

Neuroscience (NSCI)

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Directors of Undergraduate Studies: Marvin Chun (Psychology), SSS 303, marvin.chun@yale.edu, and Damon Clark, KBT 224, damon.clark@yale.edu (MCDB).

Primary Neuroscience Faculty

Professors †Amy Arnsten (School of Medicine and Psychology), Tom Brown (Psychology), Ty Cannon (Psychology), John Carlson (MCDB), BJ Casey (Psychology), Marvin Chun (Psychology), Paul Forscher (MCDB), Jutta Joorman (Psychology), Douglas Kankel (MCDB), Haig Keshishian (MCDB), †Daeyeol Lee (School of Medicine and Psychology), †Linda Mayes (School of Medicine and Psychology), Greg McCarthy (Psychology), Laurie Santos (Psychology), Jane Taylor (School of Medicine and Psychology), Nick Turk-Browne (Psychology), Robert Wyman (MCDB)

Associate Professors †Sreeganga Chandra (School of Medicine and MCDB), Thierry Emonet (MCDB), Weimin Zhong (MCDB)

Assistant Professors Damon Clark (MCDB), Arielle Baskin-Sommers (Psychology), Steve Chang (Psychology), Molly Crockett (Psychology), Dylan Gee (Psychology), Avram Holmes (Psychology), †Hedy Kober (School of Medicine and Psychology), †Ifat Levy (School of Medicine and Psychology)

Lecturers Nelson Donegan (Psychology)

†A joint appointment with primary affiliation in another department or school.

Neuroscience aims to understand how the brain produces the mind and behavior, with the goal of advancing human understanding, improving physical and mental health, and optimizing performance. This entails a broad, interdisciplinary effort that spans molecules to minds. At one end, molecular and cellular biology, chemistry, and physics are improving our understanding of the molecular and cellular mechanisms of neuronal signaling and development. At the other end, psychology, psychiatry, and neurology link neural processes and systems to the mind and behavior. At all levels, the rich array of methods and data analysis depends on a strong foundation in the basic sciences, mathematics, statistics, and computer science.

Requirements of the major The NSCI B.S. and B.A. degrees require a minimum of 18.5 credits, including two neuroscience foundation courses (2), introductory coursework in the biological sciences (2), basic statistics (1), neuroscience methods (0.5 or 1), and a senior requirement (2); 11 additional course may be chosen from among systems/circuits/behavior core electives (2+), molecular/cellular/biological core electives (2+), quantitative core electives (1+), basic and advanced allied field electives (1+ each). The B.S. degree requires 2 terms of empirical research for the senior requirement. The B.A. degree senior requirement does not require empirical research. No course may be used to fulfill more than one requirement for the major.

Biological Sciences Prerequisite Two credits in the biological sciences are required. This can be in the form of BIOL 101-104 (or their equivalents). Note that BIOL 101-104 is a prerequisite for many courses in the major.

BIOL 101+102 Biochemistry and Biophysics + Principles of Cell Biology and Membrane Physiology
BIOL 103+104 Genes and Development + Principles of Ecology and Evolutionary Biology

Statistics Prerequisite One course in statistics from the following is required: PSYC 200, STAT 103, STAT 262, or higher equivalent.

Neuroscience Foundations One course in PSYC and one course in MCDB below are required.
PSYC 160 The Human Brain or PSYC 170 Fundamentals of Neuroscience
MCDB 320 Neurobiology (BIOL101-104 Required; Chemistry and Physics Recommended)

Neuroscience Lab One course from the following is required for .5 or 1 credit.

MCDB321L Neurobiology Lab (.5 credits, with MCDB 320)
PSYC 230L Research Methods in Human Neuroscience
PSYC 23_L Computational Methods in Human Neuroscience
PSYC 260 Research Methods in Behavioral Genetics
PSYC 270 Research Methods in Behavioral Neuroscience
_____ Behavioral Endocrinology

Electives 11 courses required from the following. A minimum of one course must be from the Quantitative Core, two from the Systems/Circuits/Behavior Core, two from the Molecular/Cellular/Biological Core, one from the Basic Allied Core, and one from the Advanced Allied Core.

Quantitative Core (1+)

MATH 116 recommended, or 112, 115, 120: Calculus
MATH 222, 225, or 230+231: Linear Algebra
MATH 246 or 247: Differential Equations
AMTH 262: Computational Tools for Data Science
MCDB 261 or MCDB 361 Dynamical Systems
CPSC 202 Mathematical Tools for Computer Science
PHYS 301 Mathematical Methods in Physics

Systems/Circuits/Behavior Core (2+)

PSYC303 Social Neuroscience
PSYC316 Clinical Neuroscience
PSYC321 Psychopharmacology
PSYC335 Cognitive Neuroscience

PSYC352 Adolescent Brain
PSYC376 Learning and memory
PSYC411 Systems Neuroscience

Molecular/Cellular/Biological Core (2+)

MCDB200 Molecular Biology
MCDB205 Cell Biology
MCDB210 Development
MCDB300 or MBB300 Biochemistry
MCDB202 Genetics
MCDB310 Physiology
MCDB361 Dynamical Systems in Biology
MCDB370 Biotechnology
MCDB450 The Human Genome
MCDB452 Bioinformatics: ... Simulation and Data Mining
MCDB440 Brain Development and Plasticity
MCDB4xx Cell Biology of the Neuron

Basic Allied STEM (1+; Labs do not count towards NSCI)

PHYS 170,180,200,260: Univ.,Intro, or Intns. Physics
PHYS 171,181,201,261: Univ.,Intro, or Intns. Physics
CHEM 161,163, or equivalent General Chemistry I
CHEM 165, 167, or equivalent General Chemistry II
CHEM174 or 220 Organic Chemistry I
CHEM175 or 221 Organic Chemistry II or Orgo of Life Proc

Advanced Allied (1+; or second Quant Core)

BENG350 Physiological Systems
BENG445 Biomedical Image Processing and Analysis
CPSC100 Introduction to Computing and Programming
CPSC201 Introduction to Computer Science
CPSC 202 Mathematical Tools for Computer Science
CPSC223 Data structures
CPSC323 Systems
CPSC365 Algorithms
CPSC475/476 Computational vision
EENG 200 Introduction to Electronics
PHYS420 Thermodynamics and Statistical Mechanics
STAT361 Data analysis

Other Allied (Maximum 2 courses can be applied towards NSCI)

CGSC110 Introduction to Cognitive Science
PSYC161 Drugs, Brain, Behavior
PSYC141 The Criminal Mind

Senior Requirement In addition to the course requirements described above, all students must satisfy a senior requirement undertaken during the senior year. A booklet listing the senior requirements of the BA or BS degree is available in the office of the director of undergraduate studies. All students must fill out a checklist of requirements and go over it with the undergraduate registrar, _____, by the spring term of the junior year.

For the B.S. degree, the senior requirement is usually fulfilled by completing a yearlong research course, NSCI ___. With permission of the director of undergraduate studies, students can begin the project during the spring term of the junior year, continue it over the summer, and complete it during the fall term of the senior year. In all other cases, the senior requirement must be completed during the senior year. Yale College does not grant academic credit for summer research unless the student is enrolled in an independent research course in Yale Summer Session. Seniors working toward the B.S. degree are expected to spend at least ten hours per week in the lab conducting individual research. Research can be conducted over archival or consortium data sets.

For the B.A. degree, the senior requirement can be met either by submitting a senior essay of fifteen to twenty pages evaluating current research in a field of neuroscience, conducted through a yearlong reading course, NSCI ___, one term of which may be fulfilled with a research course, NSCI ___. A senior choosing to fulfill the requirement with a senior essay must consult with a faculty adviser on the scope and literature of the topic and submit the adviser's written approval to the director of undergraduate studies no later than the course selection period of the term in which the paper is due. The senior essay may be related to the subject matter of a course, but the essay is a separate departmental requirement in addition to any work done in a course and does not count toward the grade in any course. The senior essay must be completed and submitted to the office of the director of undergraduate studies by the last day of classes. Students electing this option should obtain an approval form from the office of the director of undergraduate studies.

Independent research courses before senior year. The only independent research course available to students prior to the senior year is NSCI ___. This course is graded pass/fail and contributes to the thirty-six course credits required for the bachelor's degree, but it does not substitute for any NSCI major requirement, including the senior requirement.

Credit/D/Fail No course taken Credit/D/Fail may be counted toward the NSCI major, including prerequisites.

Departmental advisers Schedules for all majors must be discussed with, and approved by, the director of undergraduate studies in NSCI. Only then may a schedule be submitted to the residential college dean's office. For questions concerning credits for courses taken at other institutions or at Yale but outside the Department of Psychology, students should consult with the director of undergraduate studies.

Application to the major Students may apply to start the major at the end of their freshman year. Applications will be reviewed at the end of each term, and must be submitted by the last

day of classes of each term at this <link>. More information regarding the application process is on the program's Web site.

REQUIREMENTS OF THE MAJOR

Prerequisites BIOL 101, 102, 103, 104; STAT 103, STAT 262, or PSYC 200.

Number of courses 18.5 courses for the B.S. or B.A. degree.

Specific courses required PSYC 160 or PSYC 170; MCDB 320

Distribution of courses 1 neuroscience lab course; 1 quantitative core course; 11 electives including at least 2 systems/circuits/behavior core courses, 2 molecular/cellular/biological core courses, 1 basic allied STEM, 1 advanced allied course.

Senior Requirement B.S. – Two course credits in empirical research; B.A. – Two course credits in non-empirical research.