NEUROSCIENCE TRAINING PROGRAM (NTP)

NTP/NEURODPT 610 – CELLULAR AND MOLECULAR NEUROSCIENCE
4 credits.

Study of original papers leading to an understanding of the molecular basis of electrical activity in neurons. Topics include voltage-sensitive currents, molecular biology of neuronal receptorrs, synaptic transmission and sensory transduction.
Requisites: ZOOLOGY/PSYCH 523 and (PHYSICS 202, 208, or 248), or graduate/professional standing
Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Identify the major anatomical parts of a neuron and summarize their functions
Audience: Both Grad & Undergrad

2. Name the major classes of voltage-gated ion channels responsible for the resting potential and action potential. Describe their functional roles in generating those potentials, with respect to concepts such as voltage-dependence, activation, inactivation and propagation. Identify the structural motifs in these proteins that permit their function
Audience: Both Grad & Undergrad

3. Summarize the sequence of events in the presynaptic terminal that lead from depolarization to neurotransmitter release, including the role of calcium. Explain the quantal hypothesis of neurotransmitter release and the experimental evidence that supports it. Describe the exocytosis/endocytosis cycle
Audience: Both Grad & Undergrad

4. Summarize basic principles of ligand/receptor interactions. Interpret the meaning of quantities such as the dissociation constant (Kd) and the maximum response (Vmax). Explain the experimental evidence that led to the equations (e.g., Hill Equation) that describe these principles
Audience: Both Grad & Undergrad

5. Name the major classes of ligand-gated ion channels that support fast synaptic transmission and differentiate their functions with respect to excitation versus inhibition. Identify the structural motifs in these proteins that permit their specific functions. Solve equations that describe the behavior of simple chemical and electrical systems as a function of time
Audience: Both Grad & Undergrad

6. Explain what second messengers and signaling cascades are and how they participate in regulating neuronal function. Describe the major processes leading from DNA to RNA to the production of proteins and explain how these processes are regulated with respect to the structure of chromatin and the action of transcriptional activators and repressors
Audience: Both Grad & Undergrad

7. Define the concept of sensory transduction. Describe the key components of transduction and their interactions in the following systems: vision, olfaction, touch and hearing. Explain how sensory cells

NTP/NEURODPT/PSYCH 611 – SYSTEMS NEUROSCIENCE
4 credits.

Introduction to the anatomy and physiology of the mammalian nervous system. Lectures will cover the neuroanatomy of the major subdivisions of the human brain, the major sensory and motor systems, and higher order functions. Lab/discussion sections will emphasize readings from the primary literature and hands-on dissections.
Requisites: NEURODPT/NTP 610 or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Describe the organization and structure of mammalian nervous system, including the spinal cord, brainstem, thalamus, cerebral cortex, cerebellum, basal ganglia, limbic system, and their interconnections on a systems leve
Audience: Both Grad & Undergrad

2. Demonstrate a solid understanding of the functions of the sensory and motor systems that underlie perception and action
Audience: Both Grad & Undergrad

3. Demonstrate a solid understanding of higher brain functions and behavior, including learning and memory and executive function
Audience: Both Grad & Undergrad

4. Demonstrate knowledge about approaches of modern neuroscience research including neuroanatomy, neurophysiology, functional brain imaging, behavioral assays, and quantitative data analysis methods
Audience: Both Grad & Undergrad

5. Develop and apply critical thinking to evaluate original neuroscience research
Audience: Graduate

6. Develop ability to formulate hypotheses and to apply knowledge learned from the course to design experiments for hypothesis testing
Audience: Graduate

NTP/NEURODPT 640 – COMPUTATIONAL NEUROSCIENCE: FROM SINGLE CELLS TO WHOLE BRAIN MODELS
3 credits.

Theory and application of methods in computational neuroscience across various levels of organization from single cells to global brain dynamics and cognition. Computational neuroscience is an approach to understanding the development and function of nervous systems in mechanistic terms at many different structural scales. Topics include biophysical properties of neurons and synapses, neural plasticity, sensory systems, neural circuits, whole brain analysis and modeling, and different views on brain function. Includes primers on relevant computational techniques (ICA, information theoretical approaches, dynamical systems) and a computational problem set. Starts with an introduction to MATLAB (used for problem sets).
Requisites: PSYCH/ZOOLOGY 523, PSYCH 454, MATH 221, and (PHYSICS 104, 202, 208, or 248); or graduate/professional standing and NEURODPT/NTP 610 and PSYCH/NEURODPT/NTP 611
Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Explain the basic functioning of a neuron in biophysical terms (including how action potentials are generated, the role of dendrites, and postsynaptic integration).
Audience: Both Grad & Undergrad

2. Summarize the computational properties of sensory neurons reacting to sensory stimuli (tuning curves, receptive fields, feature selectivity).
Audience: Both Grad & Undergrad

3. Demonstrate technical familiarity in evaluating the statistical and information theoretical properties of neuronal activity (basics of signal detection theory, spike train statistics, firing rate models, PCA/ICA analysis).
Audience: Both Grad & Undergrad

4. Name various types of neural circuit models and their areas of application.
Audience: Both Grad & Undergrad

5. List the main differences between artificial neural networks as developed in computer science and computational models of biological neural networks.
Audience: Both Grad & Undergrad

6. Demonstrate how to characterize the dynamical properties of neurons and neural networks.
Audience: Both Grad & Undergrad

7. Summarize the hierarchical organization of the brain in computational terms (canonical microcircuit, mini-columns, functional brain networks).
Audience: Both Grad & Undergrad

8. Distinguish between anatomical, functional, and effective cortical connectivity.
Audience: Both Grad & Undergrad

9. Summarize main theoretical approaches to understanding brain functioning (graph theory, dynamical systems, information processing, decoding, whole-brain computational models).
Audience: Both Grad & Undergrad

10. Run and adapt MATLAB scripts for building and simulating neural

NTP 660 – NEUROSCIENCE & PUBLIC POLICY SEMINAR
1-2 credits.

Covers various topics in neuroscience and in the related sciences that demonstrate the interaction between science and public policy.
Requisites: BIOCORE 485, ZOOLOGY/PSYCH 523, PSYCH/NEURODPT/NTP 611, or declared in Neuroscience graduate program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Integrate knowledge from multiple sources and reflect on how science informs policies and society, and how policies impact the conduct of science
Audience: Both Grad & Undergrad

2. Demonstrate ability to consider multiple viewpoints on complex topics and engage in respectful and enriching discussion
Audience: Both Grad & Undergrad

3. Summarize content knowledge on current topics in policy, law, and neuroscience
Audience: Both Grad & Undergrad

4. Develop critical thinking skills to identify and dissect societal issues that are informed by science and reflect on potential solutions and next steps
Audience: Both Grad & Undergrad

5. Demonstrate knowledge of career paths at the intersection of science and policy (e.g. academic, non-profit, industry, government)
Audience: Both Grad & Undergrad

6. Demonstrate ability to lead an inclusive discussion on topics at the intersection of science and policy
Audience: Graduate

NTP 666 – NEUROSCIENCE OF CONSCIOUSNESS AND ITS DISORDERS
3 credits.

Outlines contemporary strategies to study consciousness and current knowledge of the neural correlates of consciousness and their alterations during sleep, parasomnia, anesthesia, coma, stroke, seizures, meditative and psychedelic states. Reviews recent work studying the neural correlates of conscious contents and their interactions with cognitive processes. Outlines contemporary theories of consciousness, illustrate how they can be empirically tested, and discuss their implications for the presence vs. absence of consciousness in artificial intelligent systems.
Requisites: (PSYCH 454 and ZOOLOGY/PSYCH 523) or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2025
Learning Outcomes: 1. Understand approaches used to distinguish between consciousness and its pre-requisites or consequences, and the importance of arousal systems for enabling consciousness.
Audience: Both Grad & Undergrad

2. Describe current knowledge about cortical structures involved in specific conscious contents.
Audience: Both Grad & Undergrad

3. Understand the complementarity of animal vs. human models to study consciousness.
Audience: Both Grad & Undergrad

4. Describe the spectrum of alterations of consciousness present during sleep, parasomnia, anesthesia, coma, seizures, stroke, meditative and psychedelic states, and their neural correlates.
Audience: Both Grad & Undergrad

5. Understand possible interactions and dissociations between consciousness, attention and memory.
Audience: Both Grad & Undergrad

6. Describe the variety of current theoretical approaches to consciousness and their relevance to infer the presence of consciousness in artificial intelligent systems.
Audience: Both Grad & Undergrad

7. Discuss a selection of recent studies - identified shortly before class as providing significant advances and/or reflecting current directions in the consciousness research field – and learn to critically analyze the methodological strengths and limitations of these studies.
Audience: Graduate

8. Understand how to design an experiment probing the neural correlates of consciousness while accounting for its pre-requisites and consequences.
Audience: Graduate

NTP 675 – SPECIAL TOPICS
1-3 credits.

Requisites: None
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025
Learning Outcomes: 1. Apply, analyze, or evaluate advanced theories, concepts, or methods in neuroscience and neurobiology
Audience: Both Grad & Undergrad

2. Identify and describe key theories, concepts, and methods in neurobiology
Audience: Both Grad & Undergrad

3. Explore a new phenomenon or modality in the neuroscience area and apply the knowledge gained to research in the field
Audience: Graduate

NTP 677 – BASIC SLEEP MECHANISMS AND SLEEP DISORDERS: FROM NEUROBIOLOGY TO SLEEP MEDICINE
3 credits.

Sleep occupies a third of our life, is found in all animal species carefully studied so far, and loss of sleep has both acute and long- term negative consequences on the brain and the body. Still, why we sleep remains unclear, and hypotheses on the role of sleep for synaptic homeostasis, learning and memory are being tested. Focuses on the neurobiology of sleep, with detailed review of the brain structures involved in controlling wake and sleep, as well as the circadian and homeostatic regulation of sleep. Other topics include changes in sleep need with age, animal models to study sleep, sleep disorders, and genetics of sleep.
Requisites: PSYCH 454 and ZOOLOGY/PSYCH 523 or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Outline the physiology and definitions used to define sleep and wake
Audience: Both Grad & Undergrad

2. Detail the brain structures and systems involved in the control of sleep and wake
Audience: Both Grad & Undergrad

3. Describe circadian and homeostatic regulation of sleep and wakefulness
Audience: Both Grad & Undergrad

4. Describe recent evidence linking sleep, memory, and synaptic plasticity
Audience: Both Grad & Undergrad

5. Describe animal models used to study sleep
Audience: Both Grad & Undergrad

6. Describe molecular and genetic approaches to the study of sleep
Audience: Both Grad & Undergrad

7. Recognize how sleep changes across the lifespan
Audience: Both Grad & Undergrad

8. Explain how sleep affects endocrine, metabolic, and cognitive functions

Audience: Both Grad & Undergrad

9. Outline the importance of sleep for the individual and society, including negative consequences of sleep deprivation and sleep disorders
Audience: Both Grad & Undergrad

10. List the symptoms, pathological mechanisms, epidemiology, and treatments of sleep disorders (including insomnia, sleep apnea, central nervous system hypersomnias, circadian rhythm disorders, parasomnias, and sleep-related movement disorders)
Audience: Both Grad & Undergrad

11. Discuss additional very recent studies on sleep topics and learn how to recognize strengths and limitations of these studies relative to prior knowledge on sleep research
Audience: Graduate

12. Describe how to design a sleep experiment and recognize the many confounding factors often associated with sleep studies
Audience: Graduate

NTP 700 – PROFESSIONAL DEVELOPMENT FOR BIOMEDICAL GRADUATE STUDENTS
1 credit.

Provides graduate students with the skills and knowledge necessary to succeed in science. Topics which are covered include choosing a thesis advisor, grant writing, preparing a seminar presentation, etc.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2024
Learning Outcomes: 1. Define the concepts of mentorship, mentor-mentee relationships and choosing a thesis advisor, mentor, and thesis committee members
Audience: Graduate

2. Write compelling publications for peer-reviewed journals, authorship responsibilities
Audience: Graduate

3. Critically evaluate a peer-reviewed scientific article
Audience: Graduate

4. Demonstrate knowledge of the concepts of grant writing, specific aims, preparing a seminar presentation, etc.
Audience: Graduate

5. Participate in various types of research collaborations, team science
Audience: Graduate

6. Provide instruction in the responsible conduct of research (RCR) for students; animal and human subject research and ethics
Audience: Graduate

NTP 701 – EXPERIMENTAL DESIGN AND STATISTICAL METHODOLOGY
1 credit.

Application of the scientific method and experimental design, with a focus on experimental neuroscience. Topics include best practices that underlie robust and unbiased experimental approaches, methods, analyses, data interpretation and transparent reporting of results.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Summer 2025
Learning Outcomes: 1. Identify appropriate experimental designs relevant to contemporary neuroscience research
Audience: Graduate

2. Recognize well-designed, well-controlled experiments
Audience: Graduate

3. Consider experimental design and analysis principles in their own research
Audience: Graduate

4. Describe appropriate quantitative approaches used in a variety of experimental systems
Audience: Graduate

5. Recognize (in)appropriate uses of statistics in neuroscience data analysis, interpreting results, and forming appropriate conclusions
Audience: Graduate

6. Select appropriate application of statistics to neuroscience data in different experimental paradigms
Audience: Graduate

NTP 900 – NEUROSCIENCE SEMINAR: CURRENT TOPICS IN NEUROBIOLOGY
1 credit.

Critical review of selected topics in neurobiology.
Requisites: Declared in Neuroscience graduate program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2025
Learning Outcomes: 1. Describe the breadth of Neuroscience.
Audience: Graduate

2. Present neuroscience research in a seminar setting.
Audience: Graduate

3. Demonstrate ability to critically analyze specific aspects of the topic area.
Audience: Graduate

NTP 990 – RESEARCH AND THESIS
1-12 credits.

Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2025
Learning Outcomes: 1. Exhibit a broad understanding of general Neuroscience principles
Audience: Graduate

2. Conduct independent research using a variety of approaches
Audience: Graduate

3. Demonstrate knowledge by critically addressing research challenges
Audience: Graduate

4. Exhibit and foster professional and ethical conduct in their research
Audience: Graduate

5. Collaborate with other investigators within or outside the thesis lab
Audience: Graduate