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 2023

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 2024

NTP/ANTHRO/PSYCH/ZOOLOGY 619 – BIOLOGY OF MIND
3 credits.

Origins and structures of mind, brain, and consciousness. Transitions from early mammalian through primate to hominid intelligence. Genetics and plasticity in brain development. Modern studies of human brain mechanisms and consciousness.
Requisites: Junior standing
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
Repeatable for Credit: No
Last Taught: Fall 2023

NTP/ZOOLOGY 620 – NEUROETHOLOGY SEMINAR
2 credits.

A group discussion of primary literature articles relevant to the neural basis of behavior with a purpose to understand the neural basis of behavior in animals, to learn to read papers critically and improve discussion leading skills.
Requisites: PSYCH/ZOOLOGY 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: Yes, unlimited number of completions
Last Taught: Spring 2024

NTP/NEURODPT 629 – MOLECULAR AND CELLULAR MECHANISMS OF MEMORY
3 credits.

Focuses on the cell signaling and the resulting structural changes that occur at neuronal synapses during memory formation. The aim is to understand how the synaptic changes underlying memory occur.
Requisites: Graduate/professional standing or ANAT&PHY 335, 435, PHYSIOL 335, 435 or ZOOLOGY/PSYCH 523
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: Fall 2023
Learning Outcomes: 1. Describe how the neural activity at the synapse which occurs during a memory-inducing event (a memorable event) leads to the ability to recall that event, when the animal or person does recall that event, either spontaneously or by prompting. Audience: Both Grad Undergrad

2. Apply a variety of biological techniques to understand the biochemical processes that are involved in memory. Learn the principles of these advanced techniqes and apply them appropriately to work out mechanisms. Audience: Both Grad Undergrad

3. Formulate why alterations in synaptic strength between neurons in an autoassociative network lead to the ability to recall an event which involved the activation of neurons in that network. This is the concept of pattern completion, which is the core of memory formation and is an incredibly important overall concept. Audience: Both Grad Undergrad

4. Succinctly present research proposals that are students' extensions of work that has been published, including a strong component of originality on the part of the student. Audience: Both Grad Undergrad

5. Formulate the basics of synaptic transmission mechanisms including presynaptic release of neurotransmitter and effects of neurotransmitter interactions with the post synaptic membrane on biochemistry and electrophysiology of the dendritic spine. These include unique properties of the dendritic spine including anatomy,biochemical composition. Audience: Both Grad Undergrad

6. Formulate the concept of neural plasticity, the strengthening and weakening of transmission between presynaptic terminals and post synaptic dendritic spines. The realization that this occurs as the result of interaction between a large number of proteins. Describe the structure of the synapse in detail that includes the roles played by structural proteins and protein kinases and phosphatases in affecting synaptic strength. Audience: Both Grad Undergrad

7. Describe the application of the use of advanced optical approaches such as FRET (fluorescence resonance energy transfer) and several others. Formulate how they reveal detailed information about the movements and alterations in properties of the key macromolecules that comprise the synaptic region. Formulate how information is derived from these measurements to explain events of synaptic plasticity. Audience: Both Grad Undergrad

8. Formulate an approach using one or more of these techniques to answer an unresolved question regarding the mechanisms of plasticity. 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 2024
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

10. Run and adapt MATLAB scripts for building and simulating neural models. Audience: Both Grad Undergrad

11. Evaluate and critique the assumptions and limitations of different computational models and approaches to address currently open questions in neuroscience. Audience: Graduate

12. Summarize key concepts, methods, and results from primary research articles. Integrate information from these articles to explain how authors reached their conclusions. Judge the strengths and limitations of the methods, the data, and the conclusions. Audience: Graduate

13. Run and evaluate a self-designed computational model of a biological neural circuit synthesizing concepts from different parts of the course based on computer labs. Audience: Graduate

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).

NTP/MED PHYS 651 – METHODS FOR NEUROIMAGING RESEARCH
3 credits.

Provides a practical foundation for neuroimaging research studies with statistical image analysis. Specific imaging methods include functional BOLD MRI, structural MRI morphometry, and diffusion tensor imaging. Lectures and associated in-class computer exercises will cover the physics and methods of image acquisition, steps and tools for image analyses, the basis for statistical image analyses and interpretation of the results.
Requisites: Graduate/professional standing or (PHYSICS 104, 202 or 208)
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 2023

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 2024
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 2024
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 670 – STEM CELLS AND THE CENTRAL NERVOUS SYSTEM
2-3 credits.

Among the topics that will be included in the course are: embryonic stem cells, adult stem cells, and the transplantation of embryonic and adult stem cell to the developing and adult CNS for experimental and therapeutic purposes.
Requisites: BIOCHEM 501 or graduate/professional standing
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: Fall 2021
Learning Outcomes: 1. Describe how neural stem cells function during development and in the adult, and the regulation of these processes Audience: Both Grad Undergrad

2. Describe how neural stem cells can be obtained from reprogramming and can be differentiated into different types of cells, and methods and concerns for their use in modeling disease Audience: Both Grad Undergrad

3. Retrieve, evaluate, and interpret literature related to their scientific question Audience: Both Grad Undergrad

4. Participate and discuss strengths and weaknesses of literature Audience: Both Grad Undergrad

5. Identify, formulate and solve problems using appropriate information and approaches Audience: Both Grad Undergrad

6. Propose original research and develop ability to write Specific Aims page Audience: Graduate

7. Communicate effectively through written reports, oral presentations, and discussion 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: Spring 2024
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 2023
Learning Outcomes: 1. Outline the physiology and definitions used to define sleep and wake 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 (selected shortly before class to reflect pertinence and current direction in the field) 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

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

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 2023
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\\n Audience: Graduate

3. Critically evaluate a peer-reviewed scientific article\\n 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 2023
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 735 – NEUROBIOLOGY OF DISEASE
2 credits.

Seminar course relating major categories of human neurological and opthalmological disease to fundamental topics in neurobiology.
Requisites: Graduate/professional standing and NTP/NEURODPT 610
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2022
Learning Outcomes: 1. Recognize the clinical aspects (diagnosis and available treatments) for a number of neurological diseases Audience: Graduate

2. Critically discuss current papers in the neurobiology of disease literature Audience: Graduate

3. Demonstrate understanding of the latest findings and treatments for a number of neurological disorders Audience: Graduate

4. Sharpen communication skills by presenting the scientific papers and leading discussion Audience: Graduate

NTP/NEURODPT/ZOOLOGY 765 – DEVELOPMENTAL NEUROSCIENCE
3 credits.

Analysis of neural development with emphasis on experimental approaches. Combination of lectures and discussions of primary literature. Topics include neural induction, patterning, mechanisms of axon guidance, neural crest cell migration and differentiation, cortical development, and synapse formation and elimination.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023
Learning Outcomes: 1. Gain an extensive understanding of mechanisms of neural development Audience: Graduate

2. Acquire the ability to critically analyze current studies in neural development 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 2024

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: Spring 2024
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