INTERDEPARTMENTAL NEUROSCIENCE PROGRAM

Sterling Hall of Medicine L-200, 203.785.5932
http://medicine.yale.edu/inp
M.S., M.Phil., Ph.D.

Directors of Graduate Studies
Haig Keshishian (Molecular, Cellular & Developmental Biology)
(KBT 640, 203.432.3478, haig.keshishian@yale.edu)
Charles Greer (Neuroscience; Psychology)
(FMB 412, 203.785.4034, charles.greer@yale.edu)

Professors Amy Arnsten (Neuroscience; Psychology), Anton Bennett (Pharmacology; Comparative Medicine), Hal Blumenfeld (Neurology; Neuroscience; Neurosurgery), Angélique Bordey (Neurosurgery; Cellular & Molecular Physiology), Tyrone Cannon (Psychology; Psychiatry), John Carlson (Molecular, Cellular & Developmental Biology), B.J. Casey (Psychology), Marvin Chun (Psychology; Neuroscience), Lawrence Cohen (Cellular & Molecular Physiology), R. Todd Constable (Radiology & Biomedical Imaging; Neurosurgery), Michael Crair (Neuroscience; Ophthalmology & Visual Science), Pietro De Camilli (Cell Biology; Neuroscience), Nihal DeLanerolle (Neurosurgery; Neuroscience), Sabrina Diao (Obstetrics, Gynecology & Reproductive Sciences; Comparative Medicine; Neuroscience), Ralph DiLeone (Psychiatry; Neuroscience), Ronald Duman (Psychiatry; Neuroscience), Barbara Ehrlich (Pharmacology; Cellular & Molecular Physiology), Paul Forscher (Molecular, Cellular & Developmental Biology), Charles Greer (Neuroscience; Neurosurgery), Murat Gunel (Neuroscience; Genetics; Neuroscience), David Hafler (Neurology; Immunobiology), Jöy Hirsch (Psychiatry; Comparative Medicine; Neuroscience), Tamas Horvath (Comparative Medicine; Neuroscience; Obstetrics, Gynecology & Reproductive Sciences), Arthur Horwich (Genetics; Pediatrics), Jonathon Howard (Molecular Biophysics & Biochemistry; Physics), James Howe (Pharmacology), D.S. Fahmeed Hyder (Radiology & Biomedical Imaging; Biomedical Engineering), Elizabeth Jonas (Internal Medicine; Neuroscience), Leonard Kaczmarek (Pharmacology; Cellular & Molecular Physiology), Haig Keshishian (Molecular, Cellular & Developmental Biology), Jeffery Kocsis (Neurology; Neuroscience), Anthony Koleske (Molecular Biophysics & Biochemistry; Neuroscience), John Krystal (Psychiatry; Neuroscience), Robert LaMotte (Anesthesiology; Neuroscience), Daeyeol Lee (Neuroscience; Psychology), Paul Lombroso (Child Study Center; Neuroscience; Psychiatry), Laura Manuelidis (Neurobiology), Gregory McCarthy (Psychology), Mark Mooseker (Molecular, Cellular & Developmental Biology; Cell Biology), Evan Morris (Radiology & Biomedical Imaging; Biomedical Engineering; Psychiatry), Angus Nairn (Psychiatry; Pharmacology), Michael Nitabach (Cellular & Molecular Physiology; Genetics), Marina Picciotto (Psychiatry; Pharmacology; Neuroscience), Vincent Pieribone (Cellular & Molecular Physiology; Neuroscience), Marc Potenza (Psychiatry; Child Study Center; Neuroscience), Pasko Rakic (Neuroscience; Psychology), Robert Roth, Jr. (Psychiatry), Gary Rudnick (Pharmacology), W. Mark Saltzman (Biomedical Engineering; Cellular & Molecular Physiology; Chemical & Environmental Engineering), Laurie Santos (Psychology), Joseph Santos-Sacchi (Surgery; Cellular & Molecular Physiology; Neuroscience), Nenad Sestan (Neuroscience; Comparative Medicine; Genetics; Psychiatry), Gordon Shepherd (Neuroscience), Fred Sigworth (Cellular & Molecular Physiology; Biomedical Engineering), Dana Small (Psychiatry; Psychology [Assoc. Prof.]), Stephen Strittmatter (Neurology; Neuroscience), Jane Taylor (Psychiatry; Psychology), Susumu Tomita (Cellular & Molecular Physiology; Neuroscience), Nicholas Turk-Browne (Psychology), Flora Vaccarino (Child Study Center; Neuroscience), Christopher van Dyck (Psychiatry; Neuroscience; Neurology), Stephen Waxman (Neurology; Pharmacology; Neuroscience), Robert Wyman (Molecular, Cellular & Developmental Biology), Tian Xu (Genetics), David Zenisek (Cellular & Molecular Physiology; Ophthalmology & Visual Science), Z. Jimmy Zhou (Ophthalmology & Visual Science; Cellular & Molecular Physiology; Neuroscience), Steven Zucker (Computer Science; Biomedical Engineering)

Associate Professors Mecnakshi Alreja (Psychiatry; Neuroscience), Charles Bruce (Neuroscience), William Cafferty (Neurology), Sreeganga Chandra (Neurology; Neuroscience; Molecular, Cellular & Developmental Biology), Daniel Colon-Ramos (Cell Biology; Neuroscience), Kelly Cosgrove (Psychiatry; Radiology & Biomedical Imaging; Neuroscience), Ivan De Araujo (Psychiatry; Cellular & Molecular Physiology), Jonathan Demb (Ophthalmology & Visual Science; Cellular & Molecular Physiology), Tore Eide (Laboratory Medicine; Neurosurgery), Thierry Emonet (Molecular, Cellular & Developmental Biology; Physics), Jaime Gruizendler (Neurology; Neuroscience), Marc Hammarlund (Genetics; Neuroscience), Michael Higley (Neuroscience), In-Jung Kim (Ophthalmology & Visual Science; Neuroscience), Michael Koelle (Molecular Biophysics & Biochemistry), Ilat Levy (Comparative Medicine; Neuroscience), Chiang-shan Ray Li (Psychiatry; Neuroscience), Janghoo Lim (Genetics; Neuroscience), Angeliki Louvi (Neurosurgery; Neuroscience), Dhasakumar Navaratnam (Neurology; Neuroscience), Kevin O’Connor (Neurology), Maria Piñango (Linguistics), Christopher Pittenger (Psychiatry; Child Study Center; Psychology), Michael Schwartz (Neuroscience), Justus Verhagen (Neuroscience), Weimin Zhong (Molecular, Cellular & Developmental Biology)

Assistant Professors Nii Addy (Psychiatry; Cellular & Molecular Physiology), Alan Anticevic (Psychiatry; Psychology), Sviatoslav Bagriantsev (Cellular & Molecular Physiology), Jessica Cardin (Neuroscience), Steve Chang (Psychology; Neuroscience), Damon Clark (Molecular, Cellular & Developmental Biology; Physics), Philip Corlett (Psychiatry), Marcelo de Oliveira Dietrich (Comparative Medicine; Neuroscience), George Dragoi (Psychiatry; Neuroscience), Dylan Gee (Psychology), Jason Gerrard (Neurosurgery; Neuroscience), Sourav Ghosh (Neurology), Elena Gracheva (Cellular & Molecular Physiology; Neuroscience), Avram Holmes (Psychology; Pediatrics; Cellular & Molecular Physiology), Erdem Karatekin (Cellular & Molecular Physiology; Molecular Biophysics & Biochemistry), Hedy Kobr (Psychiatry; Psychology), Alex Kwan (Psychiatry; Neuroscience), John Murray (Psychiatry), Timothy Newhouse (Chemistry), Satinder Singh (Cellular & Molecular Physiology), Jianguo Zhou (Neurosurgery; Biomedical Engineering)
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.

SPECIAL ADMISSIONS REQUIREMENTS
Applicants to the Interdepartmental Neuroscience Program should have a B.S. or B.A. Most applicants have had course work in neuroscience, psychobiology, physiological psychology, mathematics through calculus, general physics, general biology, general chemistry, organic chemistry, biochemistry, computer science, or engineering. Deficiencies in these areas can be corrected through appropriate course work in the first year of residence. Laboratory research experience is desirable but is not a formal requirement. Scores for the GRE (General Test required; Subject Test recommended) or MCAT, three letters of recommendation, transcripts of undergraduate grades, and a statement of interest must accompany the application.

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

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 (INP 701, Principles of Neuroscience; INP 720, Neurobiology; INP 580, Bioethics in Neuroscience; and INP 510, Structural and Functional Organization of the Human Nervous System, all completed in the first year of enrollment; and B&BS 503, RCR Refresher for Senior BBS Students, completed during the fourth year of enrollment). Collectively, these courses are designed to ensure broad competence in modern neuroscience. Students are also required to complete at least three 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) and both terms of Second-Year Thesis Research (INP 513, INP 514). 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 annually. 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: three courses are required (INP 701, INP 510, 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.

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 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 (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 511a and INP 511b / NBIO 511a and NBIO 511b, 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.

INP 513a and INP 513b, Second-Year Thesis Research  Charles Greer
Required of all second-year INP graduate students. Both terms required. Grading is Satisfactory/Unsatisfactory.

INP 519a, Tutorial  Staff
By arrangement with faculty and approval of DGS.
INP 558b / PSYC 558b, Computational Methods in Human Neuroscience  Nicholas Turk-Browne
This course provides training on how to use computational science for the advanced analysis of brain imaging data, primarily from functional magnetic resonance imaging (fMRI). Topics include scientific programming, high-performance computing, machine learning, network/graph analysis, real-time neurofeedback, nonparametric statistics, and functional alignment. Prerequisite: some prior experience with programming, data preprocessing, and basic fMRI analysis.

INP 562b / AMTH 765b / CB&B 562b / ENAS 561b / MB&B 562b / MCDB 562b / PHYS 562b, Dynamical Systems in Biology  Damon Clark, Thierry Emonet, and Jonathon 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: MCDB 561 or equivalent, or a 200-level biology course, or permission of the instructor.

INP 580b / NBIO 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. Enrollment limited to Neuroscience track students.

INP 701a / NBIO 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.

INP 720a / MCDB 720a / NBIO 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.