Integrative Neuroscience (INNS)

INNS 5000 Synaptic Transmission 3 Credits
This course will investigate how neurons and glial cells communicate with each other. We will review basic cell biology necessary for understanding processes important for synaptic transmission between neurons and communication between glia and neurons, including protein trafficking, membrane properties, and vesicular transport. This background will allow us to consider in detail how specific chemical neurotransmitters (acetylcholine, glutamate, GABA, dopamine, serotonin, histamine, norepinephrine, neuropeptides, endocannabinoids, etc) function to send different types of information between neurons and glial cells. However, since various functions of the central nervous system are largely defined by structure, we will include a brief overview of human neuroanatomy. We will use each of these transmitter systems to explore general principles of neurons (mechanisms for transducing a signal from outside the cell to the inside, the complexity and evolutionary relatedness of receptor subtypes, differences in signal transmission versus signal modulation, methods for organization of cellular membrane proteins), and relate these principles back to the fundamental biological concepts. We will also investigate how the various neurotransmission systems are altered by medicines, drugs of abuse, and toxins; students will be responsible for giving brief oral presentations on the molecular actions of these molecules. We will consider how disruption of specific neuronal pathways affects specific systems due to the defined anatomy. Finally, we will discuss in detail, papers from the primary literature to highlight advances and areas of interest in mechanisms of synaptic transmission. In addition to class assignments, exams, and quizzes, you must submit an original research paper in the style of a grant proposal. BIOL-5000 is intended for first- and second-year graduate students with a neuroscience background.
Level: Graduate, Undergraduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

INNS 6000 Critical Readings in Neuro I 1 Credit
Students will be provided primary literature that focuses on neuroscience. This primary literature will be the nidus of in-class discussions of experimental and statistical approaches. We will focus on how the students' understanding of the approaches affects their interpretation of the data presented in the paper. One of the journal club discussions will focus on bioethics.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment limited to students in the MS-INNS or MS-INNS-SM programs.

Enrollment is limited to Graduate level students.

INNS 6001 Critical Readings in Neuro II 1 Credit
Students will be provided primary literature that focuses on neuroscience. This primary literature will be the nidus of in-class discussions of experimental and statistical approaches. We will focus on how the students' understanding of the approaches affects their interpretation of the data presented in the paper.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

INNS 6003 Applied Eng for Behav Neurosc 1 Credit
Applied Engineering for Behavioral Neuroscience is an entry-level course in coding, electronics, and 3D printing for research applications. As neuroscience increasingly intersects with technology, coding and engineering skills have become essential tools for modern research. This entry-level course introduces fundamental programming concepts, basic electrical circuit design, and the interface between hardware and software using platforms like the Arduino Uno and the Raspberry Pi. As this course is intended for beginners, no prior coding or engineering experience is required. Through interactive lectures and hands-on workshops, students will build custom software and hardware for data collection and analysis. We will also discuss the role of 3D printing for rapid prototyping. This course bridges core engineering principles with neuroscience, preparing students to design, build, and implement innovative tools for scientific discovery. Students will complete small projects throughout the course building both software and hardware tools for data collection and analysis.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to students with a program in Integrative Neuroscience, Integrative Neuroscience, Integrative Neuroscience, Integrative Neuroscience, National Security Law, National Security Law, National Security Law, National Security Law or National Security Law.

Enrollment is limited to Graduate level students.

INNS 6007 Molec Mech of Neurodegnration 3 Credits
This course examines the molecular basis of neurodegenerative diseases, including Alzheimer's disease, Parkinson's disease, Huntington's disease and Lou Gehrig's disease. The course includes discussion of mutations that cause familial forms of these diseases, and what these familial forms tell us about the sporadic forms. We examine how the genetic findings correlate with the neuropathological lesions identified in these diseases, and explore how these correlate with clinical symptoms. Classes include lectures on the background of biochemical mechanisms that lead to cell loss and discussions of recent papers chosen by students. The classes probe commonalities of the neurodegenerative diseases, selective vulnerability of subsets of neurons, genetic risk factors, and the usefulness and limitations of animal models.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Students in the MS-INNS, PHD-NEUR, PHD-PHAR or PHD-PHPH programs may **not** enroll.

Enrollment is limited to Graduate level students.

INNS 6101 Neuroscience Shaping Society 1 Credit
Advancements in neuroscience have substantial ramifications across numerous sectors such as the environment, education, healthcare, consumer behavior, bioethics, aging, and national security. In order to create effective science-based decisions, it is essential to promote active communication between researchers and society, a fundamental principle acknowledged by governments, industry leaders, and funding agencies. This course will investigate the infrastructure and networks that encompasses both policymakers and researchers, and examine how these networks enable the translation of neuroscience discoveries for broader public engagement and societal impact.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

Students in a Doctor of Philosophy degree may **not** enroll.

INNS 6201 Imaging in Neuroscience 2 Credits
This is a 2-credit graduate level course that will be focused on functional and structural imaging approaches to neuroscience. This course will use primary literature and lectures from experts in the imaging field. Topics to be covered include the basics of: microscopy (brightfield, fluorescent, confocal, 2-photon), MRI, fMRI, PET, near infrared spectroscopy and imaging (NIRS), diffusion tensor imaging (DTI), and Electroencephalography/Event Related Potentials (EEG/ERP) and Magnetoencephalography (MEG). This course is a required course for MS in Integrative Neuroscience students. It is open to undergraduate Neuroscience majors, Biology, IPN and Psychology graduate students with course director approval.
Level: Graduate, Undergraduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

INNS 6205 AI for Neuroscience Research 1 Credit
The increased popularity of generative Artificial Intelligence (AI) via online services has important implications for neuroscience research and education. This course will cover AI in relation to: data acquisition; grant writing, manuscript preparation and publishing; and student education. We will discuss how to effectively and responsibly use machine learning in neuroscience, how inadequate use of AI can lead to plagiarism/manipulation risks, funding agency policies in relation to AI, and using machine learning for research-based analysis applications across neuroscience fields.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

Enrollment limited to students in the MS in Integrative Neuroscience department.

INNS 6230 Neuroanatomy 1 Credit
Basic Anatomy for Neuroscientists
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to students with a program in Integrative Neuroscience, Integrative Neuroscience, Integrative Neuroscience or Integrative Neuroscience.

Enrollment is limited to Graduate level students.

INNS 6300 Translational Neuroscience 2 Credits
Lecture and manuscript based presentation of topics in clinical neuroscience focused on the etiology, diagnosis and treatment of disorders including seizures, dementia, autoimmune disease, infection, head trauma, pain, stroke and depression. Grading will be based on class participation and a written exam. prerequisites, Bachelor's in biology, psychology or neuroscience, or permission of course director.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment limited to students in the MS-INNS, MS-INNS-SM or PHD-NEUR-SM programs.

Enrollment is limited to Graduate level students.

INNS 6301 Neurobiology of Drug Addiction 2 Credits
The course is designed to gain an understanding of how the brain is affected by drugs of abuse. Lecturers will present different classes of naturally occurring (e.g. morphine, cocaine, alcohol) and chemically synthesized (e.g. prescription drugs, amphetamines, MDMA) drugs, their mechanisms of action and the brain areas that they affect. The lecturers will also provide an overview of the clinical presentations and course of substance use disorders. Moreover, the many factors influencing the development of substance use disorders, including developmental, environmental, social, and genetic factors, will be presented. Animal models of drug reward and addiction will be discussed.
Level: Graduate, Undergraduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

INNS 6303 Cognitive Neuroscience Aging 2 Credits
This course provides a deep dive into how and why cognition changes (or not) from early adulthood into old age, and what might influence these trajectories. We will cover various aspects of cognition in the aging brain including sensory and perception, motor functions, memory and executive functions, language, personality and emotion, and social cognition. In addition, we will examine the neurobiological bases of cognitive decline, how cognitive function can be sustained through brain maintenance, compensation and reserve and the multiple factors (e.g., genetic, sociodemographic, environmental, physiological) that can mitigate age-related decline.
Level: Graduate
Grading: Main Campus (UGrad, Grad)

INNS 6310 Principles of Neuroimmunology 2 Credits
The interplay between the innate and adaptive immune systems can provide valuable insights into mechanisms that underlie the physiology and pathology of inflammation, a hallmark of almost most diseases of the brain. This course will provide the current understanding of how the intersection of neuroscience and immunology can provide us with the knowledge to discover modern strategies to understand the immunomodulation of neural functions, and neuromodulation of immune activities, in order to develop therapies for neurodegenerative diseases.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

INNS 6400 Exp Approaches Techniques 2 Credits
This is a one-semester class where students will be using primary literature to explore neuroscience methods and experimental design. Students will be required to read 1-2 papers per week, discuss them in class and highlight the methods and approaches used in the research. This class is designed to be complementary to the Basic Neuroscience course as well as the journal club. In this course, students will take the lead as the presenters and primary discussants. This course is open to undergraduate Neuroscience majors, Biology, IPN and Psychology graduate students with course director approval.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment limited to students in the MS-INNS or MS-INNS-SM programs.

Enrollment is limited to Graduate level students.

INNS 6405 The Art of Electrophysiology 1 Credit
The Art of Electrophysiology is an entry-level course designed to introduce students to fundamental concepts and techniques in electrophysiology. The course emphasizes lecture content combined with hands-on laboratory experience with classical experiments, focusing on instrumentation, recording methods, and manipulation of invertebrate nervous systems as well as rodent ex vivo brain slices. The course consists of lectures, laboratory sessions, and a research project. Students are expected to complete assigned readings, actively participate in experiments, and share their findings and insights with peers. Enrollment is limited due to laboratory space constraints. A background in biology and basic neuroscience is required. All students must contact the course director for approval. Completion of GUMC laboratory safety training and animal protocol training is required before participating in laboratory activities.
Level: Graduate
Grading: Main Campus (UGrad, Grad)

INNS 6500 Basic Neuroscience I 4 Credits
This course is the first semester of a two semester introduction to neuroscience. This semester starts with an overview of the brain, and continues with an examination of neurons and glial cells, brain wiring, neuroanatomy, action potentials and synaptic transmission, the autonomic nervous system, the somatic sensory system, and motor function. The classes include lectures and discussion. Grades for this course will be based on a final exam as well as quizzes and class participation. Both semesters are required for students in the Masters in Integrative Neuroscience. Other graduate students and undergraduates are also welcome, and do not need to take both semesters; they must have a background in biology or psychology, and must email the course director for approval.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment limited to students in the following programs:

- MS-INNS
- MS-INNS-SM
- PHD-BIOL
- PHD-NEUR
- PHD-NEUR-SM
- PHD-PHAR
- PHD-PHAR-SM

Enrollment is limited to Graduate level students.

INNS 6501 Basic Neuroscience II 4 Credits
This course is the second semester of a two semester introduction to neuroscience. This semester covers the neural bases of motivation, the chemical, auditory and visual sensory systems, sleep, emotion, language, memory, consciousness, and mental illnesses. The classes include lectures and discussion. Grades for this course will be based on a final exam as well as quizzes and class participation. This course is a required course for students in the Masters in Integrative Neuroscience. Other graduate students and undergraduates are also welcome, but they must have a background in biology or psychology, and must email the course director for approval.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to Graduate level students.

INNS 7001 Tutorial: Neuroscience 1-3 Credits
Individualized tutorials between students and faculty to address topics not covered by other courses. Restrictions: MS INNS only but they must receive permission of the Program Director before enrolling.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment limited to students in the MS-INNS program.

Enrollment is limited to Graduate level students.

INNS 9000 Research Practicum I 4 Credits
Students will pursue a research practicum each semester. Students meet with a prospective research mentor and develop a 1?3 page summary of the focus of the work. Proposals are evaluated by a committee, and following approval, the students will intern with the mentor for Fall & Spring semesters. During the semester, students will meet with the course director to monitor progress. At the completion of the internship, students will write a review paper and give an oral presentation on a topic approved by their mentor, which includes their primary data. Students will be evaluated by their mentor, who completes an evaluation form, as well as by the quality of their paper and presentation. This course is only for MS in Integrative Neuroscience students.
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment limited to students in the MS-INNS-SM program.

Enrollment is limited to Graduate level students.

INNS 9001 Research Practicum II 4 Credits
Students will pursue a research practicum each semester. Students meet with a prospective research mentor and develop a 1#3 page summary of the focus of the work. Proposals are evaluated by a committee, and following approval, the students will intern with the mentor for two semesters. During the semester, students will meet with the course director to monitor progress. At the completion of the internship, students will write a review paper and give an oral presentation on a topic approved by their mentor, which includes their primary data. Students will be evaluated by their mentor, who completes an evaluation form, as well as by the quality of their paper and presentation. This course is for MS in Integrative Neuroscience students only!
Level: Graduate
Grading: Main Campus (UGrad, Grad)
Course registration restrictions:
Enrollment is limited to students with a major in Integrative Neuroscience, Integrative Neuroscience, Integrative Neuroscience or Integrative Neuroscience.

Enrollment is limited to Graduate level students.