DEPARTMENT OF BRAIN AND COGNITIVE SCIENCES

The study of mind, brain, and behavior has grown in recent years with unprecedented speed. New avenues of approach, opened by developments in the biological and computer sciences, raise the hope that human beings, having achieved considerable mastery over the world around them, may also come closer to an understanding of themselves. The goal of the Department of Brain and Cognitive Sciences is to answer fundamental questions concerning intelligent processes and brain organization. To this end, the department focuses on four themes: molecular and cellular neuroscience, systems neuroscience, cognitive science, and computation. Several members of the department's faculty are affiliated with two major research centers: the Picower Institute for Learning and Memory and the McGovern Institute for Brain Research.

Research in cellular neuroscience deals with the biology of neurons, emphasizing the special properties of these cells as encoders, transmitters, and processors of information. Departmental researchers apply techniques of contemporary molecular and cellular biology to problems of neuronal development, structure, and function, resulting in a new understanding of the underlying basic components of the nervous system and their interactions. These studies have profound clinical implications, in part by generating a framework for the treatment of neurological and psychiatric disorders. Primary areas of interest include the development and plasticity of neuronal morphology and connectivity, the cellular and molecular bases of behavior in simple neuronal circuits, neurochemistry, and cellular physiology.

In the area of systems neuroscience, departmental investigators use a number of new approaches ranging from computation through electrophysiology to biophysics. Of major interest are the visual and motor systems where the scientific goals are to understand transduction and encoding of sensory stimuli into nerve messages, organization and development of sensorimotor systems, processing of sensorimotor information, and the sensorimotor performance of organisms. Also of major interest is neuromodulatory regulation, where the scientific goal is to understand the effects of rewarding or stressful environments on brain circuits.

In computation and cognitive science, particularly strong interactions exist between the Department of Brain and Cognitive Sciences, the Computer Science and Artificial Intelligence Laboratory, and the Center for Biological and Computational Learning, providing new intellectual approaches in areas including vision and motor control, and biological and computer learning. Computational theories are developed and tested within the framework of neurophysiological, psychological, and other experimental approaches. In the study of vision and motor control, complementary experimental work includes single-cell and multiple-cell neurophysiological recording as well as functional brain imaging. In the area of learning, which is seen as central to intelligent behavior, departmental researchers are working to develop theories of vision, motor control, neural circuitry, and language within an experimental framework.

In cognitive science, human experimentation is combined with formal and computational analyses to understand complex intelligent processes such as language, reasoning, memory, and visual information processing. There are applications in the fields of education, artificial intelligence, human-machine interaction, and in the treatment of language, cognitive, and other disorders.

Subfields in cognitive science include psycholinguistics, comprising sentence and word processing, language acquisition, and aphasia; visual cognition, including reading, imagery, attention, and perception of complex patterns such as faces, objects, and scenes; spatial cognition; memory; and the nature and development of concepts. Another key field is the study of perception—developmental and processing approaches focus on human and machine vision, and how visual images are encoded, stored, and retrieved, with current topics that include motion analysis, stereopsis, perceptual organization, and perceptual similarity. Other research includes functional brain imaging in normal subjects as well as studies of neurologically impaired patients in an attempt to understand brain mechanisms underlying normal human sensation, perception, cognition, action, and affect.

Undergraduate Study

Bachelor of Science in Brain and Cognitive Sciences (Course 9)

Brain science and cognitive science are complementary and interactive in their research objectives. Both approaches examine perception, performance, and intervening processes in humans and animals. Central issues in the discipline include the interpretation of sensory experience; the reception, manipulation, storage, and retrieval of information within the nervous system; and the planning and execution of motor activity. Higher-level functions include the development of formal and informal reasoning skills; and the structure, acquisition, use, and internal representation of human language.

The Bachelor of Science in Brain and Cognitive Sciences (*https://catalog.mit.edu/degree-charts/brain-cognitive-sciences-course-9*) prepares students to pursue advanced degrees or careers in artificial intelligence, machine learning, neuroscience, medicine, cognitive science, psychology, linguistics, philosophy, education research and technology, and human-machine interaction.

Methods of inquiry in the brain and cognitive sciences are drawn from molecular, cellular, and systems neuroscience; cognitive and perceptual psychology; computer science and artificial intelligence; linguistics; philosophy of language and mind; and mathematics. The undergraduate program is designed to provide instruction in the relevant aspects of these various disciplines. The program is administered by an Undergraduate Officer and an Undergraduate

Administrator, consulting as necessary with faculty members from these disciplines who also serve as advisors to majors, helping them select a coherent set of subjects from within the requirements, including a research requirement. Members of the faculty are available to guide the research.

The Brain and Cognitive Sciences (BCS) major incorporates programming and computational skills to meet the increasing demands for those skills in both graduate school and the workforce. The major offers a tiered system of subjects with enough flexibility to allow multiple avenues through the Brain and Cognitive Sciences curriculum, meeting the divergent goals of BCS students. Individual guidance regarding career goals is available from faculty and from Career Advising and Professional Development.

Bachelor of Science in Computation and Cognition (Course 6-9)

The Department of Electrical Engineering and Computer Science (*https://catalog.mit.edu/schools/engineering/electrical-engineering-computer-science*) and the Department of Brain and Cognitive Sciences (p. 3) offer a joint curriculum leading to a Bachelor of Science in Computation and Cognition (*https://catalog.mit.edu/degree-charts/computation-cognition-6-9*) that focuses on the emerging field of computational and engineering approaches to brain science, cognition, and machine intelligence. The curriculum provides flexibility to accommodate students with a wide diversity of interests in this area—from biologically inspired approaches to artificial intelligence to reverse engineering circuits in the brain. This joint program prepares students for careers that include advanced applications of artificial intelligence and machine learning, as well as further graduate study in systems and cognitive neuroscience. Students in the program are full members of both departments, with an academic advisor from the Department of Brain and Cognitive Sciences.

Inquiries

Information about this program is available from the Brain and Cognitive Sciences Academic Office, Room 46-2005, 617-253-7403.

Minor in Brain and Cognitive Sciences

The Minor in Brain and Cognitive Sciences consists of six subjects arranged in two levels of study, intended to provide students breadth in the field as a whole and some depth in an area of specialization.

Core Subjects		
9.00	Introduction to Psychological Science	12
9.01	Introduction to Neuroscience	12
9.40	Introduction to Neural Computation	12
Specialized Subjects		
Select any combination of three subjects from Tier II and/or Tier III of the undergraduate degree program:		36
Tier II Subjects		
9.09[J]	Cellular and Molecular Neurobiology	
9.13	The Human Brain	
9.18[J]	Developmental Neurobiology	
9.19	Computational Psycholinguistics	
9.21[J]	Cellular Neurophysiology and Computing	
9.26[J]	Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience	
9.35	Perception	
9.49	Neural Circuits for Cognition	
9.53	Emergent Computations Within Distributed Neural Circuits	
9.66[J]	Computational Cognitive Science	
9.85	Infant and Early Childhood Cognition	
Tier III Subjects		
9.24	Disorders and Diseases of the Nervous System	
9.42	The Brain and Its Interface with the Body	
9.67[J]	Materials Physics of Neural Interfaces	
Total Units		**72**

Graduate Study

The Department of Brain and Cognitive Sciences offers programs of study leading to the doctoral degree in neuroscience or cognitive science. Areas of research specialization include cellular and molecular neuroscience, systems neuroscience, computation, and cognitive science. The graduate programs are designed to prepare students to pursue careers in research, teaching, or industry.

Doctor of Philosophy in Brain and Cognitive Sciences Fields

The doctor of philosophy in brain and cognitive sciences fields (*https://catalog.mit.edu/schools/science/#degreesandprogramstext*) (the PhD program) is normally completed in approximately six years of full-time work, including summers. Institute requirements for the PhD are given in the section on General Degree Requirements (*https://catalog.mit.edu/mit/graduate-education/general-degree-requirements*). Formal coursework for the departmental program (*https://catalog.mit.edu/degree-charts/phd-brain-cognitive-sciences*) is intended to prepare the student to pass the general examinations and do original thesis research. The written general examinations will be due in August of the second year.

All students start with first-year intensive core subjects that provide an introduction to brain and cognitive studies from the viewpoint of systems neuroscience, molecular and cellular neuroscience, cognition, and computation. Incoming graduate students are required to take at least two of these subjects but must take all within the first two years of study. Further coursework will be diversified to give each individual the appropriate background for research in his or her own area.

- **Cellular and molecular neuroscience** coursework emphasizes the current genetic, molecular, and cellular approaches to biological systems that are necessary to generate advances in neuroscience.
- **Systems neuroscience** coursework covers neuroanatomy, neurophysiology, and neurotransmitter chemistry, concentrating on the major sensory, motor, memory, and executive systems in the vertebrate brain. Specific ties to molecular neurobiology or computation may be emphasized, depending upon the research interests of the student.
- **Computation** coursework is intended to give both an understanding of empirical approaches to the study of the brain and animal behavior and a theoretical background for analyzing computational aspects of biological information processing.

Cognitive science coursework covers such topics as language processing, language acquisition, cognitive development, natural computation, neural networks, connectionist models, and visual information processing. Students also choose seminars and coursework in linguistics, philosophy, logic, mathematics, or computer science, depending on the individual student's research program.

Graduate students begin a research apprenticeship immediately upon arrival with lab rotations in the first year. To familiarize new students with the research being conducted in the department, the department hosts a series of talks in September by faculty whose labs are open for rotations. Students typically choose their first rotation by October 1. Laboratory rotations allow students to get to know several different labs; learn concepts and techniques, and select a laboratory in which they will complete their dissertation research. Students complete three 4–8 week rotations during the first year, registering for 12 units of 9.921 Research in Brain and Cognitive Sciences in both the fall and spring terms; an optional fourth rotation is also available during spring or summer term but must be approved by the rotation coordinator. Students must submit a brief rotation proposal at the start of each rotation, and a brief summary upon completion of each rotation.

At the end of the first year, an advisory committee of two to four faculty members is formed. This committee monitors progress and, with membership changing as necessary, evolves into the thesis committee. Students must pass the oral and written qualifying exams for doctoral candidacy. Upon passing the exams, students complete at least 222 additional units of 9.921 in preparation for their thesis. Thesis research normally requires 24–48 months of full-time activity after the qualifying examinations have been passed. It is expected that the research embodied in the PhD dissertation be original and significant work, publishable in scientific journals.

In addition to coursework, students are also expected to serve as a teaching assistant for two terms, registering for 12 units of 9.919 Teaching Brain and Cognitive Sciences each term. This is typically done once in the second year of the program and again in the third year.

Upon successful completion of all program requirements, the student will be awarded the PhD in the corresponding field of brain and cognitive sciences.

Financial Support

Financial assistance is provided to qualified applicants in the form of traineeships, research assistantships, teaching assistantships, and a limited number of fellowships, subject to availability of funds. Prospective students are encouraged to apply for individual fellowships such as those sponsored by the National Science Foundation and the National Defense Science and Engineering Graduate Fellowship Program to cover all or part of the cost of their education. The department's financial resources for non-US citizens are limited; international students are strongly encouraged to seek financial assistance for all or part of the cost of their education from non-MIT sources.

Inquiries

For additional information regarding teaching and research programs, contact the Academic Administrator, Department of Brain and Cognitive Sciences, Room 46-2005, 617-253-5741, or visit the department's website (*http://web.mit.edu/bcs*).

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Professor of Economics
Professor of Brain and Cognitive Sciences

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Mary C. Potter, PhD
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Professor Emeritus of Biology

Gerald Edward Schneider, PhD
Professor Emeritus of Neuroscience

Kenneth Wexler, PhD
Professor Emeritus of Psychology
Professor Emeritus of Linguistics

9.00 Introduction to Psychological Science
Prereq: None
U (Spring)
4-0-8 units. HASS-S

A survey of the scientific study of human nature, including how the mind works, and how the brain supports the mind. Topics include the mental and neural bases of perception, emotion, learning, memory, cognition, child development, personality, psychopathology, and social interaction. Consideration of how such knowledge relates to debates about nature and nurture, free will, consciousness, human differences, self, and society.
J. D. Gabrieli

9.01 Introduction to Neuroscience
Prereq: None
U (Fall)
4-0-8 units. REST

Introduction to the mammalian nervous system, with emphasis on the structure and function of the human brain. Topics include the function of nerve cells, sensory systems, control of movement, learning and memory, and diseases of the brain.
M. Bear

9.011 Systems Neuroscience Core I
Prereq: Permission of instructor
G (Fall)
6-0-12 units

Survey of brain and behavioral studies. Examines principles underlying the structure and function of the nervous system, with a focus on systems approaches. Topics include development of the nervous system and its connections, sensory systems of the brain, the motor system, higher cortical functions, and behavioral and cellular analyses of learning and memory. Preference to first-year graduate students in BCS.
R. Desimone, E. K. Miller

9.012 Cognitive Science
Prereq: Permission of instructor
G (Spring)
6-0-12 units

Intensive survey of cognitive science. Topics include visual perception, language, memory, cognitive architecture, learning, reasoning, decision-making, and cognitive development. Topics covered from behavioral, computational, and neural perspectives.
E. Gibson, P. Sinha, J. Tenenbaum

9.013[J] Molecular and Cellular Neuroscience Core II
Same subject as 7.68[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Survey and primary literature review of major areas in molecular and cellular neurobiology. Covers genetic neurotrophin signaling, adult neurogenesis, G-protein coupled receptor signaling, glia function, epigenetics, neuronal and homeostatic plasticity, neuromodulators of circuit function, and neurological/psychiatric disease mechanisms. Includes lectures and exams, and involves presentation and discussion of primary literature. 9.015[J] recommended, though the core subjects can be taken in any sequence.
G. Feng, L.-H. Tsai

9.014 Quantitative Methods and Computational Models in Neurosciences
Prereq: None
G (Fall)
3-1-8 units

Provides theoretical background and practical skills needed to analyze and model neurobiological observations at the molecular, systems and cognitive levels. Develops an intuitive understanding of mathematical tools and computational techniques which students apply to analyze, visualize and model research data using MATLAB programming. Topics include linear systems and operations, dimensionality reduction (e.g., PCA), Bayesian approaches, descriptive and generative models, classification and clustering, and dynamical systems. Limited to 18; priority to current BCS Graduate students.
M. Jazayeri, D. Zysman

9.015[J] Molecular and Cellular Neuroscience Core I
Same subject as 7.65[J]
Prereq: None
G (Fall)
3-0-9 units

Survey and primary literature review of selected major topic areas in molecular and cellular neurobiology. Covers nervous system development, axonal pathfinding, synapse formation and function, synaptic plasticity, ion channels and receptors, cellular neurophysiology, glial cells, sensory transduction, and relevant examples in human disease. Includes lectures and weekly paper write-ups, together with student presentations and discussion of primary literature. A final two-page research write-up is also due at the end of the term.
J. T. Littleton, M. Sheng, B. Weissbourd

9.016[J] Introduction to Sound, Speech, and Hearing
Same subject as HST.714[J]
Prereq: (6.3000 and 8.03) or permission of instructor
G (Fall)
Not offered regularly; consult department
4-0-8 units

See description under subject HST.714[J].
S. S. Ghosh, H. H. Nakajima, S. Puria

9.017 Systems Neuroscience Core II
Prereq: 18.06 or (9.011 and 9.014)
G (Spring)
Not offered regularly; consult department
2-2-8 units

Covers systems and computational neuroscience topics relevant to understanding how animal brains solve a wide range of cognitive tasks. Focuses on experimental approaches in systems neuroscience (behavioral design, parametric stimulus control, recording techniques) and theory-driven analyses (dynamical systems, control theory, Bayesian theory), both at the level of behavioral and neural data. Also focuses on regional organization (cortex, thalamus, basal ganglia, midbrain, and cerebellum), along with traditional divisions in systems neuroscience: sensory systems, motor systems, and associative systems.
M. Halassa

9.021[J] Cellular Neurophysiology and Computing
Same subject as 2.794[J], 6.4812[J], 20.470[J], HST.541[J]
Subject meets with 2.791[J], 6.4810[J], 9.21[J], 20.370[J]
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.2000, 6.3000, 10.301, or 20.110[J])) or permission of instructor
G (Spring)
5-2-5 units

See description under subject 6.4812[J].
J. Han, T. Heldt

9.07 Statistics for Brain and Cognitive Science
Prereq: 6.100B
U (Fall)
4-0-8 units

Provides students with the basic tools for analyzing experimental data, properly interpreting statistical reports in the literature, and reasoning under uncertain situations. Topics organized around three key theories: probability, statistical, and the linear model. Probability theory covers axioms of probability, discrete and continuous probability models, law of large numbers, and the Central Limit Theorem. Statistical theory covers estimation, likelihood theory, Bayesian methods, bootstrap and other Monte Carlo methods, as well as hypothesis testing, confidence intervals, elementary design of experiments principles and goodness-of-fit. The linear model theory covers the simple regression model and the analysis of variance. Places equal emphasis on theory, data analyses, and simulation studies.
E. N. Brown

9.073[J] Statistics for Neuroscience Research
Same subject as HST.460[J]
Prereq: Permission of instructor
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: G (Spring)
3-0-9 units

A survey of statistical methods for neuroscience research. Core topics include introductions to the theory of point processes, the generalized linear model, Monte Carlo methods, Bayesian methods, multivariate methods, time-series analysis, spectral analysis and state-space modeling. Emphasis on developing a firm conceptual understanding of the statistical paradigm and statistical methods primarily through analyses of actual experimental data.
E. N. Brown

9.09[J] Cellular and Molecular Neurobiology
Same subject as 7.29[J]
Prereq: 7.05 or 9.01
U (Spring)
4-0-8 units

See description under subject 7.29[J].
T. Littleton, S. Prescott

9.110[J] Nonlinear Control
Same subject as 2.152[J]
Prereq: 2.151, 6.7100[J], 16.31, or permission of instructor
G (Spring)
3-0-9 units

See description under subject 2.152[J].
J.-J. E. Slotine

9.12 Experimental Molecular Neurobiology
Prereq: Biology (GIR) and 9.01
U (Spring)
2-4-6 units. Institute LAB

Experimental techniques in cellular and molecular neurobiology. Designed for students without previous experience in techniques of cellular and molecular biology. Experimental approaches include DNA manipulation, molecular cloning, protein biochemistry, dissection and culture of brain cells, synaptic protein analysis, immunocytochemistry, and fluorescent microscopy. One lab session plus one paper review session per week. Instruction and practice in written communication provided. Enrollment limited.
G. Choi

9.123[J] Neurotechnology in Action
Same subject as 20.203[J]
Prereq: Permission of instructor
G (Spring)
3-6-3 units

Offers a fast-paced introduction to numerous laboratory methods at the forefront of modern neurobiology. Comprises a sequence of modules focusing on neurotechnologies that are developed and used by MIT research groups. Each module consists of a background lecture and 1-2 days of firsthand laboratory experience. Topics typically include optical imaging, optogenetics, high throughput neurobiology, MRI/fMRI, advanced electrophysiology, viral and genetic tools, and connectomics.
A. Jasanoff

9.13 The Human Brain
Prereq: 9.00, 9.01, or permission of instructor
U (Spring)
3-0-9 units

Surveys the core perceptual and cognitive abilities of the human mind and asks how these are implemented in the brain. Key themes include the functional organization of the cortex, as well as the representations and computations, developmental origins, and degree of functional specificity of particular cortical regions. Emphasizes the methods available in human cognitive neuroscience, and what inferences can and cannot be drawn from each.
N. Kanwisher

9.17 Systems Neuroscience Laboratory
Prereq: 9.01 or permission of instructor
U (Fall)
2-4-6 units. Institute LAB

Consists of a series of laboratories designed to give students experience with basic techniques for conducting systems neuroscience research. Includes sessions on anatomical, neurophysiological, and data acquisition and analysis techniques, and how these techniques are used to study nervous system function. Involves the use of experimental animals. Assignments include weekly preparation for lab sessions, two major lab reports and a series of basic computer programming tutorials (MATLAB). Instruction and practice in written communication provided. Enrollment limited.
M. Harnett, S. Flavell

9.175[J] Robotics
Same subject as 2.165[J]
Prereq: 2.151 or permission of instructor
G (Fall)
3-0-9 units

See description under subject 2.165[J].
J.-J. E. Slotine, H. Asada

9.18[J] Developmental Neurobiology
Same subject as 7.49[J]
Subject meets with 7.69[J], 9.181[J]
Prereq: 7.03, 7.05, 9.01, or permission of instructor
U (Spring)
3-0-9 units

Considers molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. Students taking graduate version complete additional readings that will be addressed in their mid-term and final exams.
E. Nedivi

9.181[J] Developmental Neurobiology
Same subject as 7.69[J]
Subject meets with 7.49[J], 9.18[J]
Prereq: 9.011 or permission of instructor
G (Spring)
3-0-9 units

Considers molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. In addition to final exam, analysis and presentation of research papers required for final grade. Students taking graduate version complete additional assignments. Students taking graduate version complete additional readings that will be addressed in their mid-term and final exams.
E. Nedivi, M. Heiman

9.19 Computational Psycholinguistics
Subject meets with 9.190
Prereq: (6.100B and (6.3700, 9.40, or 24.900)) or permission of instructor
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: U (Fall)
4-0-8 units

Introduces computational approaches to natural language processing and acquisition by humans and machines, combining symbolic and probabilistic modeling techniques. Covers models such as n-grams, finite state automata, and context-free and mildly context-sensitive grammars, for analyzing phonology, morphology, syntax, semantics, pragmatics, and larger document structure. Applications range from accurate document classification and sentence parsing by machine to modeling human language acquisition and real-time understanding. Covers both theory and contemporary computational tools and datasets. Students taking graduate version complete additional assignments.
R. P. Levy

9.190 Computational Psycholinguistics
Subject meets with 9.19
Prereq: (6.100B and (6.3702, 9.40, or 24.900)) or permission of instructor
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: G (Fall)
4-0-8 units

Introduces computational approaches to natural language processing and acquisition by humans and machines, combining symbolic and probabilistic modeling techniques. Covers models such as n-grams, finite state automata, and context-free and mildly context-sensitive grammars, for analyzing phonology, morphology, syntax, semantics, pragmatics, and larger document structure. Applications range from accurate document classification and sentence parsing by machine to modeling human language acquisition and real-time understanding. Covers both theory and contemporary computational tools and datasets. Students taking graduate version complete additional assignments.
R. P. Levy

9.21[J] Cellular Neurophysiology and Computing
Same subject as 2.791[J], 6.4810[J], 20.370[J]
Subject meets with 2.794[J], 6.4812[J], 9.021[J], 20.470[J], HST.541[J]
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.2000, 6.3000, 10.301, or 20.110[J])) or permission of instructor
U (Spring)
5-2-5 units

See description under subject 6.4810[J]. Preference to juniors and seniors.
J. Han, T. Heldt

9.24 Disorders and Diseases of the Nervous System
Prereq: (7.29[J] and 9.01) or permission of instructor
U (Spring)
3-0-9 units

Topics examined include regional functional anatomy of the CNS; brain systems and circuits; neurodevelopmental disorders including autism; neuropsychiatric disorders such as schizophrenia; neurodegenerative diseases such as Parkinson's and Alzheimer's; autoimmune disorders such as multiple sclerosis; gliomas. Emphasis on diseases for which a molecular mechanism is understood. Diagnostic criteria, clinical and pathological findings, genetics, model systems, pathophysiology, and treatment are discussed for individual disorders and diseases. Limited to 18.
M. Sur

9.26[J] Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience
Same subject as 20.205[J]
Prereq: Biology (GIR)
U (Spring)
3-0-9 units

Covers principles underlying current and future genetic engineering approaches, ranging from single cellular organisms to whole animals. Focuses on development and invention of technologies for engineering biological systems at the genomic level, and applications of engineered biological systems for medical and biotechnological needs, with particular emphasis on genetic manipulation of the nervous system. Design projects by students.
F. Zhang

9.271[J] Pioneering Technologies for Interrogating Complex Biological Systems
Same subject as 10.562[J], HST.562[J]
Prereq: None
G (Spring)
3-0-9 units

See description under subject HST.562[J]. Limited to 15.
K. Chung

9.272[J] Topics in Neural Signal Processing
Same subject as HST.576[J]
Prereq: Permission of instructor
Acad Year 2024-2025: G (Spring)
Acad Year 2025-2026: Not offered
3-0-9 units

Presents signal processing and statistical methods used to study neural systems and analyze neurophysiological data. Topics include state-space modeling formulated using the Bayesian Chapman-Kolmogorov system, theory of point processes, EM algorithm, Bayesian and sequential Monte Carlo methods. Applications include dynamic analyses of neural encoding, neural spike train decoding, studies of neural receptive field plasticity, algorithms for neural prosthetic control, EEG and MEG source localization. Students should know introductory probability theory and statistics.
E. N. Brown

9.285[J] Audition: Neural Mechanisms, Perception and Cognition
Same subject as HST.723[J]
Prereq: Permission of instructor
G (Spring)
6-0-6 units

See description under subject HST.723[J].
J. McDermott, D. Polley, M. C. Brown

9.301[J] Neural Plasticity in Learning and Memory
Same subject as 7.98[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units

Examination of the role of neural plasticity during learning and memory of invertebrates and mammals. Detailed critical analysis of the current literature of molecular, cellular, genetic, electrophysiological, and behavioral studies. Student-directed presentations and discussions of original papers supplemented by introductory lectures. Juniors and seniors require instructor's permission.
S. Tonegawa

9.32 Genes, Circuits, and Behavior
Prereq: 7.29[J], 9.16, 9.18[J], or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units

Focuses on understanding molecular and cellular mechanisms of circuitry development, function and plasticity, and their relevance to normal and abnormal behaviors/psychiatric disorders. Highlights cutting-edge technologies for neuroscience research. Students build professional skills through presentations and critical evaluation of original research papers.
G. Feng

9.34[J] Biomechanics and Neural Control of Movement
Same subject as 2.183[J]
Subject meets with 2.184
Prereq: 2.004 or permission of instructor
G (Spring)
3-0-9 units

See description under subject 2.183[J].
N. Hogan

9.35 Perception
Prereq: 9.01 or permission of instructor
U (Spring)
4-0-8 units

Studies how the senses work and how physical stimuli are transformed into signals in the nervous system. Examines how the brain uses those signals to make inferences about the world, and uses illusions and demonstrations to gain insight into those inferences. Emphasizes audition and vision, with some discussion of touch, taste, and smell. Provides experience with psychophysical methods.
J. McDermott

9.357 Current Topics in Perception
Prereq: Permission of instructor
G (Spring)
2-0-7 units
Can be repeated for credit.

Advanced seminar on issues of current interest in human and machine vision. Topics vary from year to year. Participants discuss current literature as well as their ongoing research.
E. H. Adelson

9.36 Neurobiology of Self
Subject meets with 9.360
Prereq: 9.01
U (Fall)
3-0-9 units

Discusses the neurobiological mechanisms that distinguish "the Self" from external environment; the neural circuits that enable us to know that "the Self" is in pain, or feels hungry, thirsty, and tired; and the neurons and circuits that lead to the emotional and moody Self. Examines brain mechanism that encodes the body schema and the Self in space. This includes the neural computations that allow, for example, the hand to know where the mouth is. Discusses the possibility of making robots develop a sense of Self, as well as disorders and delusions of the Self. Contemporary research — ranging from molecules, cells, circuits, to systems in both animal models and humans — explored. Students in the graduate version do additional classwork or projects.
F. Wang

9.360 Neurobiology of Self
Subject meets with 9.36
Prereq: 9.01
G (Fall)
3-0-9 units

Discusses the neurobiological mechanisms that distinguish "the Self" from external environment; the neural circuits that enable us to know that "the Self" is in pain, or feels hungry, thirsty, and tired; and the neurons and circuits that lead to the emotional and moody Self. Examines brain mechanism that encodes the body schema and the Self in space. This includes the neural computations that allow, for example, the hand to know where the mouth is. Discusses the possibility of making robots develop a sense of Self, as well as disorders and delusions of the Self. Contemporary research — ranging from molecules, cells, circuits, to systems in both animal models and humans — explored. Students in the graduate version do additional classwork or projects.
F. Wang

9.39 Language in the Mind and Brain
Subject meets with 9.390
Prereq: 9.00, 9.01, or permission of instructor
U (Spring)
3-0-9 units

Surveys the core mental abilities — and their neural substrates — that support language, and situates them within the broader landscape of human cognition. Topics explored include: how structured representations are extracted from language; the nature of abstract concepts and how they relate to words; the nature of the brain mechanisms that support language vs. other structured and/or meaningful inputs, like music, mathematical expressions, or pictures; the relationship between language and social cognition; how language is processed in individuals who speak multiple languages; how animal communication systems and artificial neural network language models differ from human language. Draws on evidence from diverse approaches and populations, focusing on cutting-edge research. Students taking graduate version complete additional assignments.
E. Fedorenko

9.390 Language in the Mind and Brain
Subject meets with 9.39
Prereq: 9.00, 9.01, or permission of instructor
G (Spring)
3-0-9 units

Surveys the core mental abilities — and their neural substrates — that support language, and situates them within the broader landscape of human cognition. Topics explored include: how structured representations are extracted from language; the nature of abstract concepts and how they relate to words; the nature of the brain mechanisms that support language vs. other structured and/or meaningful inputs, like music, mathematical expressions, or pictures; the relationship between language and social cognition; how language is processed in individuals who speak multiple languages; how animal communication systems and artificial neural network language models differ from human language. Draws on evidence from diverse approaches and populations, focusing on cutting-edge research. Students taking graduate version complete additional assignments.
E. Fedorenko

9.40 Introduction to Neural Computation
Prereq: (Physics II (GIR), 6.100B, and 9.01) or permission of instructor
U (Spring)
4-0-8 units

Introduces quantitative approaches to understanding brain and cognitive functions. Topics include mathematical description of neurons, the response of neurons to sensory stimuli, simple neuronal networks, statistical inference and decision making. Also covers foundational quantitative tools of data analysis in neuroscience: correlation, convolution, spectral analysis, principal components analysis. Mathematical concepts include simple differential equations and linear algebra.
J. Dicarlo

9.401 Tools for Robust Science
Prereq: None
G (Spring)
3-0-9 units

New tools are being developed to improve credibility, facilitate collaboration, accelerate scientific discovery, and expedite translation of results. Students (i) identify obstacles to conducting robust cognitive and neuroscientific research, (ii) practice using current cutting-edge tools designed to overcome these obstacles by improving scientific practices and incentives, and (iii) critically evaluate these tools' potential and limitations. Example tools investigated include shared pre-registration, experimental design, data management plans, meta-data standards, repositories, FAIR code, open-source data processing pipelines, alternatives to scientific paper formats, alternative publishing agreements, citation audits, reformulated incentives for hiring and promotion, and more.
R. Saxe

9.41 Research and Communication in Neuroscience and Cognitive Science
Prereq: 9.URG and permission of instructor
U (Fall)
2-12-4 units

Emphasizes research and scientific communication. Instruction and practice in written and oral communication provided. Based on results of his/her UROP research, each student creates a full-length paper and a poster as part of an oral presentation at the end of the term. Other assignments include peer editing and reading/critiquing published research papers. Prior to starting class, students must have collected enough data from their UROP research projects to write a paper. Limited to juniors and seniors.
L. Schulz

9.42 The Brain and Its Interface with the Body
Prereq: 7.28, 7.29[J], or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units

Covers a range of topics, such as brain-immune system interaction, the gut-brain axis, and bioengineering approaches for studying the brain and its interactions with different organs. Explores how these interactions may be involved in nervous system disease processes.
F. Zhang

9.422[J] Principles of Neuroengineering
Same subject as 20.452[J], MAS.881[J]
Subject meets with 20.352
Prereq: Permission of instructor
G (Fall)
3-0-9 units

See description under subject MAS.881[J].
E. S. Boyden, III

9.455[J] Revolutionary Ventures: How to Invent and Deploy Transformative Technologies
Same subject as 15.128[J], 20.454[J], MAS.883[J]
Prereq: Permission of instructor
G (Fall)
2-0-7 units

See description under subject MAS.883[J].
E. Boyden, J. Bonsen, J. Jacobson

9.48[J] Philosophical Issues in Brain Science
Same subject as 24.08[J]
Prereq: None
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: U (Fall)
3-0-9 units. HASS-H; CI-H

See description under subject 24.08[J].
E. J. Green

9.49 Neural Circuits for Cognition
Subject meets with 9.490
Prereq: 9.40, 18.06, or permission of instructor
U (Fall)
3-0-9 units

Takes a computational approach to examine circuits in the brain that perform elemental cognitive tasks: tasks that are neither directly sensory nor directly motor in function, but are essential to bridging from perception to action. Covers circuits and circuit motifs in the brain that underlie computations like integration, decision-making, spatial navigation, inference, and other cognitive elements. Students study empirical results, build dynamical models of neural circuits, and examine the mathematical theory of representations and computation in such circuits. Considers noise, stability, plasticity, and learning rules for these systems. Students taking graduate version complete additional assignments.
I. Fiete

9.490 Neural Circuits for Cognition
Subject meets with 9.49
Prereq: 9.40, 18.06, or permission of instructor
G (Fall)
3-0-9 units

Takes a computational approach to examine circuits in the brain that perform elemental cognitive tasks: tasks that are neither directly sensory nor directly motor in function, but are essential to bridging from perception to action. Covers circuits and circuit motifs in the brain that underlie computations like integration, decision-making, spatial navigation, inference, and other cognitive elements. Students study empirical results, build dynamical models of neural circuits, and examine the mathematical theory of representations and computation in such circuits. Considers noise, stability, plasticity, and learning rules for these systems. Students taking graduate version complete additional assignments.
I. Fiete

9.50 Research in Brain and Cognitive Sciences
Prereq: 9.00 and permission of instructor
U (Fall, Spring)
0-12-0 units
Can be repeated for credit.

Laboratory research in brain and cognitive science, using physiological, anatomical, pharmacological, developmental, behavioral, and computational methods. Each student carries out an experimental study under the direction of a member of the faculty. Project must be approved in advance by the faculty advisor and the undergraduate faculty officer. Written presentation of results is required.
Consult L. Schulz

9.520[J] Statistical Learning Theory and Applications
Same subject as 6.7910[J]
Prereq: 6.3700, 6.7900, 18.06, or permission of instructor
G (Fall)
3-0-9 units

Covers foundations and recent advances in statistical machine learning theory, with the dual goals of providing students with the theoretical knowledge to use machine learning and preparing more advanced students to contribute to progress in the field. The content is roughly divided into three parts. The first part is about classical regularization, margin, stochastic gradient methods, overparametrization, implicit regularization, and stability. The second part is about deep networks: approximation and optimization theory plus roots of generalization. The third part is about the connections between learning theory and the brain. Occasional talks by leading researchers on advanced research topics. Emphasis on current research topics.
T. Poggio, L. Rosasco

9.521[J] Mathematical Statistics: a Non-Asymptotic Approach
Same subject as 18.656[J], IDS.160[J]
Prereq: (6.7700[J], 18.06, and 18.6501) or permission of instructor
G (Spring)
3-0-9 units

Introduces students to modern non-asymptotic statistical analysis. Topics include high-dimensional models, nonparametric regression, covariance estimation, principal component analysis, oracle inequalities, prediction and margin analysis for classification. Develops a rigorous probabilistic toolkit, including tail bounds and a basic theory of empirical processes
S. Rakhlin, P. Rigollet

9.522 Statistical Reinforcement Learning
Prereq: None
G (Fall)
Not offered regularly; consult department
9-0-3 units

Focuses on sample complexity and algorithms for online learning and decision-making. Prediction of individual sequences, online regression, and online density estimation. Multi-armed and contextual bandits. Decision-making with structured observations and the decision-estimation coefficient. Frequentist and Bayesian approaches. Reinforcement learning: tabular methods and function approximation. Behavioral and neural mechanisms of reinforcement learning.
<p class="p1">A. Rahklin

9.53 Emergent Computations Within Distributed Neural Circuits
Subject meets with 9.530
Prereq: 9.40 or permission of instructor
U (Spring)
4-0-8 units

Addresses the fundamental scientific question of how the human brain still outperforms the best computer algorithms in most domains of sensory, motor and cognitive function, as well as the parallel and distributed nature of neural processing (as opposed to the serial organization of computer architectures/algorithms) required to answer it. Explores the biologically plausible computational mechanisms and principles that underlie neural computing, such as competitive and unsupervised learning rules, attractor networks, self-organizing feature maps, content-addressable memory, expansion recoding, the stability-plasticity dilemma, the role of lateral and top-down feedback in neural systems, the role of noise in neural computing. Students taking graduate version complete additional assignments.
R. Ajemian

9.530 Emergent Computations Within Distributed Neural Circuits
Subject meets with 9.53
Prereq: 9.40 or permission of instructor
G (Spring)
4-0-8 units

Addresses the fundamental scientific question of how the human brain still outperforms the best computer algorithms in most domains of sensory, motor and cognitive function, as well as the parallel and distributed nature of neural processing (as opposed to the serial organization of computer architectures/algorithms) required to answer it. Explores the biologically plausible computational mechanisms and principles that underlie neural computing, such as competitive and unsupervised learning rules, attractor networks, self-organizing feature maps, content-addressable memory, expansion recoding, the stability-plasticity dilemma, the role of lateral and top-down feedback in neural systems, the role of noise in neural computing. Students taking graduate version complete additional assignments.
R. Ajemian

9.55[J] Consumer Behavior
Same subject as 15.8471[J]
Prereq: None
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: U (Fall)
3-0-6 units
Credit cannot also be received for 9.550[J], 15.847[J]

See description under subject 15.8471[J].
D. Rand

9.550[J] Consumer Behavior
Same subject as 15.847[J]
Prereq: 15.809, 15.814, or permission of instructor
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: G (Fall)
3-0-6 units
Credit cannot also be received for 9.55[J], 15.8471[J]

See description under subject 15.847[J].
D. Rand

9.58 Projects in the Science of Intelligence
Prereq: (6.3900 and (9.40 or 18.06)) or permission of instructor
U (Fall)
3-0-9 units

Provides instruction on the mechanistic basis of intelligence - how the brain produces intelligent behavior and how we may be able to replicate intelligence in machines. Examines how human intelligence emerges from computations in neural circuits to reproduce similar intelligent behavior in machines. Working in teams, students complete computational projects and exercises that reinforce the theme of collaboration between (computer science + math) and (neuroscience + cognitive science). Culminates with student presentations of their projects. Instruction and practice in oral and written communication provided. Limited to 30.
T. Poggio, S. Ullman

9.583[J] Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Same subject as HST.583[J]
Prereq: 18.05 and (18.06 or permission of instructor)
Acad Year 2024-2025: G (Fall)
Acad Year 2025-2026: Not offered
2-3-7 units

See description under subject HST.583[J].
J. Polimeni, A. Yendiki, J. Chen

9.59[J] Laboratory in Psycholinguistics
Same subject as 24.905[J]
Prereq: None
U (Spring)
3-3-6 units. Institute LAB

Hands-on experience designing, conducting, analyzing, and presenting experiments on the structure and processing of human language. Focuses on constructing, conducting, analyzing, and presenting an original and independent experimental project of publishable quality. Develops skills in reading and writing scientific research reports in cognitive science, including evaluating the methods section of a published paper, reading and understanding graphical displays and statistical claims about data, and evaluating theoretical claims based on experimental data. Instruction and practice in oral and written communication provided.
E. Gibson

9.60 Machine-Motivated Human Vision
Prereq: None
U (Spring)
2-1-9 units. Institute LAB

Explores how studies of human vision can be motivated by, and enhance the capabilities of, machine-based systems. Considers the twin questions of how the performance of state-of-the-art machine vision systems compares with that of humans, and what kinds of strategies the human visual system uses in tasks where human performance exceeds that of machines. Includes presentations by engineers from companies with significant engineering efforts in vision. Based on these presentations, students define and conduct studies to address the two aforementioned questions and present their results to the public at the end of the term. Directed towards students interested in exploring vision from computational, experimental and practical perspectives. Provides instruction and practice in written and oral communication.
P. Sinha

9.611[J] Natural Language and the Computer Representation of Knowledge
Same subject as 6.8630[J], 24.984[J]
Prereq: 6.4100 or permission of instructor
G (Spring)
3-3-6 units

See description under subject 6.8630[J].
R. C. Berwick

9.66[J] Computational Cognitive Science
Same subject as 6.4120[J]
Subject meets with 9.660
Prereq: 6.3700, 6.3800, 9.40, 18.05, 6.3900, or permission of instructor
U (Fall)
3-0-9 units

Introduction to computational theories of human cognition. Focus on principles of inductive learning and inference, and the representation of knowledge. Computational frameworks covered include Bayesian and hierarchical Bayesian models; probabilistic graphical models; nonparametric statistical models and the Bayesian Occam's razor; sampling algorithms for approximate learning and inference; and probabilistic models defined over structured representations such as first-order logic, grammars, or relational schemas. Applications to understanding core aspects of cognition, such as concept learning and categorization, causal reasoning, theory formation, language acquisition, and social inference. Graduate students complete a final project.
J. Tenenbaum

9.660 Computational Cognitive Science
Subject meets with 6.4120[J], 9.66[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Introduction to computational theories of human cognition. Focuses on principles of inductive learning and inference, and the representation of knowledge. Computational frameworks include Bayesian and hierarchical Bayesian models, probabilistic graphical models, nonparametric statistical models and the Bayesian Occam's razor, sampling algorithms for approximate learning and inference, and probabilistic models defined over structured representations such as first-order logic, grammars, or relational schemas. Applications to understanding core aspects of cognition, such as concept learning and categorization, causal reasoning, theory formation, language acquisition, and social inference. Graduate students complete a final project.
J. Tenenbaum

9.67[J] Materials Physics of Neural Interfaces
Same subject as 3.056[J]
Subject meets with 3.64[J], 9.670[J]
Prereq: 3.033 or permission of instructor
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: U (Fall)
3-0-9 units

See description under subject 3.056[J].
P. Anikeeva

9.670[J] Materials Physics of Neural Interfaces
Same subject as 3.64[J]
Subject meets with 3.056[J], 9.67[J]
Prereq: Permission of instructor
Acad Year 2024-2025: Not offered
Acad Year 2025-2026: G (Fall)
3-0-9 units

See description under subject 3.64[J].
P. Anikeeva

9.72 Vision in Art and Neuroscience
Subject meets with 9.720
Prereq: None
U (Fall)
2-2-8 units

Introduces and provides practical engagement with core concepts in vision neuroscience. Combination of seminar and studio work fosters interdisciplinary dialogue between visual art and vision neuroscience, culminating in a gallery exhibition of students' individual, semester-long projects. Treats the processes of visual perception and the creation of visual art in parallel, making use of the fact that both are constructive. Through lectures and readings in experimental and computational vision research, explores the hierarchy of visual processing, from the moment that light strikes the retina to the internal experience of a rich visual world. In the studio, students examine how each stage of this process manifests in the experience of art, wherein the perceptual system observes itself. Students taking graduate version complete additional assignments.
P. Sinha, S. Riskin

9.720 Vision in Art and Neuroscience
Subject meets with 9.72
Prereq: None
G (Fall)
2-2-8 units

Introduces and provides practical engagement with core concepts in vision neuroscience. Combination of seminar and studio work fosters interdisciplinary dialogue between visual art and vision neuroscience, culminating in a gallery exhibition of students' individual, semester-long projects. Treats the processes of visual perception and the creation of visual art in parallel, making use of the fact that both are constructive. Through lectures and readings in experimental and computational vision research, explores the hierarchy of visual processing, from the moment that light strikes the retina to the internal experience of a rich visual world. In the studio, students examine how each stage of this process manifests in the experience of art, wherein the perceptual system observes itself. Students taking graduate version complete additional assignments.
P. Sinha, S. Riskin

9.822[J] Psychology and Economics
Same subject as 14.137[J]
Prereq: None
G (Spring)
4-0-8 units

See description under subject 14.137[J].
D. Prelec

9.830 Graduate Student Internship
Prereq: None
G (Fall, Spring, Summer)
Units arranged

Provides academic credit for BCS graduate students who are engaging an internship opportunity in brain or cognitive sciences. Before enrolling, students must have an offer of employment from a company or organization, and approval from their advisor and the BCS Graduate Officer.
Vallin, Sierra

9.85 Infant and Early Childhood Cognition
Prereq: 9.00
U (Fall)
3-0-9 units. HASS-S

Introduction to cognitive development focusing on childrens' understanding of objects, agents, and causality. Develops a critical understanding of experimental design. Discusses how developmental research might address philosophical questions about the origins of knowledge, appearance and reality, and the problem of other minds. Provides instruction and practice in written communication as necessary to research in cognitive science (including critical reviews of journal papers, a literature review and an original research proposal), as well as instruction and practice in oral communication in the form of a poster presentation of a journal paper.
L. Schulz

9.89 Off-Campus Undergraduate Research in Brain and Cognitive Sciences
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

For Brain and Cognitive Sciences undergraduates participating in curriculum-related research off-campus. Before enrolling, students must consult the BCS Academic Office for details on procedures and restrictions, and have approval from their faculty advisor. Subject to departmental approval. Upon completion, the off-campus advisor will provide an evaluation of the student's work. The student must also submit a write-up of the experience, approved by the MIT advisor.
Staff

9.90 Practical Experience in Brain and Cognitive Sciences
Prereq: Permission of instructor
U (Summer)
0-1-0 units

For Brain and Cognitive Sciences undergraduates participating in curriculum-related off-campus professional experiences. Before enrolling, students must consult the BCS Academic Office for details on procedures and restrictions, and have approval from their faculty advisor. Subject to departmental approval. Upon completion, the student must submit a write-up of the experience, approved by the MIT advisor.
Staff

9.900 Clinical Connection Module
Prereq: None. *Coreq: 9.011, 9.012, 9.013[J], 9.014, or 9.015[J]*; permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
0-1-0 units
Can be repeated for credit.

Provides students the opportunity to connect their core neuroscience training to clinical experience (pathogenesis, diagnosis, management and therapeutic clinical trials of nervous system diseases). Students attend, along with Harvard faculty, fellows, residents and medical students at Massachusetts General Hospital, clinical seminars at MGH conducted by clinical and basic science faculty of Harvard Medical School. Each clinical experience is one week in length; students have the option to attend up to four seminars in their individual week chosen from: neuroradiology, neuropathology, neurodegenerative diseases, epilepsy, movement disorders, psychiatry, neuropsychiatric diseases and behavioral neurology, and functional neurosurgery. Seminars are followed by one-on-one discussion with instructor to connect the clinical experience with parallel course material on the neurobiology of disease.
T. Byrne

9.901 Responsible Conduct in Science
Prereq: None
G (IAP)
1-0-1 units

Provides instruction and dialogue on practical ethical issues relating to the responsible conduct of human and animal research in the brain and cognitive sciences. Specific emphasis on topics relevant to young researchers including data handling, animal and human subjects, misconduct, mentoring, intellectual property, and publication. Preliminary assigned readings and initial faculty lecture followed by discussion groups of four to five students each. A short written summary of the discussions submitted at the end of each class. See IAP Guide for registration information.
M. Wilson

9.91 Independent Study in Brain and Cognitive Sciences
Prereq: 9.00, two additional subjects in Brain and Cognitive Sciences, and permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Individual study of a topic under the direction of a member of the faculty.
Consult Staff

9.918 BCS Grant Writing Workshop
Prereq: None
G (Fall)
1-0-0 units

Fellowship writing workshop to develop applications for predoctoral fellowships, including the NSF and NDSEG programs.
Kanwisher, Nancy

9.919 Teaching Brain and Cognitive Sciences
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit.

For teaching assistants in Brain and Cognitive Sciences, in cases where teaching assignment is approved for academic credit by the department.
Staff

9.921 Research in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Guided research under the sponsorship of individual members of the faculty. Ordinarily restricted to candidates for the doctoral degree in Course 9.
Staff

9.941 Graduate Thesis Proposal
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Students submit written proposals for thesis according to stated deadlines.
Staff

9.980[J] Leadership and Professional Strategies & Skills Training (LEAPS), Part I: Advancing Your Professional Strategies and Skills
Same subject as 5.961[J], 8.396[J], 12.396[J], 18.896[J]
Prereq: None
G (Spring; second half of term)
2-0-1 units

See description under subject 8.396[J]. Limited to 80.
A. Frebel

9.981[J] Leadership and Professional Strategies & Skills Training (LEAPS), Part II: Developing Your Leadership Competencies
Same subject as 5.962[J], 8.397[J], 12.397[J], 18.897[J]
Prereq: None
G (Spring; first half of term)
2-0-1 units

See description under subject 8.397[J]. Limited to 80.
D. Rigos

9.990 Professional Development (New)
Prereq: None
G (Fall, IAP, Spring, Summer)
0-1-0 units

Required for Course 9 students in the doctoral program to gain professional development experience. Options for professional development activities include, but are not limited to: internships, public scientific presentations, clinical experiences, and workshops. Internship experiences must be approved by the department and must adhere to the BCS Internship Policy.
J. Ormerod

9.C20[J] Introduction to Computational Science and Engineering
Same subject as 16.C20[J], 18.C20[J], CSE.C20[J]
Prereq: 6.100A; *Coreq: 8.01 and 18.01*
U (Fall, Spring; second half of term)
2-0-4 units
Credit cannot also be received for 6.100B

See description under subject 16.C20[J].
D. L. Darmofal, N. Seethapathi

9.S51 Special Subject in Brain and Cognitive Sciences
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences
U (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
I. Pepperberg

9.S52 Special Subject in Brain and Cognitive Sciences
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences
U (Spring)
Units arranged
Can be repeated for credit.

Undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
E. Fedorenko

9.S911 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall; partial term)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum. 9.S911 is graded P/D/F.
N. G. Kanwisher

9.S912 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
L. Schulz

9.S913 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
M. Kellis, M. Heiman

9.S914 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
R. Saxe

9.S915 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Staff

9.S916 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Staff

9.S917 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Spring; first half of term)
Units arranged
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
L. Udeigwe, J. DiCarlo, R. Ajemian

9.S918 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Spring; second half of term)
Units arranged [P/D/F]
Can be repeated for credit.

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum. 9.S918 is graded P/D/F.
J. DiCarlo

9.S92 Special Subject in Brain and Cognitive Sciences
Prereq: 9.00
U (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Consult F. Wang

9.S93 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]

For undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Staff

9.S94 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (IAP)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduate study in brain and cognitive sciences during Independent Activities Period; covers material not offered in regular curriculum. See IAP Guide for details.
Staff

9.S95 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (IAP)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduate study in brain and cognitive sciences during Independent Activities Period; covers material not offered in regular curriculum. See IAP Guide for details.
Staff

9.S96 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (IAP)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduate study in brain and cognitive sciences during Independent Activities Period; covers material not offered in regular curriculum. See IAP Guide for details.
Consult Staff

9.S97 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (IAP)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduate study in brain and cognitive sciences during Independent Activities Period; covers material not offered in regular curriculum. See IAP Guide for details.
Staff

9.S98 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (IAP)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduate study in brain and cognitive sciences during Independent Activities Period; covers material not offered in regular curriculum. See IAP Guide for details.
Staff

9.S99 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (Spring)
Units arranged

For undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
M. Kellis, M. Heiman

9.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a Ph.D. thesis; to be arranged by the student and an appropriate MIT faculty member.
Staff

9.THM Master of Engineering Program Thesis
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of an MEng thesis; to be arranged by the student and an appropriate MIT faculty member. Restricted to MEng graduate students.
S. Vallin

9.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Individual participation in an ongoing research project.
Staff

9.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual participation in an ongoing research project.
Consult Staff