INTERDEPARTMENTAL NEUROSCIENCE PROGRAM

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

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Associate Professors  Nii Addy (Psychiatry; Cellular and Molecular Physiology), Meenakshi Alreja (Psychiatry; Neuroscience), Alan Anticevic (Psychiatry; Psychology), Sviatoslav Bagriantsiev (Cellular and Molecular Physiology), Abhishek Bhattacharjee (Computer Science), Thomas Biederer (Neurology; Neuroscience), William Cafferty (Neurology; Neuroscience), Jessica Cardin (Neuroscience), Sreeganga Chandra (Neurology; Neuroscience), Steve Chang (Psychology; Neuroscience), Damon Clark (Molecular, Cellular, and Developmental Biology; Physics), Philip Corlett (Psychiatry; Psychology), Marcelo de Oliveira Dietrich (Comparative Medicine; Neuroscience, George Dragoi (Psychiatry; Neuroscience), Tore Eid (Laboratory Medicine; Neurosurgery), Irina Esterlis (Psychiatry; Psychology), Sourav Ghosh (Neurology; Pharmacology), Elena Gracheva (Cellular and Molecular Physiology; Neuroscience), Marc Hammarlund (Genetics; Neuroscience), Michelle Hampson (Radiology and Biomedical Imaging; Psychiatry; Child Study Center), Michael Higley (Neuroscience), Avram Holmes (Psychology), Erdem Karatekin (Cellular and Molecular Physiology; Molecular Biophysics and Biochemistry), In-Jung Kim (Ophthalmology and Visual Science; Neuroscience), Hedy Kober (Psychiatry; Psychology), Smita Krishnaswamy (Genetics; Computer Science), Ifat Levy (Comparative Medicine; Psychology; Neuroscience), Janghoo Lim (Genetics; Neuroscience), Angeliki Louvi (Neurosurgery; Neuroscience), John Murray (Psychiatry; Neuroscience; Physics), Dhaskumar Navaratnam (Neurology; Neuroscience), Timothy Newhouse (Chemistry), In-Hyun Park (Genetics), Maria Piñango (Linguistics), Helena Rutherford (Child Study Center; Psychology), Dustin Scheinost (Radiology and Biomedical Imaging; Child Study Center; Statistics and Data Science), Justus Verhagen (Neuroscience), Weimin Zhong (Molecular, Cellular, and Developmental Biology), Jiangbing Zhou (Neurosurgery; Biomedical Engineering)

Assistant Professors  Moitrayee Bhattacharyya (Pharmacology), Joel Butterwick (Pharmacology), Rui Chang (Cellular and Molecular Physiology; Neuroscience), Alicia Che (Psychiatry), Youngsun Cho (Psychiatry; Child Study Center), Eyiyemisi Damisah (Neurosurgery; Neuroscience), Carolyn Fredericks (Neurology), Dylan Gee (Psychology), Jason Gerrard (Neurosurgery; Neuroscience), Matthew Girgenti (Psychiatry), Elizabeth Goldfarb (Psychiatry; Psychology), Pallavi Gopal (Pathology), Junjie Guo (Neuroscience), Abha Gupta (Pediatrics; Neuroscience), Brian Hafler (Ophthalmology and Visual Science; Pathology), Ellen Hoffman (Child Study Center; Neuroscience), Monika Jadi (Psychiatry; Neuroscience), James Jeanne (Neuroscience), Al Kaye (Psychiatry), Liang Liang (Neuroscience), Samuel McDougle (Psychology), Anirvan Nandy (Neuroscience), Michael O’Donnell (Molecular, Cellular, and Developmental Biology), Candie Paulsen
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FIELDS OF STUDY

The Interdepartmental Neuroscience Program (INP) offers flexible but structured interdisciplinary training for independent research and teaching in neuroscience. The goal of the program is to ensure that degree candidates obtain a solid understanding of cellular and molecular neurobiology, physiology and biophysics, neural development, systems and behavior, and neural computation. In addition to course work, graduate students participate in an annual research-in-progress talk and a regular journal club, organize the Interdepartmental Neuroscience Program Seminar Series, and attend other seminar programs, named lectureships, symposia, and an annual research retreat.

To enter the Interdepartmental Neuroscience Ph.D. program, students apply to the Neuroscience track within the interdepartmental graduate program in Biological and Biomedical Sciences (BBS), https://medicine.yale.edu/bbs.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE

Each entering student is assigned a faculty advisory committee to provide guidance. This committee is responsible for establishing the student’s course of study and for monitoring the student’s progress. This committee will be subsequently modified to include faculty with expertise in the student’s emerging area of interest. Although each student’s precise course requirements are set individually to take account of background and educational goals, the course of study is based on a model curriculum beginning with five core required courses: Bioethics in Neuroscience (INP 580), Principles of Neuroscience (INP 701), Foundations of Cellular and Molecular Neurobiology (INP 702), Foundations of Systems Neuroscience (INP 703), and Comparative Neuroanatomy (INP 704), all completed in the first year of enrollment. During the second or third year of enrollment, students are required to take an advanced course on quantitative techniques. Collectively, these courses are designed to ensure broad competence in modern neuroscience. Students are also required to complete at two additional elective courses from a broad set of neuroscience-related courses. The Graduate School uses grades of Honors, High Pass, Pass, and Fail and requires two term grades of Honors during the first two years of study. Students are expected to maintain at least a High Pass average. Additional degree requirements are successful completion of both terms of Lab Rotation for First-Year Students (INP 511, INP 512); both terms of Second-Year Thesis Research (INP 513, INP 514); and RCR Refresher for Senior BBS Students (B&BS 503), completed during the fourth year of enrollment. This will ensure that degree candidates obtain a solid background in systems, cellular, and molecular approaches to neuroscience. Admission to candidacy requires passing a qualifying examination normally given during the second year, and submission of a dissertation prospectus (NIH NRSA grant format) before the end of the third year. In accordance with the expectations of the BBS program, Ph.D. students are expected to participate in two terms (or the equivalent) of teaching. Thesis committee meetings are required at six-month intervals. Also required is the completion and satisfactory defense of the thesis.
Requirements for M.D./Ph.D. students are the same as for Ph.D. students with the following differences: two laboratory rotations are completed while in the medical school prior to degree-program affiliation; three courses are required (Principles of Neuroscience, INP 701; Structural and Functional Organization of the Human Nervous System, INP 510; and one elective graduate-level course). Both terms of Second-Year Thesis Research (INP 513, INP 514) are required. 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.

**M.S.** Awarded only to students who are not continuing for the Ph.D. degree and have successfully completed the equivalent of 30 credit hours in the doctoral program. This includes a passing grade in the five 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 (INP 511, INP 512) and both terms of Second-Year Thesis Research (INP 513, INP 514). Students are not admitted for this degree. Students who are eligible for or who have already received the M.Phil. will not be awarded the M.S.

Program information is available at http://medicine.yale.edu/inp.

**COURSES**

**INP 512a, Lab Rotation for First-Year Students** Charles Greer
Required of all first-year Neuroscience track graduate students. Rotation period is one term. Grading is Satisfactory/Unsatisfactory.

**INP 514a, Second-Year Thesis Research** Charles Greer
Required of all second-year INP graduate students. Grading is Satisfactory/Unsatisfactory.

**INP 562b / AMTH 765b / CB&B 562b / ENAS 561b / MB&B 562b / MCDB 562b / PHYS 562b, Modeling Biological Systems II** Joe Howard
This course covers advanced topics in computational biology. How do cells compute, how do they count and tell time, how do they oscillate and generate spatial patterns? Topics include time-dependent dynamics in regulatory, signal-transduction, and neuronal networks; fluctuations, growth, and form; mechanics of cell shape and motion; spatially heterogeneous processes; diffusion. This year, the course spends roughly half its time on mechanical systems at the cellular and tissue level, and half on models of neurons and neural systems in computational neuroscience. Prerequisite: a 200-level biology course or permission of the instructor.

**INP 575a / CPSC 575a / ENAS 575a, Computational Vision and Biological Perception** Steven Zucker
An overview of computational vision with a biological emphasis. Suitable as an introduction to biological perception for computer science and engineering students, as well as an introduction to computational vision for mathematics, psychology, and physiology students.
INP 585b / ENAS 585b, Fundamentals of Neuroimaging  Fahmeed Hyder, Elizabeth Goldfarb, and Douglas Rothman
The neuroenergetic and neurochemical basis of several dominant neuroimaging methods, including fMRI. Topics range from technical aspects of different methods to interpretation of the neuroimaging results. Controversies and/or challenges for application of fMRI and related methods in medicine are identified.

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.