NEUROSCIENCES (NEUR)

NEUR 101. The Human Brain. 3 Units.
Your brain determines who you are, what you do, how you move, what you perceive, and why you behave the way you do. This introductory course has no prerequisites and is offered to the entire community of scholars to help elucidate brain development, structure, function, disease, and wellness. It will elaborate our current scientific knowledge, and examine societal and cultural conceptions about the brain. Faculty across departments and Schools at the University will teach what every educated individual should know about the clinical manifestations of brain disease, and strategies to protect brain health throughout life.

NEUR 166. Explorations in Neuroscience. 1 Unit.
This survey course provides students with an opportunity to learn about some of the most exciting and timely concepts in neuroscience, including topics in basic and translational research, as well as perspectives on neuroscience as a profession, through a series of 14 lectures given by members of the Neurosciences Department in the Case Western Reserve University School of Medicine. Topics are presented in a way that can be understood by students who have taken a high school biology class. Every effort is made to explain any new concepts that are included in the lectures. Each lecturer will provide general background reading material for the topics they discuss.

NEUR 201. Fundamentals of Neuroscience I. 3 Units.
The purpose of this course is to provide students with a systematic and comprehensive introduction to the field of neuroscience. The topics that will be discussed and the level at which they are discussed assumes that the students have a basic familiarity with general features of cell structure and function and specialized properties of cells found in different physiological systems, from their previous biology coursework. The course will also provide a foundation for elective upper-level courses in the undergraduate neuroscience curriculum. Prereq: BIOL 214 and BIOL 215. Prereq or Coreq: BIOL 216.

NEUR 202. Fundamentals of Neuroscience II. 3 Units.
This course is the second in a sequence and designed to provide students with an understanding of signaling mechanisms that are utilized by nerve cells, including mechanisms that are responsible for signaling within cells and mechanisms that underlie signaling between cells. These mechanisms will range from the fast, millisecond time-scale transitions of ion channels that contribute to action potentials and synaptic signaling, to slower events that underlie modulation of channel activity and neurotransmitter synthesis and degradation, to even slower events on the hour and day timescale involving changes in gene expression and protein synthesis that underlie phenotypic development and neural plasticity. Prereq: NEUR 201.

NEUR 301. Biological Mechanisms of Brain Disorders. 3 Units.
This course is designed to introduce students to a broad range of neurological and neuropsychiatric diseases and disorders in order to understand how genetic and environmental perturbations can disrupt normal brain function. The primary focus will be on understanding the biological bases of nervous system dysfunction. For each disease discussed, the subject matter will be organized to explain how normal brain function is impacted, the biological mechanisms underlying dysfunction (including still-unanswered questions) and current efforts to develop effective treatments (translational research). With this approach, students will gain an understanding of disease presentation, how animal models and human studies are being used to elucidate pathophysiological mechanisms, and opportunities and challenges in the development of new therapies. The class format will be a mix of lecture-based sessions and discussions of scientific journal articles. Offered as NEUR 301 and NEUR 401. Prereq: BIOL 216 or NEUR 201 or PSCL 352.

NEUR 303. Methods Neuroscience Research. 4 Units.
This course will provide students the knowledge necessary to choose the appropriate methods needed to explore scientific questions, understand ethical research design, use safe laboratory practices and develop research skills that are highly valuable in the field of neuroscience. The topics covered in this course include basic laboratory skills, neuroanatomy, histology, neurophysiology and behavioral neuroscience. Successful completion of this course will equip students with the kinds of practical knowledge and hands-on experiences that can enhance competitiveness for internships, doctoral training programs or careers in research laboratories. Offered as ANAT 303, ANAT 403, NEUR 303, and NEUR 403. Prereq: NEUR 201.

NEUR 304. The Neurobiology of Homeostasis. 3 Units.
This course will explore the relationship between the body and the brain through homeostasis from its development to its decline, while reviewing the known literature and discussing unanswered questions. Students will learn the basics of homeostasis in normal nervous system development and consider current research investigating perturbations leading to disorders and abnormal development. Systems that interact with the central nervous system, including the endocrine system, the immune system, and the enteric system, will be introduced and impairments in nervous system communication with these systems will be discussed in regards to neurological diseases, neuropsychiatric disorders, and injury and repair, while incorporating discussions of current diagnostic techniques, prevention and treatment. The conclusion of the course will focus on changes in the nervous system that lead to cognitive decline, memory impairments and motor deficits common in aging and neurodegenerative disorders. The overarching theme will focus on homeostatic mechanisms and how their impairment can have detrimental effects on the nervous system and its interactions with the peripheral systems throughout the lifespan. Prereq: NEUR 201.

NEUR 316. Introduction to Neural Circuits. 3 Units.
The nervous system exhibits an extraordinary capability for controlling complex behavior through processing of sensory input and storage of information. This capability primarily arises from interactions of specific groups of neurons which form circuits. This course will explore the structure and function of a diverse set of neural circuits in order to understand how the nervous system controls complex behavior. Mechanisms that govern the development and maturation of neural circuits will be defined. Neural circuits for sensory, motor, and emotional behaviors will be described in 3 ways: 1) Which brain regions/nuclei are connected in each circuit. 2) How these regions of the nervous system communicate with one another through identification and classification of individual neurons in the circuit. 3) How the input/output of each circuit relates to behavior and function. Throughout the course, students will learn how disease, trauma, or dysfunction specifically affects each circuit to result in impairment/loss of normal function. Offered as NEUR 316 and NEUR 416. Prereq: NEUR 201.

NEUR 320. Biological and Artificial (AI) Neural Networks. 4 Units.
Is AI ready to replace the human brain? Do Artificial Neural Networks (ANNs) resemble Biological Neural Networks (BNNs)? Can machines ever hope to learn the way humans and other creatures do? ANNs play a central role in machine learning/AI, and were developed in parallel with, and received inspiration from, scientific investigations into BNNs. Both of these areas are currently the focus of intense research, and popular culture continuously suggests to us that AI might rival the brain, but critical side-by-side comparisons are in short supply. Since BNNs are more aligned with the life sciences, and ANNs fall within the scope of computer science/engineering, few students are familiar with both areas. This course embraces both disciplines will enable students to identify and exploit synergies that help move both fields forward. Offered as NEUR 320, NEUR 420, PQHS 320, and PQHS 420. Prereq: MATH 121 and (BIOL 216 or NEUR 201) and (CSDS 134 or CSDS 237).

NEUR 325. Drugs and the Brain. 3 Units.
Drugs and the Brain explores how both medicinal and illicit drugs influence the structure and function of the nervous system. Topics include mechanisms of action, therapeutic applications, side effects, and the neurobiology of addiction. Students will investigate drug effects on systems such as mood, perception, movement, and consciousness through a combination of traditional lectures and problem-based learning (PBL). In weekly PBL sessions, students collaborate to solve real-world clinical and societal scenarios, integrating neuroscience concepts with ethical and public health perspectives. Prereq: NEUR 201 and NEUR 202.

NEUR 330. Neuroimmunology. 3 Units.
This course explores the intricate relationship between the nervous and immune systems, with a focus on understanding the bidirectional communication between neurons and immune cells. Students will delve into the molecular, cellular, and systemic interactions that govern neuroimmunology, examining both physiological and pathological aspects. The course will integrate concepts from neuroscience and immunology to provide a comprehensive understanding of the dynamic interplay between these two systems. An emphasis will be placed on science communication with students being required to write a scientific review article and participate in a group research presentation. Prereq: NEUR 201.

NEUR 388. Undergraduate Research. 1 - 3 Units.
Guided laboratory research under the sponsorship of a SOM faculty member who conducts basic and/or translational neuroscience research. Students are required to obtain permission from the prospective research supervisor and the Neuroscience Undergraduate Curriculum Committee (NUCC) prior to enrolling in the course. Appropriate forms must be submitted to the Neurosciences Department office. At the end of the semester, a research report, written in the format of a scientific research publication, must be submitted and approved by the research mentor and the NUCC before credit is granted.

NEUR 388S. Undergraduate Research SAGES Capstone. 3 Units.
Guided laboratory research supervised and guided by a SOM faculty member who conducts basic and/or translational neuroscience research. Students are required to obtain permission from the prospective research supervisor and the Neuroscience Undergraduate Curriculum Committee (NUCC) prior to enrolling in the course. Appropriate forms must be submitted to the Neurosciences Department office. At the end of the semester, a research report, written in the format of a scientific research publication, must be submitted and approved by the research mentor and the NUCC before credit is granted. A public presentation is required. Counts as a SAGES Senior Capstone course.

NEUR 390. Advanced Undergraduate Research in Neuroscience. 1 - 3 Units.
Guided laboratory research under the sponsorship of a SOM faculty member who conducts basic and/or translational neuroscience research. Students are required to obtain permission from the prospective research supervisor and the Neuroscience Undergraduate Curriculum Committee (NUCC) prior to enrolling in the course. Appropriate forms must be submitted to the Neurosciences Department office. Does not count toward the hours required for a major in neuroscience, but may be counted toward the total number of hours required for graduation. At the end of the semester, a research report, written in the format of a scientific research publication, must be submitted and approved by the research mentor and the NUCC before credit is granted. Prereq: NEUR 388 or NEUR 388S.

NEUR 401. Biological Mechanisms of Brain Disorders. 3 Units.
This course is designed to introduce students to a broad range of neurological and neuropsychiatric diseases and disorders in order to understand how genetic and environmental perturbations can disrupt normal brain function. The primary focus will be on understanding the biological bases of nervous system dysfunction. For each disease discussed, the subject matter will be organized to explain how normal brain function is impacted, the biological mechanisms underlying dysfunction (including still-unanswered questions) and current efforts to develop effective treatments (translational research). With this approach, students will gain an understanding of disease presentation, how animal models and human studies are being used to elucidate pathophysiological mechanisms, and opportunities and challenges in the development of new therapies. The class format will be a mix of lecture-based sessions and discussions of scientific journal articles. Offered as NEUR 301 and NEUR 401.

NEUR 402. Principles of Neural Science. 3 Units.
This graduate level lecture and discussion course covers fundamental principles in neuroscience in 3 modules. Module 1 covers the cell biology of neurons, synapses and synapse plasticity, in addition to an overview of nervous system anatomy. Module 2 covers systems neuroscience, with an emphasis on the neurophysiology of mammalian sensory and motor systems. Topics include somatosensation, movement, vision, hearing, and balance. Module 3 covers principles of nervous system development, including the developmental origins of neurons and glia, how diverse neuron types are generated, and how neuronal connectivity is specified and refined. Understanding these principles is important for understanding diseases of the nervous system and strategies to promote nervous system function and repair. This course will prepare students for graduate level studies in Neuroscience and may also be suitable for students in other graduate programs who seek a foundation in principles in neuroscience. Recommended preparation: IBMS 453. Offered as BIOL 402 and NEUR 402.

NEUR 403. Methods Neuroscience Research. 4 Units.
This course will provide students the knowledge necessary to choose the appropriate methods needed to explore scientific questions, understand ethical research design, use safe laboratory practices and develop research skills that are highly valuable in the field of neuroscience. The topics covered in this course include basic laboratory skills, neuroanatomy, histology, neurophysiology and behavioral neuroscience. Successful completion of this course will equip students with the kinds of practical knowledge and hands-on experiences that can enhance competitiveness for internships, doctoral training programs or careers in research laboratories. Offered as ANAT 303, ANAT 403, NEUR 303, and NEUR 403.

NEUR 415. Neuroscience Seminars. 1 Unit.
Current topics of interest in neurosciences. Students attend weekly seminars. From this series, students prepare critiques. No credit is given for less than 75% attendance. Students may register for this course two times for a total of two credit hours over two semesters.

NEUR 416. Introduction to Neural Circuits. 3 Units.
The nervous system exhibits an extraordinary capability for controlling complex behavior through processing of sensory input and storage of information. This capability primarily arises from interactions of specific groups of neurons which form circuits. This course will explore the structure and function of a diverse set of neural circuits in order to understand how the nervous system controls complex behavior. Mechanisms that govern the development and maturation of neural circuits will be defined. Neural circuits for sensory, motor, and emotional behaviors will be described in 3 ways: 1) Which brain regions/nuclei are connected in each circuit. 2) How these regions of the nervous system communicate with one another through identification and classification of individual neurons in the circuit. 3) How the input/output of each circuit relates to behavior and function. Throughout the course, students will learn how disease, trauma, or dysfunction specifically affects each circuit to result in impairment/loss of normal function. Offered as NEUR 316 and NEUR 416.

NEUR 419. Critical Thinking in Neuroscience. 3 Units.
The goal of this course is to develop the student's critical reasoning skills through reading and discussing primary research papers. Each year, the course will focus on 3-4 different topics selected by participating Neuroscience faculty members. Students will receive a letter grade based on their contributions to discussions, and at the discretion of the faculty, performance on exams and/or term paper. Prereq: NEUR 402.

NEUR 420. Biological and Artificial (AI) Neural Networks. 4 Units.
Is AI ready to replace the human brain? Do Artificial Neural Networks (ANNs) resemble Biological Neural Networks (BNNs)? Can machines ever hope to learn the way humans and other creatures do? ANNs play a central role in machine learning/AI, and were developed in parallel with, and received inspiration from, scientific investigations into BNNs. Both of these areas are currently the focus of intense research, and popular culture continuously suggests to us that AI might rival the brain, but critical side-by-side comparisons are in short supply. Since BNNs are more aligned with the life sciences, and ANNs fall within the scope of computer science/engineering, few students are familiar with both areas. This course embraces both disciplines will enable students to identify and exploit synergies that help move both fields forward. Offered as NEUR 320, NEUR 420, PQHS 320, and PQHS 420.

NEUR 432. Current Topics in Vision Research. 3 Units.
Vision research is an exciting and multidisciplinary area that draws on the disciplines of biochemistry, genetics, molecular biology, structural biology, neuroscience, and pathology. This graduate level course will provide the student with broad exposure to the most recent and relevant research currently being conducted in the field. Topics will cover a variety of diseases and fundamental biological processes occurring in the eye. Regions of the eye that will be discussed include the cornea, lens, and retina. Vision disorders discussed include age-related macular degeneration, retinal ciliopathies, and diabetic retinopathy. Instructors in the course are experts in their field and are members of the multidisciplinary visual sciences research community here at Case Western Reserve University. Students will be exposed to the experimental approaches and instrumentation currently being used in the laboratory and in clinical settings. Topics will be covered by traditional lectures, demonstrations in the laboratory and the clinic, and journal club presentations. Students will be graded on their performance in journal club presentations (40%), research proposal (40%), and class participation (20%). Offered as NEUR 432, PATH 432, PHRM 432 and BIOC 432.

NEUR 466. Cell Signaling. 3 Units.
This is an advanced problem set and research paper-based discussion format course that covers cell signaling mechanisms; there are no lectures. Included are discussions of neurotransmitter-gated ion channels, growth factor receptor kinases, cytokine receptors, G protein-coupled receptors, steroid receptors, heterotrimeric G proteins, ras family GTPases, second messenger cascades, protein kinase cascades, second messenger regulation of transcription factors, signals for regulation of cell growth, division, tissue development and cell death. Offered as CLBY 466, NEUR 466, PHOL 466 and PHRM 466.

NEUR 473. Introduction to Neurobiology. 3 Units.
How nervous systems control behavior. Biophysical, biochemical and molecular biological properties of nerve cells, their organization into circuitry, and their function within networks. Emphasis on quantitative methods for modeling neurons and networks, and on critical analysis of the contemporary technical literature in the neurosciences. Term paper required for graduate students. This course satisfies a lab requirement for the B.A. in Biology, and a Quantitative Laboratory requirements for the B.S. in Biology. Offered as BIOL 373, BIOL 473, and NEUR 473. Prereq: Graduate student standing.

NEUR 474. Neurobiology of Behavior. 3 Units.
In this course, students will examine how neurobiologists interested in animal behavior study the linkage between neural circuitry and complex behavior. Various vertebrate and invertebrate systems will be considered. Several exercises will be used in this endeavor. Although some lectures will provide background and context on specific neural systems, the emphasis of the course will be on classroom discussion of specific journal articles. In addition, students will each complete a project in which they will observe some animal behavior and generate both behavioral and neurobiological hypotheses related to it. In lieu of examinations, students will complete three written assignments, including a theoretical grant proposal, a one-page Specific Aims paper related to the project, and a final project paper. These assignments are designed to give each student experience in writing biologically-relevant documents. Classroom discussions will help students understand the content and format of each type document. They will also present their projects orally to the entire class. Offered as BIOL 374, BIOL 474 and NEUR 474. Prereq: Graduate student standing.

NEUR 475. Protein Biophysics. 3 Units.
This course focuses on in-depth understanding of the molecular biophysics of proteins. Structural, thermodynamic and kinetic aspects of protein function and structure-function relationships will be considered at the advanced conceptual level. The application of these theoretical frameworks will be illustrated with examples from the literature and integration of biophysical knowledge with description at the cellular and systems level. The format consists of lectures, problem sets, and student presentations. A special emphasis will be placed on discussion of original publications. Offered as BIOC 475, CHEM 475, PHOL 475, PHRM 475, and NEUR 475.

NEUR 478. Computational Neuroscience. 3 Units.
Computer simulations and mathematical analysis of neurons and neural circuits, and the computational properties of nervous systems. Students are taught a range of models for neurons and neural circuits, and are asked to implement and explore the computational and dynamic properties of these models. The course introduces students to dynamical systems theory for the analysis of neurons and neural learning, models of brain systems, and their relationship to artificial and neural networks. Term project required. Students enrolled in MATH 478 will make arrangements with the instructor to attend additional lectures and complete additional assignments addressing mathematical topics related to the course. Recommended preparation: MATH 223 and MATH 224 or BIOL 300 and BIOL 306. Offered as BIOL 378, COGS 378, MATH 378, BIOL 478, CSDS 478, EBME 478, ECSE 478, MATH 478 and NEUR 478.

NEUR 601. Research in Neuroscience. 1 - 18 Units.

NEUR 610. Internship in Experimental Biotechnology. 3 Units.
This course is the culminating experience of the Biotechnology MS program. It gives students a substantive hands-on experience in biotechnology research, providing with real-world experience to enhance their resumes and future employment prospects. The internship may be completed in a laboratory at a university or biotechnology company and must include some hands-on benchwork. The internship will strengthen the skills students have learned in the laboratory-focused coursework in the Biotechnology MS program. The goals are to i) enhance their laboratory research skill set, ii) learn about the responsibilities of laboratory workers, iii) learn how research problems are formulated and approached by research teams, iv) hone interpersonal skills and learn how research is done by collaborative teams, and v) gain insights into the careers of biotech workers and the careers they would like to pursue. This course is open only to students in the Biotechnology MS program. Offered as BIOC 610, NEUR 610, and PHRM 610.

NEUR 701. Dissertation Ph.D.. 1 - 9 Units.
(Credit as arranged.) Prereq: Predoctoral research consent or advanced to Ph.D. candidacy milestone.