

# NEUROBIOLOGY CURRICULUM (GRAD)

## Contact Information

### Neuroscience Curriculum

Visit Program Website (<https://www.med.unc.edu/neuroscience/curriculum>)

### Garret Stuber, Director

The Neuroscience Curriculum at the University of North Carolina at Chapel Hill is a broadly based interdisciplinary graduate training program in the neurosciences. With strong research funding and a long and successful training history, the curriculum ranks among the best programs in the country.

The program has 80 primary faculty members who can serve as dissertation advisors. Research opportunities in the curriculum are supported by the presence of an active neuroscience community at UNC–Chapel Hill. This community includes members of every basic science department in the School of Medicine, members of many clinical departments, as well as several departments in the College of Arts and Sciences. University research and clinical centers with a neuroscience component also contribute to the vibrant and active community that makes neurobiology a major intellectual focus at UNC–Chapel Hill.

The Neuroscience Curriculum enrolls an average of 45 students at different levels of training at any given time; typically, five to ten students are accepted each year depending on available funding. Students in the curriculum are supported during their first and/or second years by a long-standing training grant funded through NINDS, and in subsequent years by either their mentor's research grants or individual fellowships. The average time to graduation is 5.3 years.

Neuroscience is by its very nature an interdisciplinary endeavor, and at UNC–Chapel Hill the neuroscience curriculum provides a broadly structured training curriculum and research environment that spans the range from genetic studies of the nervous system through the complexities of human cognitive function.

Applicants are urged to complete their applications through BBSP (<http://bbbsp.unc.edu/admissions>) by early December.

Courses required for the Ph.D. degree in neuroscience include Molecular and Cellular Neuroscience (NBIO 722A, NBIO 722B, NBIO 722C) and Systems and Translational Neuroscience (NBIO 723A, NBIO 723B, NBIO 723C).

The purpose of the course in Molecular and Cellular Neuroscience is to explore the experimental and theoretical basis for current concepts of nervous system function. The course runs as a series of three blocks in the fall semester and three blocks in the spring semester. This is NOT a survey course in neuroscience. The goals of the course are not so much to inform as to foster an understanding of how we accumulate our knowledge and hypotheses, not to provide a complete textbook picture of the functioning nervous system as we currently know it but to provide the intellectual tools and skills to evaluate current and future hypotheses, not so much to provide answers to questions as to attempt to define the unanswered questions.

**Block 1 – Neuroscience Bootcamp: Introduction to Techniques Used in Studying the Nervous System/Electrical Signaling (NBIO 722A) (19 sessions)** Because students taking the core course have diverse backgrounds, this block is divided into two sections.

**Block 1a – Neuroscience Bootcamp: Introduction to Techniques Used in Studying the Nervous System (9 sessions).** The first block serves as an introduction to neuroscience as well as an overview of many of the techniques students will encounter while reading materials and papers for the rest of the course. Examples of topics covered include statistics and hypothesis testing, molecular biology and genetic engineering, confocal microscopy, and functional anatomy of the rodent brain. Fall. Jensen, Brenman, Robinson, Besheer, Stuber.<sup>1</sup>

**Block 1b – Electrical Signaling (10 sessions).** This block introduces materials related to electrical excitability of neurons. Topics include ion channels, membrane potentials, generation and propagation of action potentials, dendritic excitability, and computational neuroscience as it relates to electrical signaling of neurons. Fall. Smith, Frohlich, Manis<sup>1</sup>

**Block 2 – Synaptic Mechanisms (NBIO 722B) (10 sessions).** This block focuses on synaptic mechanisms of neurotransmitter release and termination of signaling, as well as intracellular signaling cascades that are regulated by synaptic transmission. Topics include electrophysiological and molecular analysis of neurotransmitter release, short-term plasticity in neurotransmitter release, synaptic plasticity, calcium signaling and regulation of intracellular signaling cascades, and gene expression. Fall. Philpot,<sup>1</sup> Reissner, McElligott, Dudek.

**Block 3 – Receptors (NBIO 722C) (10 sessions).** This block focuses on neurotransmitter signaling through distinct receptor subclasses. Topics include G-protein coupled receptors and associated signaling, receptor binding theory, ionotropic and metabotropic glutamate and GABA receptors, receptor trafficking and localization. Fall. Kash,<sup>1</sup> Harden, Nicholas, McCorvy, McElligott, Herman.

**Block 4 – Development of the Nervous System (NBIO 723A) (11 sessions).** This block focuses on molecular mechanisms of neuronal development and their relation to disease. Topics include neurogenesis, neural stem cells, molecular control of axonal guidance and neuronal migration, and cell and synaptic adhesions molecules. Spring. Crews, Maness, Anton,<sup>1</sup> Deshmukh, Gupton, Song, Stein.

**Block 5 – Anatomy and Function of Sensory and Motor Systems (NBIO 723B) (17 sessions).** This block focuses on the neural circuitry that comprises sensory and motor systems. Topics include organization and function of the retina and visual cortex, mechanosensation, genetically defined circuits for nociception, organization and function of somatosensory cortex, motor cortex, basal ganglia neural circuitry, and cerebellar organization and function. Spring. Zylka,<sup>1</sup> Manis, Fitzpatrick, Stuber, Snider, Weiss, Cheney.

**Block 6 – Neurobiology of Disease (NBIO 723C) (12 sessions).** This block focuses on the neurobiological underpinnings of disease. For each topic the disease and its impact on society is introduced, and then detailed discussions of the molecular, genetic underpinnings and circuit and behavioral consequences of the disorder are presented. Topics include epilepsy, addiction, fear and anxiety circuitry, schizophrenia, autism, Alzheimer's disease, and Parkinson's disease. This block also includes two classes devoted to human neuroimaging methods such as fMRI and DTI. Spring. Snider,<sup>1</sup> Gilmore, Cohen, Ditcher, Stein, Stuber, Zylka, Piven.

<sup>1</sup> denotes the head of the block

**Communication of Scientific Results Neurobiology (NBIO 850)**

The class teaches the principles for giving effective talks. The course also covers how to introduce speakers, prepare slides, and speak with the public about science. Spencer Smith currently directs the course, with additional faculty members participating in each class. The class is limited to Neuroscience Curriculum students. Students prepare talks, refine them in small groups (three to four students), and then present them in class. The in-class talk is videotaped, and these tapes are reviewed by the students in a session with their peers. After another round of refining their talks with their small group, the students give their polished talks to the department in a formal setting. Writing is critiqued in class, with peers and guest faculty members all offering input. The videotaped reviews and peer critiques help tremendously to teach effective speaking and writing methods in NBIO 850 (a.k.a. PClass); thus, preparing students for the next stage in their scientific careers. Fall. S. Smith.

**Neuroanalytics (NBIO 750)**

The purpose of this course is to provide both practical and theoretical training in advanced data analysis approaches commonly used in neuroscience research. Over the past 10 years there has been a dramatic shift within the field from relatively simple data analysis approaches such as calculating means and standard errors of grouped data, to now performing complex analysis on higher dimensional datasets to uncover unappreciated features. The material in this course should be immediately useful to any student who is working with modern data collected in neuroscience, from sequencing, electrophysiology, imaging, biochemistry, and behavior. The concepts in the course will be taught through programming in python. While understanding mathematical concepts behind analysis is important, we will largely focus on the big picture and try to illustrate concepts by emphasizing graphical representations of how datasets are treated with these approaches. Throughout the course, we will utilize real-world neuroscience data from a variety of sub-disciplines as examples, and also focus on teaching the implications and limitations of the approaches we cover. At the end of the course, students should have a solid foundation of scientific computing, which will prepare them to independently conduct analysis of their own data or prepare them for more advanced courses. Fall. Stuber.

**Neuroscience Seminar Series (NBIO 893)**

Diverse but current topics in all aspects of neuroscience. Relates new techniques and current research of notables in the field of neuroscience. Content focuses on presentations by invited, non-UNC faculty, UNC faculty, and mini-series presentations from current neuroscience students. Topics vary from week to week. Students in the curriculum are expected to attend and participate in the neuroscience seminar series, and in particular year 2 and 3 students will be enrolled in NBIO 893 each semester, for which their attendance and participation in seminars and dissertation defenses is tracked and graded. Fall and spring. Stuber.

On the curriculum's Web site, the courses menu lists descriptions of the core courses of the neuroscience curriculum; other selected offerings are shown under the electives menu. Additional elective courses in biochemistry, statistics, molecular biology, physiology, etc., are available to compensate for specific deficiencies or enhance training. It is the current philosophy of the curriculum faculty that students should receive a broad exposure to as many aspects of neuroscience as reasonable, from molecules and genetics through systems, behavior, and human diseases of the nervous system.

The following is a partial list of courses that neuroscience students may consider for their elective requirements.

**Microscopy (NBIO 731)**

**Special Topics in Neuroscience: The Methods in Genetic Engineering (NBIO 890-002)**  
**Special Topics in Neuroscience: Network Neuroscience (NBIO 890-003) Developmental Neuroscience (NBIO 724)**  
**Neural Information Processing (NBIO 729)**  
**Introductory Statistics for Laboratory Scientists (BBSP 610)**  
**Gene Brain Behavior Interactions in Neurodevelopmental Disorders: Towards an Integration of Perspectives on Disease Mechanisms (NBIO 800)**  
**Clinical Syndromes and Neurodevelopmental Disorders (NBIO 801)**  
**Neurocircuits and Behavior Journal Club (NBIO 733)**  
**Biological Bases of Behavior I (PSYC 701)**  
**Biological Bases of Behavior II (PSYC 702)**  
**Translational Seminar in Cognitive and Clinical Neuroscience (NBIO 727)**  
**Neuropharmacology of Alcohol and Substance Abuse (PHCO 728)**  
**Principles of Statistics Infer (BIOS 600)**  
**Research Ethics (GRAD 721)**  
**Seminar in the Biological Foundations of Psychology (PSYC 708 )**  
**Statistical Methods in Psychology (PSYC 830 )**

## Professors

**Eva Anton**, Neural Circuitry in the Cerebral Cortex  
**Aysenil Belger**, Cortical Circuits Underlying Attention and Executive Function in the Brain  
**Jay Brenman**, AMP-Activated Protein Kinase (AMPK) Plays A Central Role in Energy Balance/Metabolism  
**Regina Carelli**, Brain Reward Processes  
**Paul Carney**, Child Neurology, Epilepsy, Sleep Disorders  
**Richard Cheney**, Fundamental Cell Biology Unconventional Myosins, Filopodia, and Motility  
**Fulton Crews**, Molecular Aspects of Neuronal Vitality and Alcohol  
**Stephen Crews**, Molecular Genetics of Drosophila Nervous System Development  
**Mohanish Deshmukh**, Mechanisms of Apoptosis Regulation in Neurons, Stem Cells, and Cancer Cells  
**Nikolay Dokholyan**, Molecular Etiologies of Human Disease  
**Serena Dudek (NIEHS)**, Connections in the Brain (Synapses) Change in Response to Activity  
**John Gilmore**, Human Brain Development, Immune Regulation of Neurodevelopment, Schizophrenia  
**Klaus Hahn**, Understand Cell Behaviors Mediated by Structural Dynamics  
**Clyde Hodge**, Neurobehavioral Pharmacology and Pharmacogenomics of Addiction  
**Patricia Jensen (NIEHS)**, Genetic and Environmental Perturbations During Development  
**Tom Kash**, Synaptic Transmission and Plasticity  
**Weili Lin**, Cerebral Ischemia, Human Brain Development, PET, MR  
**Donald Lysle**, Neuroimmunology, Learning Processes  
**Patricia Maness**, Cell Adhesion and Signal Transduction in Developing Neurons  
**Paul Manis**, Cellular Basis of Auditory Information Processing in Brainstem and Cortex  
**Greg Matera**, Genetics and Cell Biology of RNP Assembly and Transport  
**Glenn Matsushima**, Responses of Macrophages During Injury to the CNS  
**Rick Meeker**, Neuroendocrine Regulation, Glutamate Receptors, Mechanisms of AIDS Dementia  
**A. Leslie Morrow**, Molecular Neurobiology of GABAA Receptors and Alcoholism  
**Mark Peifer**, Cell Adhesion, Signal Transduction, and Cytoskeletal Regulation in Development and Disease

**Benjamin Philpot**, Modification of the Cerebral Cortex by Sensory Experience  
**Joseph Piven**, Pathogenesis of Autism, Genetic Basis, and Neuropsychological and Behavioral Phenotype  
**Bryan Roth**, GPCR Structure and Function, Drug Discovery  
**Richard J. Samulski**, Development of Viral Vectors for Brain-Specific Gene Delivery  
**William Snider**, Developmental Regulation of Neuronal Growth Factors  
**Patrick Sullivan**, Complex Traits in Humans, Psychiatric Genetics, Pharmacogenetics  
**Todd Thiele**, Neurobiology of Alcoholism  
**Jenny Ting**, Use of Murine Models in the Regulation of Inflammatory Genes in Demyelination and Remyelination  
**Richard Weinberg**, Organization of the Postsynaptic Density, Calcium Sources and Actin-Binding Proteins in Spines  
**Ellen Weiss**, Regulation of G-Protein Signaling Pathways, Visual Signal Transduction  
**Kirk Wilhelmsen**, Genetic Mapping of Susceptibility Loci for Complex Neurological Diseases  
**Mark Zylka**, Molecules and Mechanisms for Pain

## Associate Professors

**Joyce Besheer**, Neurobiological Mechanisms Underlying Alcoholism and Addiction  
**Charlotte Boettiger**, Neurobiological Mechanisms of Executive Function Irregularities in Addiction  
**Gabriel Dichter**, Understanding and Improving Treatments for Neurodevelopmental and Neuropsychiatric Disorders  
**Kelly Giovanello**, Exploring the Cognitive and Neural Processes Mediating Memory in Young Adults  
**Silva Markovic-Plese**, Autoimmune Response in MS, New Immunomodulatory Therapies  
**Donita Robinson**, Chemistry and Physiology of the Nucleus Accumbens  
**Rebecca Knickmeyer-Santelli**, Hormonal and Genetic Factors in Neurodevelopmental Disorders  
**Garret Stuber**, Neural Circuit Mechanisms That Regulate the Activity and Function Midbrain Dopamine Neurons

## Assistant Professors

**Jessica Cohen**, Functional Brain Networks Interaction When Confronted with Changing Cognitive Demands  
**Todd Cohen**, Alzheimer's Disease, Frontotemporal Dementia, Amyotrophic Lateral Sclerosis  
**Eran Dayan**, Brain Connectivity, Functional Neuroimaging  
**Graham Diering**, Molecular Mechanisms of Synaptic Plasticity in Sleep  
**Sylvia Fitting**, Structural and Functional Consequences of Behavior/Neurocognition in Disease  
**Flavio Frohlich**, Cortical Networks Generate Physiological, Pathological Activity States  
**Tim Gershon**, Regulation of Neural Progenitor Proliferation in Normal Development and in Pediatric Brain Tumors  
**Steven Gray**, Development and Optimization of AAV Vectors Specifically Tailored Toward CNS Applications  
**Stephanie Gupton**, Coordination and Regulation of Cytoskeletal Dynamics and Membrane Trafficking  
**Melissa Herman**, Inhibitory Microcircuitry Governing Network Function in Motivated Behaviors  
**Toshi Hige**, Mechanisms of Behavioral Responses in Regards to Synaptic Plasticity, Neural Circuit and Behavior  
**Shawn Hingtgen**, Stem Cells, Treatment of Terminal Cancers, Brain Cancer

**Hiroyuki Kato**, Neural Encoding of Complex Auditory Stimuli  
**Damaris Lorenzo**, Roles of Cytoskeletal Proteins in the Regulation of Cellular Dynamics and Bioenergetics  
**Zoe Mcelligott**, Mechanisms That Underlie Affective Disorders – Anxiety, Depression and Substance Abuse  
**Ryan Miller**, Characterization of the Molecular Genetic Mechanisms Responsible for Heterogeneity Using Tumor Tissues  
**Kathryn Reissner**, Chronic Self-Administration of Cocaine, Neuronastrocyte Communication, Long-Term Drug Seeking  
**Celia Shiau**, Genetic, Cellular and Developmental Systems for Vertebrate Biology  
**Yen-Yu Ian Shih**, Developing and Applying Innovative MRI Technologies in Neurovascular Functions of the Brain  
**Spencer Smith**, Development and Function Circuitry – Using Imaging, Electrophysiology and Behavior  
**Juan Song**, Adult Neurogenesis Function and Regulation  
**Jason Stein**, Genetic Effects on Multiple Aspects of the Human Brain  
**Lisa Tarantino**, Genes That Increase Risk for Psychiatric Disorders  
**Ann Marion Taylor**, Micro-Scale Devices, Microfluidics, Synapse Formation, Synaptic Plasticity, Protein Synthesis

## NBIO

### Advanced Undergraduate and Graduate-level Courses

**NBIO 400. Conditioning and Learning. 3 Credits.**  
 A comprehensive survey of the methods, findings, and theories of classical and operant conditioning. Skills necessary to evaluate, integrate, and summarize significant original literature will be developed.  
**Requisites:** Prerequisites, PSYC 101 and 222.  
**Gen Ed:** PL.  
**Grading status:** Letter grade  
**Same as:** PSYC 400.

**NBIO 401. Animal Behavior. 3 Credits.**  
 PSYC 270 recommended. Ethological, genetic, and physiological variables will be studied in relation to their behavioral effects.  
**Requisites:** Prerequisites, PSYC 101, and PSYC 222 or BIOL 101.  
**Gen Ed:** PL.  
**Grading status:** Letter grade  
**Same as:** PSYC 401.

**NBIO 402. Advanced Biopsychology. 3 Credits.**  
 Elements of neurophysiology, neuroanatomy, and neurochemistry as they apply to the understanding of brain-behavior relationships.  
**Requisites:** Prerequisites, PSYC 101 and 175 or 220.  
**Gen Ed:** PX.  
**Grading status:** Letter grade  
**Same as:** PSYC 402.

**NBIO 411. Neurobiology Laboratory Apprenticeship. 1-21 Credits.**

**NBIO 412. Neurobiology Laboratory Apprenticeship. 1-21 Credits.**

**NBIO 450. Tutorial in Neurobiology. 3 Credits.**

**Graduate-level Courses**

**NBIO 701A. Brain & Behavior I. 3 Credits.**  
 Graduate standing required. A survey of psychological and biological approaches to the study of sensory and perceptual information processing, with an emphasis on touch and pain.  
**Grading status:** Letter grade  
**Same as:** PSYC 701.

**NBIO 702A. Brain & Behavior II. 3 Credits.**

A survey of psychological and biological approaches to the study of basic learning and higher integrative processing.

**Grading status:** Letter grade

**Same as:** PSYC 702.

**NBIO 703. Advanced Biological Psychology: Central Nervous System. 3 Credits.**

Each fall one special topic will be covered in depth (e.g., neural bases of memory storage, homeostasis, and perception). Format includes lectures and seminar meetings with student presentations.

**Requisites:** Prerequisite, PSYC 402.

**Grading status:** Letter grade

**Same as:** PSYC 703.

**NBIO 704. Applications of Experimental Psychology to Health Research. 3 Credits.**

This course provides a critical analysis of interdisciplinary research within experimental psychology, including such topics as psychopharmacology, psychoneuroimmunology, psychophysiology, and animal models of brain/behavior disorders.

**Grading status:** Letter grade

**Same as:** PSYC 704.

**NBIO 705. Behavioral Pharmacology. 3 Credits.**

Basic principles of pharmacology and behavior analysis are considered in relation to drugs that affect the central nervous system.

**Requisites:** Prerequisite, PSYC 404; permission of the instructor for students lacking the prerequisite.

**Grading status:** Letter grade

**Same as:** PSYC 705, PHCO 705.

**NBIO 708. Seminar in the Biological Foundations of Psychology. 3 Credits.**

Permission of the instructor. Limited to graduate students in psychology and neurobiology. Lectures and seminar presentations on a wide range of topics in the area of physiological psychology.

**Repeat rules:** May be repeated for credit.

**Grading status:** Letter grade

**Same as:** PSYC 708.

**NBIO 721. Directed Studies in Oral Biology. 1 Credit.**

Topics include extracellular matrices, immunology, inflammation, neurobiology, and pain management.

**Grading status:** Letter grade

**Same as:** OCBM 723.

**NBIO 722. Cellular and Molecular Neurobiology. 2-6 Credits.****NBIO 722A. Cellular and Molecular Neurobiology: Introduction and Electrical Signaling. 2 Credits.**

Permission of the department. Introduces topics as brain cell biology, molecular biology applied to neurons, membrane potentials and imaging methods. The second half of this block introduces such topics as resistance, capacitance, passive membranes, classes of ion channels, potassium and calcium channels, and action potential initiation.

**Grading status:** Letter grade

**Same as:** BIOC 722A, PHCO 722A.

**NBIO 722B. Cellular and Molecular Neurobiology: Postsynaptic Mechanisms-Receptors. 2 Credits.**

Permission of the department. Consideration of membrane receptor molecules activated by neurotransmitters in the nervous system with emphasis on ligand binding behavior and molecular and functional properties of different classes of receptors. Course meets for four weeks with six lecture hours per week.

**Grading status:** Letter grade

**Same as:** BIOC 722B, PHCO 722B.

**NBIO 722C. Cellular and Molecular Neurobiology: Synaptic Transmissions. 2 Credits.**

Permission of the department. This block focuses on neurotransmitter signaling through distinct receptor subclasses. Topics include G-protein coupled receptors and associated signaling, receptor binding theory, ionotropic and metabotropic glutamate and GABA receptors, receptor trafficking and localization. Course meets for five weeks with six lecture hours per week.

**Grading status:** Letter grade

**Same as:** BIOC 722C, PHCO 722C.

**NBIO 723A. Cellular and Molecular Neurobiology: Development of the Nervous System. 2 Credits.**

Permission of the department. This block covers neural induction, neural stem cells, glial development, neural cell death and neurotrophin during development, and synaptic adhesion molecules.

**Grading status:** Letter grade

**Same as:** BIOC 723A, PHCO 723A.

**NBIO 723B. Cellular and Molecular Neurobiology: Anatomy and Function of Sensory and Motor Systems. 2 Credits.**

Permission of the department. This block introduces the sensory pathways of vision, audition, taste, olfaction, pain, and touch, as well as the motor pathways of the spinal cord, basal ganglia, cerebellum, and motor cortex. Discusses mechanisms of sensory information processing and motor execution. Includes peripheral and central mechanisms of pain.

**Grading status:** Letter grade

**Same as:** BIOC 723B, PHCO 723B.

**NBIO 723C. Cellular and Molecular Neurobiology: Imaging & Disease. 2 Credits.**

This block covers CNS imaging, regeneration, and such diseases as Alzheimer's, ALS, Parkinson's, epilepsy, addiction, autism, and schizophrenia.

**Grading status:** Letter grade.

**NBIO 724. Developmental Neurobiology. 2 Credits.**

A survey of nervous system development emphasizing detailed analysis of selected research topics such as neuronal induction, neural crest development, neuronal differentiation, synapse formation, neurotrophic factors, glial development, and the effects of experience.

**Requisites:** Prerequisite, NBIO 722; Permission of the instructor for students lacking the prerequisite.

**Grading status:** Letter grade.

**NBIO 725. Experimental Neurophysiology. 3 Credits.**

Permission of the instructor. Six or more laboratory hours a week.

**Grading status:** Letter grade.

**NBIO 727. Translational Seminar in Cognitive and Clinical Neuroscience. 2 Credits.**

Introduces new neuroimaging techniques and their application to the study of neural correlates of cognitive and behavioral impairments in brain disorders. Reviews the theories and research methodologies that investigate how brain functions support and give rise to mental operations such as attention, memory, emotions, social cognition in the healthy brain.

**Repeat rules:** May be repeated for credit.

**Grading status:** Letter grade.

**NBIO 728. Diseases of the Nervous System. 2 Credits.**

Explores the basic neurobiology and the clinical aspects of a range of diseases of the nervous system, including ALS, Alzheimer's, autism, schizophrenia, multiple sclerosis, deafness, epilepsy, pain, brain tumors, stroke, Parkinson's, and other neurodegenerative diseases.

**Requisites:** Prerequisites, NBIO 201, or 722 and 223.

**Grading status:** Letter grade.

**NBIO 729. Sensory Neural Information Processing and Representation. 3 Credits.**

Additional required preparation, one year of calculus, familiarity with MATLAB or Python, or permission of the instructor. A discussion/reading seminar covering the fundamentals of nervous system information processing and integration, with examples from sensory systems.

**Requisites:** Prerequisites, NBIO 722 and 733.

**Grading status:** Letter grade.

**NBIO 731. Microscopy: Principles & Applications. 2 Credits.**

This course aims to provide the knowledge one may need to understand the reach of microscopy imaging techniques, to be able to choose the right imaging modality, label the sample, carry out the experiment, analyze data, troubleshoot any pitfalls that may occur, and put together a custom optical setup.

**Grading status:** Letter grade.

**NBIO 732. Biological Concepts. 1.5 Credit.**

Overview of structures and biological determinants of conditions and diseases of the oral cavity. Both growth and development and pathophysiology will be introduced in the context of three areas of oral biology: biology of extracellular matrices, host-pathogens interactions, and orofacial neurobiology.

**Grading status:** Letter grade

**Same as:** OCBM 732, PHCO 747.

**NBIO 733. Neurocircuits and Behavior Journal Club. 1 Credit.**

This is journal club course will meet once per week for 90 minutes to discuss new research papers focused on delineating how neurocircuits function to orchestrate various behavioral states. Papers for discussion will be chosen by the instructor and students, and students will rotate in leading discussions.

**Requisites:** Prerequisites, NBIO 722 and 723.

**Grading status:** Letter grade.

**NBIO 735. Seminar in Chemical Neurobiology. 2 Credits.**

Required preparation, two semesters of biochemistry.

**Grading status:** Letter grade.

**NBIO 750. Neuroanalytics: Programming, Statistics, and Machine Learning for the Analysis of Neuroscience Data. 4 Credits.**

Practical/theoretical training in advanced data analysis approaches commonly used in neuroscience research. Course useful with modern data collected in Neuroscience, from sequencing, electrophysiology, imaging, biochemistry, and behavior. The concepts will be taught through programming in python, focusing on illustrating concepts by emphasizing graphical representations of how datasets.

**Requisites:** Prerequisites, NBIO 722 and 723.

**Grading status:** Letter grade.

**NBIO 751. Neurodevelopmental Basis of Brain Disorders. 2 Credits.**

The basic principles guiding in the formation and maintenance of human nervous system and how do distinct genetic/ epigenetic disruptions during development cause different types of human neurodevelopmental disorders. The intent of this course is to present latest advances in developmental neuroscience in the context of this theme. Topics covered IMII include neural patterning, neurogenesis, neural cell fate specification, neuronal migration, axon/dendritic growth and connectivity.

**Grading status:** Letter grade.

**NBIO 800. Gene-Brain-Behavior Interactions in Neurodevelopmental Disorders: Perspectives on Disease Mechanisms. 3 Credits.**

This seminar examines the topics of genetics, neuroanatomy, physiology, and behavioral development to provide a broad-based and integrated background to understand the etiology and potential mechanism underlying neurodevelopmental disorders.

**Grading status:** Letter grade.

**NBIO 801. Clinical Syndromes and Neurodevelopmental Disorders. 3 Credits.**

This seminar will review the epidemiology, pathogenesis, diagnosis and treatment of neurodevelopmental syndromes and disorders. Topics will range from single gene (e.g. fragile X syndrome and tuberous sclerosis) to complex genetic (e.g., autism, schizophrenia), to environmental disorders with varied phenotypes, pathogenetic mechanisms, and treatments.

**Grading status:** Letter grade.

**NBIO 850. Seminar in Neurobiology. 3 Credits.**

Permission of the department. An intensive consideration of selected topics and problems in neurobiology. The course focuses on the development of presentation and evaluation skills of the trainees. Six credit hours required for neurobiology graduates.

**Grading status:** Letter grade

**Same as:** BIOL 850, PHCO 850.

**NBIO 857. Seminar in Comparative Animal Behavior. 1-2 Credits.**

Permission of the instructor. Advanced seminar in comparative animal behavior. May be repeated for credit.

**Repeat rules:** May be repeated for credit; may be repeated in the same term for different topics.

**Grading status:** Letter grade

**Same as:** BIOL 857.

**NBIO 858. Seminar in Comparative Physiology. 1-2 Credits.**

Advanced seminar in comparative physiology.

**Requisites:** Prerequisite, BIOL 451; permission of the instructor for students lacking the prerequisite.

**Repeat rules:** May be repeated for credit; may be repeated in the same term for different topics.

**Grading status:** Letter grade

**Same as:** BIOL 858.

**NBIO 890. Special Topics in Neurobiology. 1-5 Credits.**

Special topics in neurobiology. Content will vary from semester to semester.

**Grading status:** Letter grade.

**NBIO 892. Special Topics in Physiology. 1-5 Credits.**

Permission of the instructor. Individually arranged in-depth programs of selected topics such as membrane function, transport physiology, renal physiology, etc.

**Grading status:** Letter grade.

**NBIO 893. Neuroscience Seminar Series. 1 Credit.**

Diverse but current topics in all aspects of neuroscience. Relates new techniques and current research of notables in the field of neuroscience. Content focuses on presentations by invited, non-UNC faculty, UNC faculty and mini-series presentations from current Neuroscience students. Topics vary from week to week.

**Grading status:** Letter grade.

**NBIO 951. Research in Neurobiology. 3-12 Credits.**

Permission of the department. Research in various aspects of neurobiology. Six to 24 hours a week.

**Grading status:** Letter grade

**Same as:** BIOL 951, PHCO 951.

**NBIO 993. Master's Research and Thesis. 3 Credits.**

Course is designed to certify that the students have achieved a high level of knowledge competence in clinical and basic neurosciences, without the rigorous research experience required of a Ph.D.

**Repeat rules:** May be repeated for credit.

**NBIO 994. Doctoral Research and Dissertation. 3 Credits.**