function</td>
<td>3</td>
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</table>
Electives: 4 courses

Select one of the following:

- BIO 311 Bioinformatics
- PSY 370 Applying Research Methods and Statistics in Psychology
- MTH 360 Elementary Probability and Statistics
- MTH 361 Probability and Statistics in the Health Sciences

A minimum of 4 additional courses (12 hours) from any of the following groups:

**Cellular and Organismal Neuroscience**
- NES 464 Neurobiology of Disease
- NES 466 Pharmacology of Drugs and Abuse
- NES 500 Introduction to Clinical Neuroscience
- BIO 371 Animal Behavior
- BIO 372 Animal Behavior Laboratory
- BIO 467 Developmental Biology
- BIO 567 Current Topics in Neuroscience

**Behavioral Neuroscience**
- PSY 351 Psychopathology
- PSY 361 Neuropsychology
- PSY 431 Cognitive Psychology
- or PSY 441 Cognitive Neuroscience
- PSY 434 Learning: Basic Processes
- PSY 436 Sensation and Perception

**Physical Neuroscience**
- PHY 301 Modern Physics
- PHY 302 Modern Physics Laboratory
- PHY 303 Electronics Laboratory
- PHY 351 Physics in Medicine
- PHY 353 Introduction to Biological Physics
- PHY 565 Radiation Biophysics
- PHY 566 Physics of Medical Imaging I
- PHY 567 Physics of Medical Imaging II

**Computational Neuroscience**
- BIO 501 Bioinformatics
- MTH 429 Advanced Linear Algebra
- MTH 445 Advanced Differential Equations
- MTH 448 Mathematics in Medicine and Life Sciences II
- CSC 321 Data Structures
- CSC 421 Algorithm Design and Analysis
- CSC 550 Introduction To Artificial Intelligence
- CSC 590 Special Topics

**Philosophical Neuroscience**
- PHL 321 Epistemology
- PHL 333 Philosophy Of The Human Sciences
- PHL 334 Philosophy Of The Natural Sciences
- PHL 342 Metaphysics

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**Research - Introduction to Research Design and Methods (Instructor Consent)**

NES 297 Directed Research

**Neuroscience Research Designation (Optional - Instructor Consent)**

An equivalent of two semesters worth of directed research credit is required (NES 397, NES 497). Research of 0 credits may be taken if the student has reached 18hrs of course credit. The research designation will be met by submission of a written abstract and evaluation of a presentation (oral and/or written) of the research project at a local, regional, and/or national meetings for each semester of NES 397 or NES 497.

NES 397 Directed Independent Research (Extramural) 0 to 3 credits
NES 497 Directed Independent Research (Intramural) 0 to 3 credits

**Courses**

**NES 297. Directed Research. 0-3 credits.**

An introduction to laboratory methods intended to prepare students for independent research. This course is only an addition to and not a substitution for any portion of the major requirement. This course may not be repeated; research students should enroll in NES 397 or 497 in subsequent semesters. No more than 12 semester hours of credit may be accrued in any combination of NES 297, 397, 493, 495, and 497. P: Instructor’s Consent.

**NES 397. Directed Independent Research (Extramural). 0-3 credits.**

A program of independent study emphasizing laboratory or field research, intended for students working with mentors outside of the Biology department housing the Neuroscience major or the College of Arts and Sciences. The director of the Neuroscience serves as the instructor of record and oversees completion of course requirements by the student under the research supervision of the outside mentor. No more than 12 semester hours of credit may be accrued in any combination of NES 297, 397, 493, 495, and 497. P: Instructor consent.

**NES 464. Neurobiology of Disease. 3 credits. (Same as BIO 464; Meets Designated Ethics & Written Comm)**

To understand neurological disease, its profession, and discover novel therapeutics requires in-depth knowledge of the cellular and molecular underpinnings of the disorders. Students will revisit concepts from prerequisite courses but apply them to the function and activity of the brain and to circumstances where normal biology breaks down. P: Ethics; Contemporary Composition; BIO 202 and BIO 362.

**NES 466. Pharmacology of Drugs and Abuse. 3 credits.**

The course will introduce the psychopharmacology of drug abuse and addiction, and has a strong neuroscience orientation. An introduction to pharmacologic thought and basic principles will be provided. The acute and long-term effects of selected drugs of abuse on behavior, mood, cognition and neuronal function will be discussed. Studies with humans will be integrated with basic preclinical studies on the neuropsychological basis of drug action and drug abuse. There will be detailed coverage of synaptic transmission and the distribution, regulation and integration of brain neurotransmitter systems. The focus is on addictive drugs, including: opiates (heroin, morphine, opium), sedative - hypnotics (alcohol, barbiturates), anxiolytics (benzodiazepines), psychomotor stimulants (amphetamine, cocaine, nicotine), marijuana, hallucinogens (LSD, mescaline), hallucinogen-stimulants (MDA, MDMA), and dissociative anesthetics (PCP). P: BIO 201, CHM 203, PSY 201, PSY 437.
NES 497. Directed Independent Research (Intramural). 0-3 credits.
A program of independent study emphasizing laboratory or field
research, intended for students working with mentors within the Biology
department housing the Neuroscience Program. The mentor acts as the
instructor of record. No more than 12 semester hours of credit may be
accrued in any combination of NES 297, 397, 495, and 497. P: Instructor’s
consent.

NES 500. Introduction to Clinical Neuroscience. 4 credits.
This course provides an introduction to the various diseases and injuries
that affect the human nervous system, an introduction to the professions
that work with neurologically impaired individuals and recent research
into the treatment of these disorders. The topics covered will include the
underlying pathology and mechanisms, the signs, symptoms and deficits,
patient management, and the prognosis of selected diagnoses including
(but not limited to) spinal cord injury, chronic traumatic encephalopathy,
Alzheimer’s disease, Parkinson’s disease, bipolar disorder. Included will
be a survey of the training and role of the various healthcare professions
that address neurological impairments. Relevant research concerning
the pathophysiology of nervous system disorders and the repair and
regeneration of nervous system tissue will be introduced. P: BIO 462, BIO
463 or instructor consent.

NES 510. Neurophysiology Lab. 2 credits.
This laboratory course is focused on delivering extensive instruction
and exploration of neurophysiology and neural basis of behavior
with emphasis on the mastering of techniques used within the
field of neuroscience to evaluate electrical activity and intracellular
communication within the nervous system. The course is designed to
build upon and allow for mastering of neurophysiology concepts and
techniques learned in BIO 463, Neurobiology Laboratory. This team-
taught course draws upon diverse expertise of instructors to deliver a
comprehensive course using both invertebrate and vertebrate models
for the study of neurophysiology. Students will use neuronal systems
network modeling during hands-on laboratory activities and will be
expected to apply the scientific method during the implementation and
critical analysis of experiments involving model systems. Students will
meet the designated writing component of the Magis Core curriculum
by writing an independent grant proposal directed at testing a novel
hypothesis in the field of neurophysiology. The grant proposal will serve
as a mechanism to improve students' written communication, critical
thinking and problem solving skills. P: BIO 462, BIO 463 or instructor consent.

NES 566. Pharmacology of Drugs and Abuse. 4 credits.
This course will introduce the psychopharmacology of drug abuse and
addiction, and has a strong neuroscience orientation. An introduction to
pharmacologic thought and basic principles will be provided. The acute
and long-term effects of selected drugs of abuse on behavior, mood,
 cognition and neuronal function will be discussed. Studies with humans
will be integrated with basic preclinical studies on the neurobiological
basis of drug action and drug abuse. There will be detailed coverage of
synaptic transmission and the distribution, regulation and integration
of brain neurotransmitter systems. The focus is on addictive drugs,
including: opiates (heroin, morphine, opium), sedative-hypnotics (alcohol,
barbiturates), anxiolytics (benzodiazepines), psychomotor stimulants
(amphetamine, cocaine, nicotine), marijuana, hallucinogens (LSD,
mescaline), hallucinogenic-stimulants (MDA, MDMA), and dissociative
anesthetics (PCP). P: BIO 201; CHEM 203; PSY 201; PSY 437; and
Instructor consent.

NES 592. Neuroscience Senior Seminar. 1 credit.
This course covers in-depth reading and discussions on current
neuroscience research topics. Students will learn to critically
review current scientific papers. Students will be expected to select,
read, present and lead discussions of scientific articles covering
prevailing theories, concepts, ideas, and experimental techniques in
neuroscience. This course will meet the Magis Core Designation for
Oral Communication by recording and evaluating student presentations
for accuracy of content, mastery of scientific discipline, effective oral
delivery, and engagement of the audience. P: Oral Communication course;
Senior Standing.