

# NORTHWESTERN UNIVERSITY INTERDEPARTMENTAL NEUROSCIENCE PROGRAM (NUIN)

Degree Types: PhD

Northwestern University Interdepartmental Neuroscience Program (<https://www.nuin.northwestern.edu/>) (NUIN) is a highly interactive and collaborative program, with faculty distributed across more than 20 departments on the Chicago and Evanston campuses. Our program encourages interdisciplinary neuroscience research among six NU-affiliated centers, including in the Feinberg School of Medicine (FSM), Shirley Ryan Ability Lab, and Lurie Children's Hospital on NU's Chicago campus, and the Weinberg College of Arts and Sciences (WCAS), McCormick School of Engineering, and the School of Communication on the Evanston campus. NUIN faculty pursue a broad range of research interests including molecular and developmental neuroscience, cellular physiology, cognition and systems neuroscience, and medical or 'translational' research. Training in research is supplemented with core and elective coursework, mentorship, teaching and other professional development opportunities.

This program attracts applicants from a broad array of academic backgrounds, including neuroscience, biology, computer science, chemistry, engineering, physics, and psychology. Our curriculum is designed to embrace this diversity while also providing intensive training in fundamental principles of neuroscience.

## Additional resources:

- Department website (<https://www.nuin.northwestern.edu/>)
- Program handbook(s)

## Degree Offered

- Interdepartmental Neuroscience Program (NUIN) PhD (<https://catalogs.northwestern.edu/tgs/nuin/interdepartmental-neuroscience-programs-phd/>)

Learning objective(s)/Students should be able to...

- Comprehend fundamental principles of neuroscience
- Develop critical thinking skills
- Communicate science in written and oral formats
- Develop a depth and breadth of knowledge in their research field
- Contribute to their field
- Conduct ethical and reproducible research

## Northwestern University Interdepartmental Neuroscience Program (NUIN) Courses

### NUIN 401-1 Fundamentals of Neuroscience (1 Unit)

This course fulfills the Fundamentals Core Class requirement for first-year graduate students in the NUIN program. Lectures and discussion sections are organized by class module directors, lectures and discussion

sections are team-taught. This course covers neurogenetics/cell biology and cellular neurophysiology.

### NUIN 401-2 Fundamentals of Neuroscience (1 Unit)

This course fulfills the Fundamentals Core Class requirement for first-year graduate students in the NUIN program. Lectures and discussion sections are organized by class module directors, lectures and discussion sections are team-taught. This course covers neural development/signaling pathways and sensory systems.

### NUIN 401-3 Fundamentals of Neuroscience (1 Unit)

This course fulfills the Fundamentals Core Class requirement for first-year graduate students in the NUIN program. Lectures and discussion sections are organized by class module directors, lectures and discussion sections are team-taught. This course covers motor systems and cognitive neuroscience.

### NUIN 402-0 NUIN Additional Rotation (0 Unit)

Laboratory rotations are an essential component of the graduate experience in NUIN, in which students perform independent research in a laboratory of their choosing, and learn the scientific communication skills that are required to develop as scientists. An additional rotation (beyond the required three rotations) may be required for the student to find a laboratory that is a good fit for their dissertation research, or for factors beyond the students control. Additional rotations typically take place in the Summer quarter of the first year. Additional rotations are evaluated by the faculty mentor based on their rotation student's overall commitment to training during the quarter and performance during the rotation. Additional rotations do not require an end of rotation presentation, and do not receive a graded credit.

### NUIN 402-1 NUIN Fall Rotation (0.33 Unit)

Laboratory rotations are an essential component of the graduate experience in NUIN, in which students perform independent research in a laboratory of their choosing, and learn the scientific communication skills that are required to develop as scientists. The rotation will be graded independently by the faculty mentor based on their rotation student's overall commitment to training during the quarter, performance during the rotation, and performance on the end of quarter requirement. For the Fall rotation, the end of quarter requirement is a scientific poster presentation.

### NUIN 402-2 NUIN Winter Rotation (0.33 Unit)

Laboratory rotations are an essential component of the graduate experience in NUIN, in which students perform independent research in a laboratory of their choosing, and learn the scientific communication skills that are required to develop as scientists. The rotation will be graded independently by the faculty mentor based on their rotation student's overall commitment to training during the quarter, performance during the rotation, and performance on the end of quarter requirement. For the Winter rotation, the end of quarter requirement is a written scientific report.

### NUIN 402-3 NUIN Spring Rotation (0.33 Unit)

Laboratory rotations are an essential component of the graduate experience in NUIN, in which students perform independent research in a laboratory of their choosing, and learn the scientific communication skills that are required to develop as scientists. The rotation will be graded independently by the faculty mentor based on their rotation student's overall commitment to training during the quarter, performance during the rotation, and performance on the end of quarter requirement. For the Spring rotation, the end of quarter requirement is an oral research presentation.

### NUIN 407-0 NUIN Graduate Foundations (0 Unit)

NUIN Graduate Foundations provides an introduction to academia, graduate school, Northwestern, and NUIN. At the end of the class, students will have a basic understanding of what to expect during graduate school, and how to use existing resources to help them be successful.

#### **NUIN 411-1 Great Experiments in Molecular and Developmental Neuro Science (1 Unit)**

This course aims to fill the informational gap in the current curriculum between the basic overview provided by NUIN 401 and the highly focused, often recent material covered in electives. Students will read and discuss classic papers that generated concepts that form the basis for our understanding of development, function and diseases of the nervous system at the molecular/genetic level.

#### **NUIN 411-2 Great Experiments in Cellular Neurophysiology (1 Unit)**

This course aims to fill the informational gap in the current curriculum between the basic overview of cellular neurophysiology and biophysics provided by NUIN 401 and the highly focused, often recent material covered in electives. In this course, students will read and will be guided through written problem sets and discussions of a series of classic papers in cellular neuroscience.

#### **NUIN 411-3 Great Expts in System & Cognitive Neuroscience (1 Unit)**

The general aim of the course is to fill the gap between the basic overview of Systems and Cognitive Neuroscience provided by the first-year core course (NUIN 401) and the highly focused, often recent material covered in special topics courses taken as electives. Students will read a series of classic papers in systems and cognitive Neuroscience.

#### **NUIN 414-0 Finding Your Voice as a Scientist (1 Unit)**

A workshop series for NUIN students offered in Spring. Full participation by second year students is strongly encouraged. The goal of the series is to help students find their individual voices to communicate their science effectively and passionately in both oral and written form.

#### **NUIN 417-0 Mechanisms of Neurodegeneration: Alzheimer's Disease as a Case Study (1 Unit)**

This discussion course considers neuroscience research into the cause and treatment of Alzheimer's disease. Topics include neuropathology, human genetics, structural biology, transgenic modeling, synapse morphology/function, plasticity and memory, brain cell biology and signaling mechanisms, epigenetics, brain imaging, nanotechnology, vaccine development, drug discovery, and gene therapy. Students will practice and improve skills in presentation, organization of facts, writing and grantsmanship.

#### **NUIN 422-0 Anatomy and Physiology of the Central Hearing Mechanism (1 Unit)**

Neuroanatomical and neurophysiological aspects of the central auditory pathway.

#### **NUIN 424-0 Sensory Transduction and Early Visual Processing (1 Unit)**

Course focuses on the first stages of the reception and processing of sensory information in the nervous system. Each session will be lead by an expert in the field. We will begin with an introduction to the topic, followed by a detailed discussion of primary literature. Participation is required, and students will be evaluated based on demonstrating a critical understanding of the assigned papers.

#### **NUIN 433-0 The Neurobiology of Disease (1 Unit)**

This course aims to orient graduate students in Neuroscience or related disciplines to important neurological diseases and general aspects of related research. For every session, a neurological clinician presents material discussing the disease process in question, followed by a lecture given by a basic scientist focused on a relatively narrow research

question. The examination consists of writing a small NIH-style grant on a neuroscience research question.

#### **NUIN 435-0 Biological Foundations of Speech and Music (1 Unit)**

This course examines the role of sound and the central auditory system in the experience of music and speech. Students learn the principles of acoustic signals and the neuroanatomy and physiology of the auditory system, and from this foundation explore how speech and music are processed by the nervous system. Auditory learning and the brain's ability to change with sonic experience will be explored through a range of case studies related to vocal learning (birdsong), auditory expertise (bilinguals and musicians), and training and remediation strategies for the treatment of communication difficulties. Students are shown the vital social implications of sound science through discussions of hearing health, music education, and clinical approaches to communication disorders.

#### **NUIN 436-0 Drugs and the Brain (1 Unit)**

Graduate neuropharmacology course with a mix of didactic instruction (33%) and in-depth classroom discussion of primary research papers (66%). The course is not a survey course, but rather will cover selected topics in neuropharmacology with the goals of 1) informing the student of the latest neuropharmacology knowledge, 2) inculcating a rigorous approach to examination of the scientific literature, and 3) encouraging best practices in experimental design.

Prerequisite: Open Registration restricted to IGP Students Only.

#### **NUIN 438-0 Cellular and Molecular Aspects of Motor Neuron Biology (1 Unit)**

This course is designed to expose students to the current findings and developments in the field of motor neuron biology in the context of development, health, and disease. Both cortical and spinal components of motor neuron circuitry will be discussed in depth.

#### **NUIN 440-0 Advanced Neuroanatomy (1 Unit)**

Designed to provide a fundamental understanding of neuroanatomy, this course considers the nervous system from both structural and functional perspectives, resulting in an integrated view of the brain. In addition to lectures and demonstrations, half the time is devoted to laboratory exercises in which students view histological sections and participate in the dissection of a human brain. Course extends over only seven weeks of the quarter.

#### **NUIN 441-0 Biophysical Signal Processing for Movement & Rehabilitation Sciences (1 Unit)**

Students in this course learn how to collect and analyze kinematic, kinetic and electrophysiological data associated with the neuromusculoskeletal system. Emphasis is on understanding and implementing time and frequency domain signal processing methods important for analyzing movement data. Students develop and implement the signal processing tools using Matlab. This course is not intended for engineering graduate students to replace complete courses in signal processing.

#### **NUIN 442-0 Issues in Movement & Rehabilitation Science (1 Unit)**

This course emphasizes literature on key principles and models in the field of movement and rehabilitation science. Course explores theoretical, biological, physical, behavioral and computational approaches to understanding the control of movement in the context of rehabilitation, as well as therapeutic approaches used in rehabilitation. Topics include stroke, spinal cord injury, Parkinson's disease, movement disorders, cerebellar disease, etc.

#### **NUIN 443-1 Computational Neuroscience (1 Unit)**

NUIN-443, "Computational Neuroscience" is primarily targeted at first- and second-year NUIN graduate students in labs that use advanced

computational tools for modeling and data analysis, and by graduate students in other programs (e.g. biomedical engineering) who are interested in computational neuroscience. It covers core topics in systems, computational and theoretical neuroscience, including but not limited to: analysis of time series (e.g., generalized linear models, dimensionality reduction, systems identification), latent variable models, manifold inference, dynamical systems modeling, learning rules, and artificial neural networks. Students enrolling in the class are expected to be familiar with python programming and basic mathematical concepts, especially linear algebra.

#### **NUIN 451-1 Topics in Contemporary Neuroscience (2 Units)**

The aim of the course is to explore at high resolution the process of doing basic neuroscience. Each week, a different instructor will lead a literature-based seminar focused specifically on their own work. In discussing their work, often in the context of other related work in the field, instructors will closely narrate how their work came to be. The course is intended for those that (a) are actively engaged in basic neuroscience research, and (b) have sufficient fluency with fundamental neuroscience to read contemporary papers with some degree of understanding and criticality. Prerequisites: A year of coursework in fundamental neuroscience or permission of the instructor.

#### **NUIN 455-0 Instrumentation for Neuroscience (1 Unit)**

This is a practical course in electronics and mechanical instrumentation ranging from Ohm's law, power supplies and fasteners to machining, microprocessors and computers. We cover the basics of instrumentation theory, design, construction, use, repair and safety. We emphasize basic machine shop practices and basic to intermediate-level applications of active electronics devices (integrated circuits or ICs). No prior knowledge is required.

#### **NUIN 470-0 Mechanisms of Information Storage (1 Unit)**

Literature-based course designed to give a framework to understand the current state of our knowledge about the cellular to system basis for information processing and storage. Classes facilitated by faculty experts in specific areas of neural plasticity and information storage. Students will read papers assigned and submit two relevant questions to for each paper (to be discussed in class).

#### **NUIN 473-0 Cellular and Behavioral Mechanisms of Aging and Dementia (1 Unit)**

This course is designed to familiarize students with aging and age-related dementias. Lectures given on incidence, diagnostics and mechanisms studied in cell and animal models and in humans. Class also includes student-led discussions of literature. Grade determined by student presentations, class participation and on a written and oral presentation of research proposal relevant to topics covered during the course.

#### **NUIN 480-0 Circuits and Systems of Motor Control (1 Unit)**

The overarching question that NUIN 480 will address is: "How do specific circuits within the nervous system movement regulate movement?" The course will be delivered by 14 world-leading experts in their respective fields and is a combination of didactic teaching and discussion of key papers. Course is open to NUIN and BME students. Postdoctoral scientists may participate in the course.

#### **NUIN 481-0 Neural Mechanism of Pain (1 Unit)**

The course covers aspects of pain research, including inflammation, peripheral, spinal cord, brainstem, thalamus and cortical circuits for acute and chronic pain mechanisms. Students will explore the application of genetic, molecular, electrophysiological and human brain imaging approaches to unravel mechanisms of pain and analgesia.

#### **NUIN 490-0 Responsible Conduct in Neuroscience Research (0 Unit)**

Through a combination of lecture and discussion, students will explore the ethical dimensions of biomedical research. Emphasis will be on practicing skills in moral reasoning and identifying relevant institutional, professional and governmental regulations and guidelines. Ethical issues special to or unique to neuroscience will be presented by student groups.

#### **NUIN 499-0 Independent Study (1 Unit)**

SEE DEPT FOR SECTION AND PERMISSION NUMBERS.

#### **NUIN 590-0 Research (1-3 Units)**

SEE DEPT FOR SECTION AND PERMISSION NUMBERS.