

# Neuroscience

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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 from molecules to minds. At one end, 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 computer science 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.

## PREREQUISITES

The foundational biology courses required of all Neuroscience majors are BIOL 1010, 1020, 1030, and 1040. All majors must also complete one of the following: PSYC 2100, S&DS 1030, 1050, 2300, 2380.

## PLACEMENT PROCEDURES

When declaring the major, students are encouraged to send a completed Neuroscience major worksheet to the department registrar (neuroscience.registrar@yale.edu) to help with advising. We encourage all majors to take the Human Brain (NSCI 1600) and Neurobiology (NSCI 3200) as early as possible since these courses provide foundations for the NSCI curriculum and independent research.

## REQUIREMENTS OF THE MAJOR

See Links to attributes indicating courses approved for Neuroscience major requirements.

A minimum of 18.5 credits is required, including the prerequisites (5 courses for 3 credits), 15 lecture or seminar courses (which include the senior requirement), and one laboratory, as follows:

1. Two Neuroscience foundation courses, NSCI 1600 and 3200.
2. One Neuroscience lab (YC NSCI Neuroscience Lab) chosen from NSCI 2280L, 2290L, 2400, NSCI 2580, 2600, 2700, 3210L; PSYC 2538.
3. Eleven electives from the following core groupings. Students may search for approved courses using the attributes indicated in each core grouping. The complete list of approved courses can be found on the NSCI website.
  - minimum of 2 courses from *Systems/Circuits/Behavior Core* (YC NSCI Systems/Circuit/Behav)
  - minimum of 2 courses from *Molecular/Cellular/Biological Core* (YC NSCI Molecular/Cell/Biol)
  - minimum of 1 course from *Quantitative Core* (YC NSCI Quantitative)
  - minimum of 1 course from *Computational Core* (YC NSCI Computational)

- minimum of 1 course from *Basic Allied Core* (YC NSCI Basic Allied Core)
- no more than 2 courses from *Other Allied Core* (YC NSCI Other Allied)

**Credit/D/Fail** No course taken Credit/D/Fail may be applied toward the requirements of the major, including prerequisites.

**Outside credit** Courses taken at another institution or during an approved summer or term-time study abroad program may count toward the major requirements with DUS approval.

#### SENIOR REQUIREMENT

In addition to the course requirements described above, all students must satisfy a senior requirement undertaken during the senior year. 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.

**B.S. degree program** The B.S. degree program requires two-course credits of empirical research, NSCI 4900 and 4910. These courses are only available to Neuroscience seniors and receive a letter grade. Students are expected to spend at least 10 hours per week in the laboratory, to complete written assignments, and to give a presentation. In addition to time in the lab, and as part of NSCI 4900 and 4910, students are expected to attend a semi-regular capstone seminar, hear guest speakers, and discuss senior work progress with their peers and the directors of undergraduate studies (DUSs.) Research can be conducted over original, archival, or consortium data sets. Written assignments include a short research plan due at the beginning of the fall term, a grant proposal due at the end of the fall term, and a final report due at the end of the spring term. Students should pursue the same research project for two terms, with the grant proposal guiding and serving as the background for the research and final report. Seniors are also required to present their research in the spring term at a poster session. Students should find a research laboratory during the term preceding the research. Yale College does not grant academic credit for summer research unless the student is enrolled in an independent research course in Yale Summer Session. To register for NSCI 4900 and 4910, students must submit a form and the research plan with a bibliography, approved by the faculty research adviser and a DUS, by the end of the first week of classes.

**B.A. degree program** The B.A. degree program requires two course credits in nonempirical research, NSCI 4800 and 4810; or one credit in nonempirical research, NSCI 4800 or 4810, and one credit in empirical research, NSCI 4900 or 4910. These courses are only open to Neuroscience seniors and receive a letter grade. Under faculty supervision, for NSCI 4800 or 4810, students are required to conduct original research for at least 10 hours per week that does not involve direct interaction with data, such as developing a theory or conducting a meta-analysis to synthesize existing findings. A literature review without novel intellectual contributions is not adequate. Written assignments include a short research plan due at the beginning of the fall term, a literature review or draft theoretical paper due at the end of the fall term, and a theoretical paper due at the end of the spring term. Seniors are also required to present their research in the spring term at a poster session. To register, students must submit a form and the research plan with a bibliography, approved by the faculty adviser and a DUS, by the end of the first week of classes.

More detailed guidelines, forms, and deadline information are available on the program website.

#### ADDITIONAL INFORMATION

**Independent research courses before senior year.** The only independent research courses available to students prior to senior year are NSCI 4700, 4710. These courses are graded Pass/Fail and count toward the thirty-six credits required for the bachelor's degree, but they do not substitute for any NSCI major requirement, including the senior requirement. Independent research courses do not satisfy the lab requirement for the NSCI major. These courses are for non-Senior Neuroscience students only.

#### ADVISING

Due to overlap in the major course requirements, the Neuroscience major should not be combined with a second major in Molecular, Cellular and Developmental Biology or Psychology.

**Program advisers** Each term, students should update their Neuroscience major worksheet and then meet with their assigned faculty adviser to discuss their schedule and review their worksheet. These documents should then be submitted to the Neuroscience registrar for DUS review and approval. For questions concerning credits for courses taken at other institutions, or courses not listed in Yale Course Search, students should contact the Neuroscience registrar.

#### SUMMARY OF MAJOR REQUIREMENTS

**Prerequisites** BIOL 1010, 1020, 1030, and 1040; and one of PSYC 2100, 2300, 2380

**Number of courses** 18.5 credits (including prereqs and senior req)

**Specific courses required** 2 neuroscience foundation courses, NSCI 1600 and 3200

**Distribution of courses** *B.S. or B.A.* – 1 lab course; 11 electives including at least: 2 Systems/Circuits/Behavior Core courses, 2 Molecular/Cellular/Biological Core courses, 1 Quantitative Core course, 1 Computational Core course, 1 Basic Allied Core course, and no more than 2 Other Allied Core courses

**Senior requirement** *B.S.* – 2 empirical research courses, NSCI 4900 and 4910; *B.A.* – 2 nonempirical research courses, NSCI 4800 and 4810, or 1 empirical research course (NSCI 4900 or 4910) and 1 nonempirical research course (NSCI 4800 or 4810)

#### FACULTY OF THE NEUROSCIENCE MAJOR

**Professors** †Amy Arnsten (*School of Medicine, Psychology*), Ty Cannon (*Psychology*), John Carlson (*Molecular, Cellular, and Developmental Biology*), Marvin Chun (*Psychology*), Damon Clark (*Molecular, Cellular, and Developmental Biology*), Thierry Emonet (*Molecular, Cellular, and Developmental Biology*), Jutta Joormann (*Psychology*), Douglas Kankel (*Molecular, Cellular, and Developmental Biology*), Haig Keshishian (*Molecular, Cellular, and Developmental Biology*), †John Krystal (*School of Medicine, Psychology*), Rajit Manohar (*Electrical Engineering*), †Linda Mayes (*School of Medicine, Psychology*), Greg McCarthy (*Psychology*), Wendy Mendes (*Psychology*), Kia Nobre (*Psychology*), Laurie Santos (*Psychology*), †Dana Small (*School of Medicine, Psychology*), †Jane Taylor (*School of Medicine, Psychology*), Nick Turk-Browne (*Psychology*)

**Associate Professors** Arielle Baskin-Sommers (*Psychology*), Abhishek Bhattacharjee (*Computer Science*), †Sreeganga Chandra (*School of Medicine, Molecular, Cellular, and Developmental Biology*), Steve Chang (*Psychology*), †Philip Corlett (*School of Medicine, Psychology*), Dylan Gee (*Psychology*), Smita Krishnaswamy (*Genetics*), †Ifat Levy (*School of Medicine, Psychology*), †James McPartland (*School of Medicine, Psychology*), Weimin Zhong (*Molecular, Cellular, and Developmental Biology*)

**Assistant Professors** Maria Gendron (*Psychology*), Randolph Helfrich (*Psychology*), Julia Leonard (*Psychology*), Samuel McDougale (*Psychology*), Harry McNamara (*Molecular, Cellular, and Developmental Biology*), Michael O'Donnell (*Molecular, Cellular, and Developmental Biology*), Priya Panda (*Electrical Engineering*), Robb Rutledge (*Psychology*), Shreya Saxena (*Biomedical Engineering*), Ilker Yildirim (*Psychology*)

**Lecturer** Stephanie Lazzaro (*Psychology*)

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