

NEUROSCIENCE

Our Website (<http://www.neuroscience.vt.edu>)

Overview

Embark on a journey into the brain with the Neuroscience undergraduate program at Virginia Tech. This program, designed for ambitious students, offers dynamic majors: Clinical Neuroscience, Cognitive and Behavioral Neuroscience, Computational and Systems Neuroscience, and Experimental Neuroscience. Whether you aspire to become a physician, researcher, or industry innovator, our curriculum ensures you are prepared. Many of our students follow a pre-med track, gaining a robust foundation that paves the way for medical school and beyond. With a comprehensive education that spans the fundamentals of brain functioning, research, healthcare, and numerous other fields, you'll be equipped to tackle the complexities of the human brain and nervous system.

Our interdisciplinary approach integrates knowledge from biology, psychology, computer science, and more, fostering a holistic understanding of neuroscience. As part of our Computational Neuroscience major, you'll also delve into artificial intelligence, gaining skills to leverage AI in understanding neural processes and developing innovative solutions. Beyond academics, we emphasize professional development, ensuring you acquire essential problem-solving and critical thinking skills. With global perspectives and study abroad opportunities, you'll be prepared to apply your knowledge in diverse, real-world contexts. Join us to synthesize and apply knowledge in innovative ways, preparing you for a future where you can make a significant impact in your chosen field.

Neuroscience Majors

- Neuroscience B.S. Clinical Neuroscience (CNEU)
- Neuroscience B.S. Cognitive and Behavioral Neuroscience (CBNU)
- Neuroscience B.S. Computational and Systems Neuroscience (CSNU)
- Neuroscience B.S. Experimental Neuroscience (EXPN)

Transfer students should contact the department early, preferably one full semester prior to entrance. This procedure will allow a thorough evaluation of transfer credits and correct placement.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward Pathway to General Education (see "Academics (<https://catalog.vt.edu/undergraduate/academic-policies/>)") and toward the degree.

Satisfactory progress requirements toward the B.S. in Neuroscience can be found on the major checklist by visiting the University Registrar website at <http://registrar.vt.edu/graduation-multi-brief/index1.html>.

- Clinical Neuroscience Major (<https://catalog.vt.edu/undergraduate/college-science/neuroscience/neuroscience-bs-clinical-neuroscience/>)
- Cognitive and Behavioral Neuroscience Major (<https://catalog.vt.edu/undergraduate/college-science/neuroscience/neuroscience-bs-cognitive-behavioral-neuroscience/>)

- Computational and Systems Neuroscience Major (<https://catalog.vt.edu/undergraduate/college-science/neuroscience/neuroscience-bs-computational-systems-neuroscience/>)
- Experimental Neuroscience Major (<https://catalog.vt.edu/undergraduate/college-science/neuroscience/neuroscience-bs-experimental-neuroscience/>)

Director: M. Olsen

Professor: M. Olsen, M. Cline, E. Gilbert

Associate Professor: S. Clinton, K. Phillips, S. Vijayan, A. Pickrell, L. Ni, M. Weston, T. Jarome, K. Sewall

Assistant Professor: S. Agrawal, M. Buczynski, D. English, A. Gregus, M. Howe, G. Hodes, S. Macias, C. Thompson, J. Rainville, A. Shah, W. Legon, J. Basso, M. van der Heijden

Affiliated Faculty: L. Apfel, S. Ball, M. A. Bell, L. Bergamasco, A.S. Bertke, D. Bevan, W. Bickel, R. Blieszner, G. Cao, P. Carlier, A. Cate, J. Chappell, P. Chiu, B. Corl, B. Costa, R. Davalos, S. DeLuca, M. Denbow, N. Dervis, R. Diana, A.G. DiFeliceantonio, H. Dorn, S. Farris, X. Feng, C. Finkielstein, C. Frank, J. Fraser, M. Friedlander, B. Friedman, D. Good, R. Gourdie, D. Harrison, G. Howes, R. Jensen, X. Jia, B. Johnson, J. Jones, B. S. Jortner, D. Kelly, B. King-Casas, B. Klein, S. Kojima, S. Laconte, Y. W. Lee, L. Li, C. Logan, E. Marvin, T. Milam, R. Montague, I. Moore, A. Morozov, K. Mukherjee, N. Nanthakumar, M. Orr, R. Panneton, B. Patel, J. Phillips, J. Prickett, S. Ramey, K. Roberto, C. Rogers, J. Rossmesl Jr., W. Santos, A. Scarpa, Z. Sheng, G. Simonds, D. J. Slade, A. Smith, M. Theus, P. VandeVord, S. Verbridge, E. Weaver, M. Witcher, C. Wyatt, D. Xie, B. Xu, and D. Zallen

Instructors: Z. Fu, D. McDaniel, and K. Unroe

Undergraduate Advisors: C. Cook, H. Tucker, and E. Vedder

Undergraduate Course Descriptions (NEUR)

NEUR 1004 - Neuroscience Orientation Seminar (2 credits)

Introduction to the field of neuroscience. Exposure to areas of practice and research, opportunities for education and training, and employment in the field. Academic and career planning for neuroscience majors. Discussion of university resources to promote student success.

Instructional Contact Hours: (2 Lec, 2 Crd)

NEUR 1984 - Special Study (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 2014H - Honors Fundamentals of Neuroscience (3 credits)

Fundamental concepts in neuroscience including nervous system organization, signaling within neurons and across synapses, sensory and motor systems, emotion, memory, and language. Major neurological disorders and animal models used in neuroscience. Restricted to non-neuroscience majors in the Honors College.

Prerequisite(s): BIOL 1105

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2025 - Introduction to Neuroscience (3 credits)

Introduction to the fundamental principles of neuroscience. 2025: Structure and function of the nervous system. Cellular and molecular basis of neuronal signaling including electrical properties of neurons, synaptic transmission, and integration. Neurotransmitter systems and molecular signaling. Neural development and synaptic plasticity. 2026: Systems-level overview of the central nervous system. Sensory systems including olfaction, temperature, and pain. Retinal control of vision. Vestibular system and hearing. Motor systems and control of movement. Circuits related to stress, learning and behavior.

Prerequisite(s): BIOL 1005 or BIOL 1105 or ISC 1106H

Corequisite(s): NEUR 2035

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2026 - Introduction to Neuroscience (3 credits)

Introduction to the fundamental principles of neuroscience. 2025: Structure and function of the nervous system. Cellular and molecular basis of neuronal signaling including electrical properties of neurons, synaptic transmission, and integration. Neurotransmitter systems and molecular signaling. Neural development and synaptic plasticity. 2026: Systems-level overview of the central nervous system. Sensory systems including olfaction, temperature, and pain. Retinal control of vision. Vestibular system and hearing. Motor systems and control of movement. Circuits related to stress, learning and behavior.

Prerequisite(s): NEUR 2025

Corequisite(s): NEUR 2036

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2035 - Neuroscience Laboratory (1 credit)

Organization and function of the nervous system. 2035: neuroanatomy, microscopy, intracellular stimulation, extracellular recording, electrophysiology, neurotransmitters, and neuroplasticity. 2036: receptive field, sensation and perception, motor system, simple neural circuitry, neuroendocrine and higher level cognitive processes.

Corequisite(s): NEUR 2025

Instructional Contact Hours: (3 Lab, 1 Crd)

NEUR 2036 - Neuroscience Laboratory (1 credit)

Organization and function of the nervous system. 2035: neuroanatomy, microscopy, intercellular stimulation, extracellular recording, nerve stimulation, electrophysiology, neurotransmitters, and neuroplasticity. 2036: receptive field, sensation and perception, motor system, simple neural circuitry, neuroendocrine and higher level cognitive processes.

Prerequisite(s): NEUR 2035

Corequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lab, 1 Crd)

NEUR 2364 - Mind Altering Plants (3 credits)

Neurobiological effects of psychoactive chemicals from nature. Neurotoxic effects and dangers of psychoactive plants and fungi. Therapeutic applications of mind-altering substances in neurological disease. Experimental uses of mind-altering chemicals in neuroscience research. Cultural history, legal standing, regulatory oversight, and contemporary use portrayals of mind-altering substances from nature in medicine and society. Neurobiological effects of psychoactive plant chemicals.

Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2464 - Neuroscience and Society (3 credits)

Social, ethical, and legal issues faced by human societies from the perspective of neuroscience. Broader questions about how neuroscience informs education, medicine, law, and public health. Research in neuroscience as it relates to issues of mental health, poverty, stress, and politics.

Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2554 - Experimental Neuroscience (3 credits)

Introduction to the conceptual framework of contemporary experimental methods and practices in neuroscience research. Exploration of experimental techniques including electrophysiology, advanced imaging, immunohistochemistry, transgenic animal models, and behavioral assays. Includes face-to-face interaction with various research faculty to explore research methods in practice and discuss current research and expertise.

Prerequisite(s): NEUR 2025 and NEUR 2035

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2594 - Exploring Clinical Neuroscience (3 credits)

Exploration of careers in clinical neuroscience. Introduction to neuroanatomy, clinical presentation of neurological diseases, application of neuroscientific research to clinical practice, and clinical treatments. Ethical challenges in clinical practice. Burnout and resilience.

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2974 - Independent Study (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 2984 - Special Study (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 2994 - Undergraduate Research (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 3034 - Global Perspectives Pre-Departure (2 credits)

Preparation for Global Perspectives in Neuroscience and Medicine summer study abroad program. Travel preparations and financial planning. Academic overview and preparation. Risk management and travel etiquette. Introduction to global perspectives of neurological diseases. Restricted to students accepted into Global Perspectives in Neuroscience and Medicine summer study abroad program.

Instructional Contact Hours: (2 Lec, 2 Crd)

NEUR 3044 - Cellular and Molecular Neuroscience (3 credits)

Fundamental principles of cellular and molecular neuroscience. Methods to study neurochemistry and neurobiology, theoretical and practical issues of relating cellular/molecular structures and functions to higher-level nervous system functioning, and current understanding of cellular/molecular bases of nervous system disorders.

Prerequisite(s): NEUR 2025 and (CHEM 1036 or ISC 2105)

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3054 - Brain-Body Interactions in Health and Disease (3 credits)

Role of brain-body interactions in influencing an organism's health. Biological mechanisms involved in bidirectional communication between the brain, endocrine system, immune system, and digestive system. Gut microbiome and gut-brain axis in health and disease. Disease states linked to disturbed communication between brain and body, including diabetes, depression, autism, and Alzheimer's disease.

Prerequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3074 - Evolutionary Neuroscience (3 credits)

Role of evolution and natural selection in shaping genetic, molecular, and cellular components of brain within invertebrates and vertebrates through modern humans. Evolution of molecules and cells in the brain. Comparing brain structure and function between invertebrates and vertebrates, including evolution of animal and human cognition and behavior. Adaptations of brain structure and function necessary for human cognition, emotion, language, and intelligence.

Prerequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3084 - Cognitive Neuroscience (3 credits)

Concepts in cognitive neuroscience. Methods available to study brain and nervous system function, theoretical and practical issues of relating mental functions to biological brain functions. Overview of current understanding of the neural bases of various mental functions (e.g., memory, attention, emotion, decision making).

Prerequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3144 - Mechanisms of Learning and Memory (3 credits)

Foundation of social interactions in human and non-human: ability to learn and memorize locations, situations, individuals, facts and tasks forms. Cellular and molecular mechanism underlying learning and memory and model systems. Approaches to these processes along with diseases presenting with learning and memory deficits in humans.

Prerequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3234 - The Artificial Brain (3 credits)

Introduction to brain-machine interactions and computer models of neural systems. Exploration of brain-computer interface applications, biophysically-based computational models of the brain, and computer neural networks in the context of artificial intelligence. Emphasis on the capabilities and limitations of neural networks and how they inform our understanding of the human brain. Discussion of societal impact and ethical considerations.

Prerequisite(s): NEUR 2026 and (MATH 1026 or MATH 1226)

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3554 - Neuroscience Research and Practical Experience (3 credits)

Integration of the interdisciplinary fields of neuroscience: includes the conceptual frameworks and theories of neuroscience spanning molecules to behavior, the methods available to study nervous system structure and function from molecules to behavior, theoretical and practical issues of linking these lower-levels structures and processes to higher-level neurological and psychological functions, and the latest applications and technologies for translating neuroscience into more effective interventions and treatments. Practical experience includes literature review research and writing, data analysis and interpretation, written and oral presentation, and site-specific training.

Prerequisite(s): NEUR 2026 and NEUR 2554

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3594 - Neurobiology of Psychiatric Disorders (3 credits)

Neurobiological and clinical aspects of psychiatry. Overview of disorders such as depression, anxiety, schizophrenia, addiction, and obsessive-compulsive disorder. Neurobiology of emotional behavior. Clinical perspectives of psychiatric treatment, interventional psychiatry, and cross-disciplinary approaches to psychiatry. Underlying pathophysiology of a variety of psychiatric disorders. Neuropharmacology of commonly used psychiatric medications. Ethical issues related to psychiatric care.

Prerequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3774 - Neuroendocrinology (3 credits)

Comprehensive survey of the interrelationships between human neural and endocrine systems. Regulatory mechanisms for neural control of hormone secretions, peripheral hormone action on physiological processes, and hormonal influences on behavior.

Prerequisite(s): NEUR 2025

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3844 - Computational Neuroscience and Neural Engineering (3 credits)

Introduction to computational and systems neuroscience. Data analysis and signal processing techniques for neural data. Neural modeling to include mean field models, Hodgkin-Huxley models, integrate and fire models. Neural engineering and brain machine interface (BMI) applications.

Prerequisite(s): MATH 1226

Instructional Contact Hours: (3 Lec, 3 Crd)

Course Crosslist: BMES 3844

NEUR 3900 - Bridge Experience (0 credits)

Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.

Instructional Contact Hours: (0 Crd)

NEUR 3914 - Neuroscience of Drug Addiction (3 credits)

History of addiction as a chronic, relapsing brain disease. Neurocircuitry and molecular basis of the brain affected by common drugs of abuse. Overview of the use, abuse, liability, and psychotherapeutic effects of drugs on humans. Common classes of drug abuse: alcohol, sedatives, tobacco/ nicotine, opioids, cannabinoids, psychostimulants, psychedelics, steroids, anti-anxiety, antidepressants, and antipsychotics. Animal models in drug addiction studies. Current and future pharmacotherapeutics for drug addiction treatment and ethical considerations of treatments.

Prerequisite(s): NEUR 2025 and NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3944 - War and the Brain (3 credits)

Neurological and psychological factors associated with military and war. Neuroscientific basis of decision making, mental resilience, and cognitive enhancement. Etiology and treatment of brain injuries sustained during war including post-traumatic stress disorder, traumatic brain injury, and chemical warfare. Neurotechnological advances that shape soldiers and warfare. Ethical considerations of militarization of neuroscience.

Prerequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3984 - Special Study (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 4034 - Diseases of the Nervous System (3 credits)

Common brain and Central Nervous System (CNS) disorders ranging from trauma to autism. Genetic, molecules and cellular changes in disease. Therapeutic implications and development of novel drugs. Challenges in drug discovery and implementation of personalized medicine. Ethical issues regarding genetic findings.

Prerequisite(s): NEUR 2026 and NEUR 3044

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4044 - Neuroscience Senior Seminar (3 credits)

Integration of methods and results from cutting-edge interdisciplinary neuroscience research; theoretical and practical issues when linking molecular/cellular structures and processes to higher-level neurological and psychological functions. May be repeated twice with different content for a maximum of 9 credits.

Prerequisite(s): NEUR 3044 or NEUR 3084

Instructional Contact Hours: (3 Lec, 3 Crd)

Repeatability: up to 9 credit hours

NEUR 4054 - Developmental Neuroscience (3 credits)

Genetic, molecular, and cellular processes underlying brain development and neural circuit formation, including neural induction, cell differentiation, cell fate determination, axon guidance, neuronal migration, synapse formation, and cell death. Neurodevelopment processes in vertebrate and invertebrate animal models. Molecular and cellular underpinnings of neurodevelopmental disorders.

Prerequisite(s): NEUR 3044

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4064 - Neuropharmacology (3 credits)

Role of drugs affecting function of the brain, spinal cord, and peripheral nerves. Principles of pharmacology and biological mechanisms involved in pharmacokinetics (drug absorption, distribution, metabolism, elimination, and toxicity). Neurotransmission in peripheral and central nervous systems. Major classes of drugs affecting the nervous system (antidepressants, anxiolytics, antipsychotics, anticonvulsants, sedatives/hypnotics, analgesics, general and local anesthetics) and their mechanisms of action. Evaluate scientific findings of drug pharmacodynamics for major drug classes used to treat diseases of the nervous system.

Prerequisite(s): NEUR 2026

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4244 - Neural Control of Movement (3 credits)

Neuroscience of motor control and related disorders. How the neural system sub-components involved in motor control mediate motor reflexes, motor learning, central pattern generation, and motor control of speech and language. Sensorimotor physiology, proprioceptive system, exercise physiology. Neuro-rehabilitative technology and disruption of motor control by injury or disease.

Prerequisite(s): NEUR 3044 or NEUR 3084

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4314 - Genetics in Neuroscience (3 credits)

Concepts of classical, modern genetics and epigenetics as it relates to neuroscience. Practical applications including genome-wide association (GWAS), next-generation sequencing, epigenetics, genome editing and screening methods. Use of model organisms in neurogenetic disorders research. Relationship of genetics and its influences on theoretical and practical issues in neurological and neurodevelopmental disorders. Personalized medicine in neurodevelopmental and neurogenetic disorders.

Prerequisite(s): NEUR 3044

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4364 - Neuroscience of Language and Communication Disorders (3 credits)

Concepts of language as distinctive human behavior and central to social life. Neural underpinnings of humans ability to speak and understand language. Neurologic processing of language comprehension and production in healthy and language-impaired individuals. Auditory and visual word recognition, reading, understanding speech, representation of word meaning, language production, and bilingualism. Neuroethology of communication and neurological disorders of communication: dyslexia, stuttering, and aphasia. Theoretical issues in language processing and converging evidence from different techniques and animal models addressing these issues.

Prerequisite(s): NEUR 3044 or NEUR 3084

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4454 - Neuroeconomics (3 credits)

Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics in economics, policy, law and business.

Prerequisite(s): NEUR 2026 or ECON 3104

Instructional Contact Hours: (3 Lec, 3 Crd)

Course Crosslist: ECON 4454, PSYC 4454

NEUR 4514 - Neuroimmunology in Health and Disease (3 credits)

Immune system and its role in neurological health and psychiatric and neurological disorders. Details of cell type, functions and signaling of the peripheral and central immune system and sympathetic nervous system. Cross-talk between the brain and immune system across the blood brain barrier and circumventricular organs. Neurobiological basis and treatment options for autoimmune diseases. Role of immune system in psychiatric illness.

Prerequisite(s): NEUR 3044

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4594 - Clinical Neuroscience in Practice (3 credits)

Clinical approaches to diagnose and treat neurological disorders. Diseases include stroke, trauma, brain tumors, psychiatric illnesses, and epilepsy. Clinical experience includes diagnostic procedures, radiological techniques, and surgical procedures in operating room. Patient rounding, follow-up, and outcomes. Medical emergencies and appropriate professional responses. Ethical issues regarding health care, disparity, life and death decisions. Medical profession exploration.

Prerequisite(s): NEUR 4034

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4814 - Nutritional Neuroscience (3 credits)

Concepts in nutritional aspects of neuroscience. Energy metabolism in central nervous system and brain regulating ingestive behavior. Communication with peripheral organs, regulation of whole body energy homeostasis, brain physiology and pathology on molecular and cellular level. Role of appetite neurocircuitry in formulation of practical solutions to societal problems such as nutrition, eating disorders, and obesity.

Prerequisite(s): NEUR 2026 or ALS 2304

Instructional Contact Hours: (3 Lec, 3 Crd)

Course Crosslist: ALS 4814

NEUR 4914 - Drug Development in Neuroscience (3 credits)

Current approaches and pitfalls for developing therapeutics for treating disorders of the central nervous system (CNS). Theoretical issues and practical applications targeting identification, high-throughput screening, pharmacokinetics and pharmacodynamics, preclinical testing, clinical trials, and the FDA approval process. Ethical implications for drug development and testing.

Prerequisite(s): NEUR 3044 or NEUR 3914

Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4964 - Field Work (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 4974 - Independent Study (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 4984 - Special Study (1-19 credits)

Instructional Contact Hours: Variable credit course

NEUR 4994 - Undergraduate Research (1-19 credits)

\$30 fee

Instructional Contact Hours: Variable credit course

NEUR 4994H - Undergraduate Research (1-19 credits)

Instructional Contact Hours: Variable credit course