CELL BIOLOGY

Sterling Hall of Medicine C207, 203.737.5603
http://cellbiology.yale.edu
M.S., M.Phil., Ph.D.

Chair
James Rothman

Director of Graduate Studies
Karin Reinisch (SHM C214a, 203.785.6469, karin.reinisch@yale.edu)

Professors Christopher Burd, Michael Caplan (Cellular & Molecular Physiology), Lynn Cooley (Genetics), Peter Cresswell (Immunobiology), Pietro De Camilli, Jorge Galán (Microbial Pathogenesis), Fred Gorelick, Carl Hashimoto (Emeritus), James Jamieson, Diane Krause (Laboratory Medicine), Thomas Lentz (Emeritus), Haifan Lin, Vincent Marchesi (Pathology), Mark Mooseker (Molecular, Cellular & Developmental Biology), Michael Nathanson (Internal Medicine/Digestive Diseases), Karla Neugebauer (Molecular Biophysics & Biochemistry), Thomas Pollard (Molecular, Cellular & Developmental Biology), Karin Reinisch, James Rothman, Martin Schwartz (Internal Medicine/Cardiology), Felix Weiland (Adjunct), Sandra Wolin (Emerita)

Associate Professors Joerg Bewersdorf, Jonathan Bogan (Internal Medicine/Endocrinology), David Calderwood (Pharmacology), Daniel Colón-Ramos, Shawn Ferguson, Valentina Greco (Genetics), Megan King, Patrick Lusk, Thomas Melia, Christian Schlicker (Molecular Biophysics & Biochemistry), Derek Toomre, Yongli Zhang

Assistant Professors David Baddeley (Adjunct), Julien Berro, Shangqin Guo, Chenxiang Lin, Malayalam Mariappan, Xiaolei Su, Peter Takizawa, Siyuan Wang

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, and crystallography; bacterial, yeast, *Drosophila*, *C. elegans*, and mouse genetics; immunocytocchemistry and electron microscopy; live cell and super-resolution imaging.

SPECIAL ADMISSIONS REQUIREMENTS
An undergraduate major in the biological sciences is recommended. GRE General Test is required; GRE Subject Test is recommended (in Biology or in Biochemistry, Cell and Molecular Biology).

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), http://bbs.yale.edu.

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 602 (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 603 (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 and 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. Laboratory rotations and thesis research may be conducted outside of 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 901 (First-Year Introduction to Research—Ethics: Scientific Integrity in Biomedical Research) prior to the end of their first year of study. In their fourth year of study, all students must successfully complete B&BS 503 (RCR Refresher for Senior BBS Students).

**M.D./PH.D. STUDENTS**

M.D./Ph.D. students are required to take a total of five graduate-level courses for a grade, including the CBIO 500/CBIO 501/CBIO 502 sequence (Molecules to Systems; three terms, counts as one course), CBIO 602 (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 602 (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 900 (First-Year Introduction to Research—Grant Writing and Scientific Communication), CBIO 901 (First-Year Introduction to Research—Ethics: Scientific Integrity in Biomedical Research), CBIO 911 (First Laboratory Rotation), CBIO 912 (Second Laboratory Rotation), and CBIO 913 (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 (http://bbs.yale.edu), 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 501a and CBIO 502b, 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 relating cell and tissue structure. The course is offered only to M.D. and M.D./Ph.D. students.

**CBIO 600a and CBIO 601b, Frontiers in Medicine**  
Fred Gorelick, Karin Finberg, Jonathan Bogan, and George Lister

A full-year graduate credit course (CBIO 600/CBIO 601) for first-year M.D./Ph.D. students and an elective course for M.D. students, emphasizing the connections between basic and clinical science, human physiology, and disease. It parallels the content of Yale School of Medicine’s first-year courses and is designed for students who are considering a career in medical research or who choose to explore scientific topics in depth, learn about cutting-edge research, and improve their presentation skills. Discussions cover the challenges faced in research, selecting a topic, and pursuing an academic career. Select topics are presented by eminent faculty who serve as excellent role models for students’ academic careers. In most sessions, two students review relevant manuscripts under the guidance of a faculty mentor and present the material to the group. Prior to the start of class, students are required to submit questions concerning techniques and concepts that may not be clear from the assigned papers. These questions are then addressed during the presentation. Student evaluations are graded on attendance, participation in group discussions, and formal presentations. The organizational meeting/introduction is August 23 at 4:30 pm (most sessions are in Hope 203 at YSM). Enrollment limited to students who have taken or are currently taking CBIO 501/CBIO 502.

**CBIO 602a / MB&B 602a / MCDB 602a, Molecular Cell Biology**  
Charles Lusk, Michael Caplan, Nadya Dimitrova, Thomas Pollard, James Rothman, Valerie Horsley, Thomas Melia, Megan King, Martin Schwartz, Christopher Burd, Josephina van Wolfswinkel, and David Breslow

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. Prerequisites: none, but 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* (3rd ed., 2016), Alberts et al., *Molecular Biology of the Cell* (6th ed., 2014), or Lodish et al., *Molecular Cell Biology* (8th edition, 2016).

**CBIO 603a / MCDB 603a, Seminar in Molecular Cell Biology**  
Charles Lusk, Michael Caplan, Nadya Dimitrova, Thomas Pollard, James Rothman, Valerie Horsley, Thomas Melia, Megan King, Martin Schwartz, Christopher Burd, and David Breslow

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 602 lecture schedule. Thus, concurrent enrollment in CBIO 602 is required.
CBIO 604b, Systems Cell Biology  Agnes Vignery
Introduction to the organization and function of cells within complex multicellular systems as encountered in the human body. Covers major tissues and organs as well as the cardiovascular, immune, and nervous systems, with special emphasis on the molecular and cellular bases of developmental processes and human diseases. Lectures supplemented by electronic-based tutorials on the histology of tissues and organs.

CBIO 606b, Advanced Topics in Cell Biology  Shawn Ferguson and Christopher Burd
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.

CBIO 611b, Vascular Cell Biology  Martin Schwartz
This course introduces the structure and organ-level physiology of the vascular system, then covers in greater depth the development, regulation, mechanics, and pathology of blood vessels. The major focus is on cellular and molecular mechanisms. The course includes both lectures and reading and discussion of recent literature.

CBIO 655a / GENE 655a, Stem Cells: Biology and Application  In-Hyun Park
This course is designed for first-year or second-year students to learn the fundamentals of stem cell biology and to gain familiarity with current research in the field. The course is presented in a lecture and discussion format based on primary literature. Topics include stem cell concepts, methodologies for stem cell research, embryonic stem cells, adult stem cells, cloning and stem cell reprogramming, and clinical applications of stem cell research. Prerequisites: undergraduate-level cell biology, molecular biology, and genetics.

CBIO 701b, Illuminating Cellular Function  Derek Toomre and Joerg Bewersdorf
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 900a / GENE 900a / MCDB 900a, Research Skills and Ethics I  Valerie Horsley
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 901b / GENE 901b / MCDB 901b, Research Skills and Ethics II  Joerg Bewersdorf
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 911a / GENE 911a / MCDB 911a, First Laboratory Rotation  Valerie Horsley
First laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

CBIO 912a / GENE 912a / MCDB 912a, Second Laboratory Rotation  Valerie Horsley
Second laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

CBIO 913b / GENE 913b / MCDB 913b, Third Laboratory Rotation  Valerie Horsley
Third laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.