CELL BIOLOGY

Boyer Center Molecular Medicine (BCMM) 236E, 203.737.1257
http://cellbiology.yale.edu
M.S., M.Phil., Ph.D.

Chair
Gillian Griffiths

Director of Graduate Studies
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Professors Joerg Bewersdorf, Jonathan Bogan (*Internal Medicine/ Endocrinology*), Christopher Burd, David Calderwood (*Pharmacology*), Michael Caplan (*Cellular and Molecular Physiology*), Daniel Colón-Ramos, Lynn Cooley (*Genetics*), Peter Cresswell (*Immunobiology*), Pietro De Camilli, Jorge Galán (*Microbial Pathogenesis*), Fred Gorelick, Valentina Greco (*Genetics*), Gillian Griffiths, Carl Hashimoto (*Emeritus*), Diane Krause (*Laboratory Medicine*), Thomas Lentz (*Emeritus*), Haifan Lin, Jun Liu (*Microbial Pathogenesis*), Vivek Malhotra (*Adjunct*), Vincent Marchesi (*Pathology*), Thomas Melia, Mark Mooseker (*Molecular, Cellular, and Developmental Biology*), Michael Nathanson (*Internal Medicine/Digestive Diseases*), Karla Neugebauer (*Molecular Biophysics and Biochemistry*), Karin Reinisch, James Rothman, Christian Schlieker (*Molecular Biophysics and Biochemistry*), Martin Schwartz (*Internal Medicine/Cardiology*), Derek Toomre, Felix Weiland (*Adjunct*), Sandra Wolin (*Emerita*), Yongli Zhang

Associate Professors Julien Berro (*Molecular Biophysics and Biochemistry*), Shawn Ferguson, Shangqin Guo, Megan King, Chenxiang Lin, Patrick Lusk, Xiaolei Su, Peter Takizawa, Kirill Volynski (*Adjunct*), Julia von Blume, Siyuan Wang (*Genetics*), Min Wu, Shaul Yogev (*Neuroscience*)

Assistant Professors David Baddeley (*Adjunct*), Kallol Gupta

FIELDS OF STUDY

Fields include membrane traffic and protein sorting, organelle biogenesis, epithelial cell polarity, membrane function in the nervous system (synapse formation and function), neural circuit development, cell biology of protozoan parasites and of pathogen/host interactions, cell biology of the immune response, mRNA biogenesis and localization, RNA folding, non-coding RNAs, stem cells, the cytoskeleton, nuclear structure and dynamics, DNA nanostructures, cellular signaling and motility, cytokinesis. Approaches to these topics include biochemistry, biophysics, molecular biology, crystallography, and single-particle electron microscopy; bacterial, yeast, *Drosophila, C. elegans,* and mouse genetics; immunocytochemistry and electron microscopy and tomography; live cell and super-resolution imaging.

To enter the Ph.D. program, students apply to an interest-based track, usually the Molecular Cell Biology, Genetics, and Development (MCGD) track or the Biochemistry, Quantitative Biology, Biophysics, and Structural Biology (BQBS) track, within the interdepartmental graduate program in Biological and Biomedical Sciences (BBS), https://medicine.yale.edu/bbs.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE

Students are required to take at least five graduate-level courses. No specific curriculum of courses is required, but CBIO 6020 (Molecular Cell Biology) is recommended for all students to attain a solid foundation in molecular cell biology. Also recommended is a seminar course, such as CBIO 6030 (Seminar in Molecular Cell Biology), in which students can develop the skill for critical analysis of research papers. Students design their own curriculum of courses to meet individual interests and needs, in consultation with the director of graduate studies. During the first year, students participate in three laboratory rotations. In the second year, a committee of faculty members determines whether each student is qualified to continue in the Ph.D. program. There is an oral qualifying examination by the end of the third term. In order to be admitted to candidacy, students must have met the graduate school Honors requirement, maintained a High Pass average in course work, passed the qualifying examination, submitted an approved prospectus, and received a positive evaluation of their laboratory work from the thesis committee. All students are required to present a talk at the departmental progress report series each year after passing the qualifying exam. The remaining degree requirements include completion of the dissertation project, submission for publication of at least one first-author paper to a peer-reviewed journal describing the dissertation research, the writing of the dissertation and its oral defense, the formal submission of copies of the written dissertation to the graduate school, and the deposit of an additional copy with the department.

An important aspect of graduate training in cell biology 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 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.

In addition to all other requirements, students must successfully complete CBIO 9000 and CBIO 9010 (Research Skills and Ethics I and II) prior to the end of their first year of study. In their fourth year of study, all students must successfully complete B&BS 5502 (RCR Refresher for Senior BBS Students).

M.D.–PH.D.

M.D.-Ph.D. students are required to take a total of five graduate-level courses for a grade, including the CBIO 5501/CBIO 5502 sequence (Molecules to Systems), CBIO 6020 (Molecular Cell Biology), and a seminar course that involves the reading and class discussion of research papers. The remaining courses can be in areas such as genetics, neuroscience, immunology, microbiology, pharmacology, and physiology. Students must meet the graduate school requirement of a grade of Honors in two courses, if necessary taking additional courses beyond the five required in the department to fulfill this requirement. Students must also maintain an average grade of High Pass in all courses. One term of teaching is required.

MASTER'S DEGREES

M.Phil. Requirements for the M.Phil. degree are the same as for admission to candidacy (see above).

M.S. This degree is normally granted only to students who are withdrawing from the Ph.D. program. To be eligible for the degree, a student must have completed at least five graduate-level term courses at Yale, including CBIO 6020 (Molecular Cell Biology) and a seminar course, with a grade of Pass and at least one grade of Honors or three of High Pass. In addition to these five courses, the student must have received a Satisfactory grade in the following five courses: CBIO 9000 (Research Skills and Ethics I), CBIO 9010 (Research Skills and Ethics II), CBIO 9110 (First Laboratory Rotation), CBIO 9120 (Second Laboratory Rotation), and CBIO 9130 (Third Laboratory Rotation). Students who are eligible for or who have already received the M.Phil. will not be awarded the M.S.

Prospective applicants are encouraged to visit the BBS website (https://medicine.yale.edu/bbs), MCGD and BQBS tracks. Program materials are available upon request to the Director of Graduate Studies, Department of Cell Biology, Yale University, PO Box 208002, New Haven CT 06520-8002.

COURSES

*** CBIO 4200b / CGSC 4200b / NSCI 4400b / PSYC 4200b, Topics in Clinical Neuroscience** Tyrone Cannon

An overview and examination of the neuroscience of psychiatric illness. We focus on cutting-edge research in humans and animals aimed at understanding the biological mechanisms that underlie psychiatric illness. Although these questions date back to early philosophical texts, only recently have experimental psychologists and neuroscientists begun to explore this vast and exciting domain of study. We discuss the evolutionary and developmental origins of individual differences in human personality, measurement issues, fundamental dimensions of psychopathology, stability/plasticity, heritability, and implications therapeutic interventions as well as the associated broader implications for public policy. A major focus is on the neurobiology of fear and anxiety, including brain circuits, molecular genetic pathways, and epigenetics. A secondary focus is on differences in behavior and biology that confer risk for the development of depression and addiction, including the biological systems involved in hedonic pleasure, motivated goal pursuit, and the regulation of impulses in the face of everyday temptation. Students should have some background in psychology; PSYC 110 and PSYC 160 preferred. SO

CBIO 5501a and CBIO 5502b, Molecules to Systems Peter Takizawa

This full-year course (CBIO 501/CBIO 502) is designed to provide medical students with a current and comprehensive review of biologic structure and function at the cellular, tissue, and organ system levels. Areas covered include structure and organization of cells; regulation of the cell cycle and mitosis; protein biosynthesis and membrane targeting; cell motility and the cytoskeleton; signal transduction; cell adhesion; cell and tissue organization of organ systems. Clinical correlation sessions, which illustrate the contributions of cell biology to specific medical problems, are interspersed in the lecture schedule. Histophysiology laboratories provide practical experience with an understanding of exploring cell and tissue structure. The course is offered only to M.D. and M.D./Ph.D. students.

CBIO 6020a / MB&B 6020a / MCDB 6020a, Molecular Cell Biology Thomas Melia

A comprehensive introduction to the molecular and mechanistic aspects of cell biology for graduate students in all programs. Emphasizes fundamental issues of cellular

organization, regulation, biogenesis, and function at the molecular level. Graduate Prerequisites: Some knowledge of basic cell biology and biochemistry is assumed. Students who have not taken courses in these areas can prepare by reading relevant sections in basic molecular cell biology texts. We recommend Pollard et al., *Cell Biology* (4th ed., 2024), Alberts et al., *Molecular Biology of the Cell* (7th ed., 2022), or Lodish et al., *Molecular Cell Biology* (9th edition, 2021). Undergraduate Prerequisites: This is a graduate-level cell biology class. Any undergraduates wishing to enroll must have already taken MCDB 2050. In addition, undergraduates are strongly encouraged to reach out to the course directors prior to enrollment.

CBIO 6030a / MCDB 603a, Seminar in Molecular Cell Biology Min Wu
A graduate-level seminar in modern cell biology. The class is devoted to the reading and critical evaluation of classical and current papers. The topics are coordinated with the CBIO 6602 lecture schedule. Thus, concurrent enrollment in CBIO 6602 is required. Prerequisites: Any undergraduates wishing to enroll must have already taken MCDB 205. In addition, undergraduates are strongly encouraged to reach out to the course directors prior to enrollment.

CBIO 6600a and CBIO 6601b, Science at the Frontiers of Medicine Fred Gorelick
This full-year graduate seminar (CBIO 6600/CBIO 6601) for first-year M.D./Ph.D. students—an elective course for M.D. students—matches the progression of topics in the eighteen-month preclinical medical school curriculum and emphasizes the connections between basic and clinical science, human physiology, and disease. It is directed by M.D./Ph.D. program faculty, and many class discussions are led by expert Yale School of Medicine faculty members who select the papers to be read. Students explore scientific topics in depth, learn about cutting-edge research, and improve their presentation skills. The curriculum provides a framework for critically reading and analyzing papers drawn broadly from the biomedical sciences; this breadth of knowledge is also leveraged in team-based exercises that promote peer-to-peer teaching and learning. Enrollment limited to students who have taken or are currently taking CBIO 5501/CBIO 5502.

CBIO 6606b, Advanced Topics in Cell Biology Xiaolei Su
This seminar course, which meets once weekly, covers advanced topics in cell biology. Each topic is spread over two or three sessions, which start with an introductory overview and are followed by a discussion of key papers led by an expert in the field. This class is designed for MCGD students as a follow-up to CBIO 6020. Students who do not meet these pre-existing criteria should contact the course coordinator before enrolling. Graduate Prerequisite: CBIO 6020. Undergraduate Prerequisite: Undergraduates are to reach out to the course instructor prior to enrollment for approval. Priority is given to MCGD graduate students.

CBIO 7701b, Illuminating Cellular Function Derek Toomre
The focus of the course is on the technical treatment of light microscopy and its applications. The course provides biology and bioengineering students with the knowledge and skills necessary to design and undertake advanced light microscopy experiments. It covers conceptual elements of fluorescence microscopy imaging and analysis (without going too heavily into the theory and math); new advances in super-resolution modalities; biological applications; and hands-on practical work. Enrollment limited to fifteen.

CBIO 9000a / GENE 9000a / MCDB 9000a, Research Skills and Ethics I Andrew Xiao

This course consists of a weekly seminar that covers ethics, writing, and research methods in cellular and molecular biology as well as student presentations ("rotation talks") of work completed in the first and second laboratory rotations.

CBIO 9010b / GENE 9010b / MCDB 9010b, Research Skills and Ethics II Chenxiang Lin

This course consists of a weekly seminar that covers ethics, writing, and research methods in cellular and molecular biology as well as student presentations ("rotation talks") of work completed in the third laboratory rotation.

CBIO 9110a / GENE 9110a / MCDB 9110a, First Laboratory Rotation Andrew Xiao

First laboratory rotation for Molecular Cell Biology, Genetics, and Development (MCGD) and Plant Molecular Biology (PMB) track students.

CBIO 9120a / GENE 9120a / MCDB 9120a, Second Laboratory Rotation Andrew Xiao

Second laboratory rotation for Molecular Cell Biology, Genetics, and Development (MCGD) and Plant Molecular Biology (PMB) track students.

CBIO 9130b / GENE 9130b / MCDB 9130b / MCDB 913b and MCDB 9130b, Third Laboratory Rotation Andrew Xiao

Third laboratory rotation for Molecular Cell Biology, Genetics, and Development (MCGD) and Plant Molecular Biology (PMB) track students.