**NEUROSCIENCE**

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http://medicine.yale.edu/neuroscience  
M.S., M.Phil., Ph.D.

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**Associate Professors**  
Meeakshi Alreja (Psychiatry), Charles Bruce, Sreeganga Chandra, Bo Chen (Ophthalmology & Visual Science), Daniel Colón-Ramos, Kelly Cosgrove (Psychiatry), Jaime Gruzenbinder (Neurology), Marc Hammarland, Michael Higley, In-Jung Kim (Ophthalmology & Visual Science), Ifat Levy (Comparative Medicine), Chiang-Shan Ray Li (Psychiatry), Janghoo Lim (Genetics), Angeliki Louvi (Neurosurgery), Dhasakumar Navaratnam (Neurology), Michael Schwartz, Justus Verhagen

**Assistant Professors**  
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Starting in the 2018–2019 academic year, graduate degrees will no longer be offered through the Department of Neuroscience graduate program. Instead, all students interested in pursuing a graduate degree in neuroscience should enter through the Interdepartmental Neuroscience Program (INP), which will continue to offer graduate degrees in neuroscience for all interested Yale graduate students. See INP for information on admissions requirements and process.

**FIELDS OF STUDY**

Fields include the development, neuronal organization, and function of the mammalian central nervous system. The range of methods includes molecular-genetic and cellular neuroscience, neuroanatomy, biochemistry, neuropharmacology, computational modeling, neurophysiology, neuroimaging and behavior. An integrative, multidisciplinary approach is encouraged.

**SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE**

**Course Requirements**

Six courses are required, and students must obtain a grade of Honors in two of these courses and maintain an HP average or better. Students not achieving this will be put on academic probation and may be dismissed from the graduate program. Without exception, students are required to earn two Honors by the end of the second year of enrollment. All students will be reviewed academically at the end of the year. For purposes of calculating an overall High Pass or above average, Honors=3, High Pass=2, Pass=1, and Fail=0.

Required courses are Principles of Neuroscience (NBIO 701), Neurobiology (NBIO 720), and Structural and Functional Organization of the Human Nervous System (NBIO 500). In addition, three more elective graduate-level courses are required. Additional degree requirements are successful completion of both terms of Lab Rotation for First-Year Students (NBIO 511, NBIO 512) and both terms of Second-Year Thesis Research (NBIO 513, NBIO 514). This will ensure that degree candidates obtain a solid background in systems, cellular, and molecular approaches to neuroscience. In addition to all other requirements, students must successfully complete NBIO 580, Bioethics in Neuroscience, prior to the end of their first year of study. This requirement must be met prior to registering for a second year of study. In their fourth year of study, all students must successfully complete B&BS 503, RCR Refresher for Senior BBS Students.

**Laboratory Rotations**

Two rotations are required; they are typically completed in the first year. Rotations outside the Neuroscience track will count toward this requirement upon approval of the Neuroscience track directors.
Teaching Requirements

An important aspect of graduate training in Neuroscience is the acquisition of teaching skills through participation in courses appropriate for the student’s scientific interests. These opportunities can be drawn from a diverse menu of lecture, laboratory, and seminar courses at the undergraduate, graduate, and medical school levels. Ph.D. students are required to serve as Teaching Fellows (TF) for two terms. First-year students may not serve as a TF without written permission from the Neuroscience track directors. It is recommended that one term of teaching should be completed by the end of the third year, and both requirements be completed by the end of the fourth year.

Specifically, it is recommended that the first requirement be met by teaching in either Principles of Neurosciences (NBIO 701), Neurobiology (NBIO 720), Brain and Thought (CGSC 201), or Structural and Functional Organization of the Human Nervous System (NBIO 500). The second course may be chosen from the list of neuroscience-related courses in the Graduate School of Arts and Sciences bulletin, or from the Interdepartmental Neuroscience Program’s Bioethics course. A course not directly related to neuroscience must have the approval of the director of graduate studies (DGS).

Qualifying Exam

Ph.D. students must complete their qualifying exam by June 1 of their second year as a graduate student. The student must choose four faculty members to read with in consultation with the DGS and the student’s Ph.D. mentor; it is strongly encouraged that these faculty represent interests spanning from molecular to systems/cognitive neuroscience and not include the Ph.D. mentor. The student and faculty should devise a reading list of about fifteen papers on a defined topic. They should meet regularly (at least three or four meetings) to discuss the papers in depth. For the written exam, the student is given two questions from each faculty member. The student has three hours to write an answer to one of the two questions for each faculty member, i.e., a twelve-hour written exam spread over two days. The exam is performed on a laptop observing the honor system and is proctored by the DGS. The student may refer to the papers and the student’s notes but not to the Internet. The answers are distributed to the faculty, and several days later an oral exam is held to further evaluate the student’s knowledge. A fifth faculty member (a reader) chosen by the student may also be present at the oral exam, along with the DGS. If the student fails the qualifying exam, the student may have one more attempt at passage; this must be completed within one term of taking the original exam. A unanimous Pass vote from the Qualifying Examination committee is required. Students who do not pass the Qualifying Examination will be put on academic probation and will be required to either retake parts of the qualifier and/or complete additional course work. They will receive a letter from the DGS explaining why their performance was marginal, and they may be dismissed from the graduate program if they do not show improvement within one term. Areas of weakness will be outlined, as well as specific guidelines as to how they can demonstrate improvement. Proof of timely continual academic progress will be required.

Prospectus

Ph.D. students must complete and submit their dissertation prospectus (also called thesis proposal) by June 1 of the third year as a graduate student. The guidelines are as follows:

1. The student should discuss with the mentor an appropriate topic and research plan for the thesis proposal, as well as discuss likely names of faculty to serve on the thesis committee. The thesis committee is required to have four members: the mentor and three other faculty, with at least one of those three faculty with a primary appointment in the Department of Neuroscience and one member with a primary appointment outside the Department of Neuroscience. Faculty outside of Yale can be included if they can attend on a regular basis. Non-Yale faculty are often best included as a fifth member, so that a meeting can officially be held in their absence if needed. One member of the thesis committee (not the mentor) is appointed chair.

2. The student should write a proposal of approximately seven (7) pages (following the format of an NIH/NRSA application). This should include (a) the hypothesis to be addressed (specific aims), (b) a few pages of background and significance, (c) preliminary data to demonstrate feasibility, and (d) a research plan including strategies in case proposed experiments fail. It is highly recommended that the thesis include a core of conservative experiments, i.e., very feasible, well-controlled studies. High-risk/high-payoff studies should only be included as “halo” research; i.e., if these fail, the student should still be able to graduate.

3. The mentor should approve the thesis proposal.

4. The student should distribute the proposal to the thesis committee members at least one week before the thesis committee meeting, and optimally discuss the proposal with each member individually prior to the meeting to ensure that there are no major problems.

5. The student meets with the thesis committee to approve the thesis proposal. It is at this time that the proposal is often modified, for instance by the suggestion of an additional control experiment. Goals should be realistic and in the interest of the student completing the degree in a timely manner. The finalized approved protocol is then provided to the Neuroscience business office, where the registrar will complete the paperwork for advancement to candidacy, obtain the DGS’s signature, and then send it to the Graduate School. As this must be completed before June 1, students should convene the thesis committee meetings prior to mid-May.

The student is required to meet with the thesis committee on at least a yearly basis to update progress and problems. A one-page summary of this meeting is written and signed by the chair of the thesis committee. The student is provided with written feedback. The registrar receives a copy of the report and files it in the student’s file.
Admission to Candidacy

Ph.D. students are required to have been admitted to candidacy by June 1 of the third year as a graduate student. Generally, the submission of the thesis prospectus is the final requirement for admission to candidacy. The paperwork for both is submitted to the Graduate School at the same time. Students who do not meet this standard may be required to petition the Graduate School for permission to register for the following term and can be placed on academic probation until these requirements have been met.

Other Requirements

All graduate students who are admitted to candidacy are required to have an annual thesis committee meeting; more frequent meetings are encouraged. All graduate students are required to give a student research presentation annually (a brief INP rotation talk early in the graduate career, followed by a longer Neuroscience Student Research Talk as the student’s research advances). All students are expected to attend rotation/student research talks.

Thesis Defense

There are several parts to the thesis defense: (1) The student gives the full thesis document to the thesis committee with sufficient time (approximately two weeks) for the committee to read and comment on this large document before the thesis defense. (2) The student defends the thesis in front of the thesis committee in a private setting. It is expected that small changes to the thesis document will be made before submission to the Graduate School. Major changes to the thesis may require additional meetings between the student and the thesis committee before a public defense can be scheduled. (3) The student gives the public defense no less than one month following the private (thesis committee) defense, following approval of the DGS. The public defense is a one-hour seminar summarizing the research and open to the community.

Vacation Policy

Students making satisfactory progress toward the completion of their Ph.D. degree will have two weeks of vacation in addition to the stated Yale University holidays and the break from Christmas Eve through New Year’s Day. Additional vacation time will require permission from the thesis adviser. Although classes are not held, Fall and Spring recesses are not considered Yale University holidays. Proposed exceptions must be discussed with the DGS.

SPECIAL REQUIREMENTS FOR THE M.D./PH.D.

Requirements for M.D./Ph.D. students are the same as for Ph.D. students with the following differences: three courses are required (Principles of Neuroscience [NBIO 701], Structural and Functional Organization of the Human Nervous System [NBIO 500], and one elective graduate-level course). M.D./Ph.D. students are required to serve for one term as teaching assistants; however, two terms of teaching are preferred.

MASTER’S DEGREES

M.Phil. See Degree Requirements under Policies and Regulations. Awarded only to students who are continuing for the Ph.D. degree. Students are not admitted for this degree.

M.S. Awarded only to students who are not continuing for the Ph.D. Students must have successfully completed our equivalent of 30 credit hours in the doctoral program. This includes a passing grade in the four required courses plus two elective courses, a minimum of two Honors grades, and successful completion of both terms of Lab Rotation for First-Year Students (NBIO 511, NBIO 512) and both terms of Second-Year Thesis Research (NBIO 513, NBIO 514). Students are not admitted for this degree.

Program materials are available upon request to the Director of Graduate Studies, Department of Neuroscience, Yale University, PO Box 208001, New Haven CT 06520-8001.

COURSES

NBIO 511a and NBIO 512b / INP 511a and INP 512b, Lab Rotation for First-Year Students  Charles Greer
Required of all first-year Neuroscience track graduate students. Rotation period is one term. Both terms required. Grading is Satisfactory/Unsatisfactory.

NBIO 514b / INP 514b, Second-Year Thesis Research  Charles Greer
Required of all second-year Department of Neuroscience graduate students. Both terms required. Grading is Satisfactory/Unsatisfactory.

NBIO 570b / C&MP 570b, Sensory Physiology  David Zenisek
The course provides an overview of the mammalian special sensory systems, including molecular and cellular bases of vision, audition, taste, olfaction, and somatosensation. Faculty with focus in those areas lead presentations and discussions on peripheral and central mechanisms. Psychophysical aspects of sensation are introduced.

NBIO 580b / INP 580b, Bioethics in Neuroscience  Charles Greer
This course is an introduction to ethics and ethical decision making in the neurosciences. Format for the course is an informal discussion. Each week we are joined by members of the Yale faculty and community who can share their experiences and expertise as it relates to
the topic of the week. This course is mandatory for first-year graduate students in the Interdepartmental Neuroscience Program (INP). Grading is Satisfactory/Unsatisfactory and is based on attendance/participation, weekly reaction papers, and a final term paper. The successful (Satisfactory) completion of this course is worth one full graduate course credit.

**NBIO 701a / INP 701a, Principles of Neuroscience**  Angeliki Louvi, Ralph DiLeone, and Ivan de Araujo
General neuroscience seminar: lectures, readings, and discussion of selected topics in neuroscience. Emphasis is on how approaches at the molecular, cellular, physiological, and organismal levels can lead to understanding of neuronal and brain function.

**NBIO 720a / INP 720a / MCDB 720a, Neurobiology**  Haig Keshishian and Paul Forscher
Examination of the excitability of the nerve cell membrane as a starting point for the study of molecular, cellular, and intracellular mechanisms underlying the generation and control of behavior.