PHARMACOLOGY

Sterling Hall of Medicine B316, 203.785.7469
http://medicine.yale.edu/pharm
M.S., M.Phil., Ph.D.

Chair
Joseph Schlessinger

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Associate Professors
Titus Boggon, Kathryn Ferguson, Ya Ha, Benjamin Turk

Assistant Professors
Claudio Alarcón, Moitrayee Bhattacharyya, Joel Butterwick, Daryl Klein,
Sangwon Lee, Yansheng Liu, Wei Mi

FIELDS OF STUDY

Major emphases in the department are in the areas of molecular pharmacology,
mechanisms of drug action, signal transduction, structural biology,
neuroparmacology, and chemotherapy.

To enter the Ph.D. program, students should apply to an interest-based track within
the interdepartmental graduate program in Biological and Biomedical Sciences (BBS),
https://medicine.yale.edu/bbs. Most students interested in a Ph.D. in Pharmacology
apply through the Translational Molecular Medicine, Pharmacology, and Physiology
(TMMPP) track or the Biochemistry, Quantitative Biology, Biophysics, and Structural
Biology (BQBS) track.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE

Because the field of pharmacology encompasses many disciplines, the department’s
flexible program of study toward the Ph.D. degree permits students to concentrate
in areas of their particular interest. Students must take both terms of the graduate
seminar course (PHAR 501 and PHAR 502) or equivalents from another department.
The other courses will be selected based on each student’s interest but must include at
least one of the following courses: PHAR 504, PHAR 528, and PHAR 529. Students
are required to do three laboratory rotations. The Graduate School requires a grade of
Honors for a minimum of two courses. Honors for rotations cannot be used toward this
requirement. Students must meet the Honors requirement prior to being admitted to
candidacy. Students must pass a total of five courses and maintain an overall High Pass
average. A grade of Honors or High Pass is required for the core Pharmacology courses.
Student progress toward these goals is reviewed at the end of the second term.
Prior to registering for a second year of study, students must successfully complete PHAR 580, The Responsible Conduct of Research, or the equivalent from another department. In addition, B&B 503, RCR Refresher for Senior BBS Students, must be completed by the end of the fourth year.

Students are also required to pass the qualifying examination by the end of their fourth term. Before the end of the third year, a thesis prospectus must be submitted and accepted for admission to candidacy. A doctoral dissertation based upon original research includes an oral presentation given only to the pharmacology faculty (pre-defense). Within six months of passing the pre-defense, the student must submit a preliminary written thesis to the thesis committee and an outside reader. A public Ph.D. dissertation seminar will be scheduled, followed by a closed examination by the thesis committee and the outside examiner. Once the draft of the written thesis is approved by the thesis committee, it is submitted to the Graduate School. One first-author manuscript is required from the thesis research. The Pharmacology faculty recognizes that some thesis-related work takes a longer time and may not yield anticipated results. As long as the student has made significant progress in parallel experiments, the faculty can exempt a student from the one first-author paper requirement.

An important aspect of graduate training in pharmacology is the acquisition of teaching skills through the participation in courses related to the student’s scientific interests. These opportunities can be drawn from a diverse menu of lecture, laboratory, and seminar courses given at the undergraduate, graduate, and medical school levels. Ph.D. students are required to participate in two terms (or the equivalent) of teaching. Students are not expected to teach during their first year.

M.D./PH.D. STUDENTS

M.D./Ph.D. students must satisfy all of the above requirements for the Ph.D. with the following modifications: (1) only two of three laboratory rotations are required; (2) some medical school courses (except Pharmacology) can qualify as Graduate School courses as long as the M.D./Ph.D. student registers for them in OCS (Online Course Selection); and (3) only one term of teaching is required. Current Graduate School courses cannot be used to fulfill any medical school course requirements.

MASTER’S DEGREES

M.Phil. See Degree Requirements under Policies and Regulations.

M.S. (en route to the Ph.D.) Students are eligible for the M.S. degree upon successful completion of the first three terms of the Ph.D. program. This includes one year of lab rotations and course requirements.

Program materials are available upon request to the Director of Graduate Studies, Department of Pharmacology, Yale University, PO Box 208066, New Haven CT 06520-8066.

COURSES

PHAR 501a / C&MP 629a / PATH 679a, Seminar in Molecular Medicine, Pharmacology, and Physiology  Titus Boggon, Don Nguyen, and Susumu Tomita Readings and discussion on a diverse range of current topics in molecular medicine, pharmacology, and physiology. The class emphasizes analysis of primary research
literature and development of presentation and writing skills. Contemporary articles are assigned on a related topic every week, and a student leads discussions with input from faculty who are experts in the topic area. The overall goal is to cover a specific topic of medical relevance (e.g., cancer, neurodegeneration) from the perspective of three primary disciplines (i.e., physiology: normal function; pathology: abnormal function; and pharmacology: intervention). Required of and open only to Ph.D. and M.D./Ph.D. students in the Molecular Medicine, Pharmacology, and Physiology track.

**PHAR 504a / PTB 504a, Molecular Mechanisms of Drug Actions**  
Elias Lolis, Roy Herbst, Naftali Kaminski, Michael DiGiovanna, Ryan Jensen, Craig Crews, Ya Ha, Jose Gomez Villalobos, Elijah Paintsil, Wei Mi, Jason Cai, Yung-Chi Cheng, Karen Anderson, Dan Wu, and Demetrios Braddock

This course covers the molecular mechanisms of therapeutics, which are presented in a conceptual framework to increase understanding but decrease memorization. Topics include (but are not limited to) receptor affinity, efficacy, multiple equilibria, pharmacokinetics, and toxicity; enzyme kinetics and inhibition, drug discovery and design; molecular basis of antimicrobial therapy, cardiology drugs, anticancer and antiviral therapies; and therapeutics for inflammatory disorders, asthma, and allergy.

**PHAR 505a, Current Topics in Pharmacology**  
Sangwon Lee and Moitrayee Bhattacharyya

This weekly course is sponsored by the Pharmacology Department and involves discussing manuscripts authored by an individual scientist from outside institution invited to present a seminar at Yale. Since these individuals are established investigators focusing on their own research program, the students will read and discuss manuscripts on a wide range of current topics in Pharmacology. This seminar course is open to all students and postdocs, and will prepare the trainees for the upcoming presentation by the seminar speaker and the separate appointment for questions, discussion, and networking with the seminar speaker.

**PHAR 550a / C&MP 550a / ENAS 550a / MCDB 550a / PTB 550a, Physiological Systems**  
W. Mark Saltzman and Stuart Campbell

The course develops a foundation in human physiology by examining the homeostasis of vital parameters within the body, and the biophysical properties of cells, tissues, and organs. Basic concepts in cell and membrane physiology are synthesized through exploring the function of skeletal, smooth, and cardiac muscle. The physical basis of blood flow, mechanisms of vascular exchange, cardiac performance, and regulation of overall circulatory function are discussed. Respiratory physiology explores the mechanics of ventilation, gas diffusion, and acid-base balance. Renal physiology examines the formation and composition of urine and the regulation of electrolyte, fluid, and acid-base balance. Organs of the digestive system are discussed from the perspective of substrate metabolism and energy balance. Hormonal regulation is applied to metabolic control and to calcium, water, and electrolyte balance. The biology of nerve cells is addressed with emphasis on synaptic transmission and simple neuronal circuits within the central nervous system. The special senses are considered in the framework of sensory transduction. Weekly discussion sections provide a forum for in-depth exploration of topics. Graduate students evaluate research findings through literature review and weekly meetings with the instructor.