M. S., M. Phil., Ph. D.

**Director of Graduate Studies**
Walther Mothes

**Professors** Serap Aksoy (Epidemiology), Susan Baserga (Molecular Biophysics & Biochemistry; Genetics; Therapeutic Radiology), Choukri Ben Mamoun (Internal Medicine; Microbial Pathogenesis), Ronald Breaker (Molecular, Cellular, & Developmental Biology; Molecular Biophysics & Biochemistry), Richard Bucala (Internal Medicine; Epidemiology; Pathology), Michael Cappello (Pediatrics; Epidemiology; Microbial Pathogenesis), Yung-Chi Cheng (Pharmacology), Peter Cresswell (Immunobiology; Cell Biology), Daniel DiMaio (Genetics; Molecular Biophysics & Biochemistry; Therapeutic Radiology), Erol Fikrig (Internal Medicine; Epidemiology; Microbial Pathogenesis), Richard Flavell (Immunobiology), Jorge Galán (Microbial Pathogenesis; Cell Biology), Andrew Goodman (Microbial Pathogenesis), Eduardo Groisman (Microbial Pathogenesis), Akiko Iwasaki (Immunobiology; Molecular, Cellular, & Developmental Biology), Barbara Kazmierczak (Internal Medicine; Microbial Pathogenesis), Albert Ko (Epidemiology; Internal Medicine), Jun Liu (Microbial Pathogenesis), Ruslan Medzhitov (Immunobiology), I. George Miller (Pediatrics; Epidemiology; Molecular Biophysics & Biochemistry), Walther Mothes (Microbial Pathogenesis), Melinda Pettigrew (Epidemiology), Carla Rothlin (Immunobiology; Pharmacology), Craig Roy (Microbial Pathogenesis; Immunobiology), Dieter Söll (Molecular Biophysics & Biochemistry; Chemistry), Richard Sutton (Internal Medicine; Microbial Pathogenesis), Jeffrey Townsend (Biotatistics; Ecology & Evolutionary Biology), Christian Tschudi (Epidemiology), Paul Turner (Ecology & Evolutionary Biology), Yong Xiong (Molecular Biophysics & Biochemistry)

**Associate Professors** Murat Acar (Molecular, Cellular, & Developmental Biology; Physics), Jason Crawford (Chemistry; Microbial Pathogenesis), Charles Dela Cruz (Internal Medicine; Microbial Pathogenesis), Nathan Grubaugh (Microbial Diseases), Ya-Chi Ho (Microbial Pathogenesis; Internal Medicine/Infectious Diseases), Farren Isaacs (Molecular, Cellular, & Developmental Biology), Priti Kumar (Internal Medicine/Infectious Diseases), Brett Lindenbach (Microbial Pathogenesis), John MacMicking (Microbial Pathogenesis; Immunobiology), Kathryn Miller-Jensen (Biomedical Engineering; Molecular, Cellular, & Developmental Biology), Noah Palm (Immunobiology), Christian Schlieker (Molecular Biophysics & Biochemistry; Cell Biology)

**Assistant Professors** Amy Bei (Epidemiology of Microbial Diseases), Ellen F. Foxman (Laboratory Medicine; Immunobiology), Stavroula Hatzios (Molecular, Cellular, & Developmental Biology), E. Hesper Rego (Microbial Pathogenesis), Craig B. Wilen (Laboratory Medicine; Immunobiology), Jing Yan (Molecular, Cellular, & Developmental Biology)

**FIELDS OF STUDY**
The Graduate Program in Microbiology is a multidepartmental, interdisciplinary Ph.D. program in training and research in the study of microorganisms and their effects on
their hosts. The faculty of the program share the view that understanding the biology of microorganisms requires a multidisciplinary approach; therefore, the Microbiology graduate program emphasizes the need for strong multidisciplinary training. The program is designed to provide individualized education in modern microbiology and to prepare students for independent careers in research and teaching. Students can specialize in various areas, including bacteriology, virology, microbe-host interactions, microbial pathogenesis, cell biology and immunobiology of microbial infections, microbial genetics and physiology, structural biology, parasitology, microbiome, and microbial ecology and evolution.

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

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE

Course work generally occupies the first two years of study. Each student, together with a faculty committee, outlines a course of study tailored to the individual’s background and career goals. A program of course work may include general microbiology, virology, parasitology, and/or microbial genetics, as well as complementary courses in such areas as epidemiology, cell biology, immunology, biochemistry, and genetics. Students must take a minimum of four courses, three of which have to be in microbiology. Students must receive a grade of Honors in two full-term courses. All students participate in three laboratory rotations (MBIO 670, MBIO 671, and MBIO 672), with different faculty members, in their area of interest. Laboratory rotations ensure that students quickly become familiar with the variety of research opportunities available in the program. A qualifying proposal, defended in an exam on the student’s thesis project, is given before the end of the second year. Students then undertake an original research project under the direct supervision of a faculty member. In the third year, students organize their thesis committee and prepare a dissertation prospectus, which is submitted to the Graduate School after approval by their committee. The student is then admitted to candidacy. Upon completion of the student’s research project, the Ph.D. requirements conclude with the writing of a dissertation and its oral defense.

An important aspect of graduate training in microbiology 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 expected to participate in two terms (or the equivalent) of teaching. Students are not permitted to teach during their first year.

In addition to all other requirements, students must successfully complete IBIO 601, Fundamentals of Research: Responsible Conduct of Research, prior to the end of their first year of study. This requirement must be met prior to registering for a second year of study. In their fourth year of study, all students must successfully complete B&BBS 503, RCR Refresher for Senior BBS Students.

MASTER’S DEGREES

M.Phil. The M.Phil. degree can be awarded to Ph.D. students who have been admitted to candidacy. See Degree Requirements under Policies and Regulations.
COURSES

**MBIO 530a / IBIO 530a / MCDB 530a, Biology of the Immune System**  Nikhil Joshi, Ann Haberman, Carla Rothlin, Kevin O’Connor, Carrie Lucas, Ellen Foxman, Craig Wilen, Grace Chen, Jeffrey Ishizuka, Markus Müschen, Daniel Jane-Wit, Andrew Wang, David Schatz, Peter Cresswell, Jordan Pober, Joao Pereira, Craig Roy, Joseph Craft, Paula Kavathas, Aaron Ring, and Noah Palm

The development of the immune system. Cellular and molecular mechanisms of immune recognition. Effector responses against pathogens. Immunologic memory and vaccines. Human diseases including allergy, autoimmunity, cancer, immunodeficiency, HIV/AIDS.

**MBIO 670a and MBIO 671a or b and MBIO 672b and MBIO 674b, Laboratory Rotations**  Staff

Rotation in three laboratories. Required of all first-year graduate students.

**MBIO 685b, The Biology of Bacterial Pathogens II**  Hesper Rego

This interdisciplinary course focuses on current topics related to host-pathogen interactions. Each week a lecture is given on the topic, followed by student presentations of seminal papers in the field. All participants are required to present a paper.

**MBIO 686a, The Biology of Bacterial Pathogens I**  Eduardo Groisman

The course provides an introduction to basic principles in bacterial pathogenesis. Topics focus on the bacterial determinants mediating infection and pathogenesis, as well as strategies to prevent and treat diseases. Each week a lecture is given on the topic, followed by student presentations of seminal papers in the field. All participants are required to present a paper.

**MBIO 700b, Seminal Papers on the Foundations of Modern Microbiology**  Priti Kumar

A required course for Microbiology first-year students; not for credit. The course is offered every spring. Students present and discuss papers describing fundamental discoveries in areas related to microbiology. The goal is to familiarize students with the process of scientific discovery and with the history of major developments in the field. Topics include important discoveries involving major human pathogens, fundamental processes in molecular biology, and the development of technology that has a major impact on current biomedical research.
MBIO 701a and MBIO 702b, Research in Progress  Walther Mothes
All students, beginning in their third year, are required to present their research once a year at the Graduate Student Research in Progress. These presentations are intended to give each student practice in presenting the student’s own work before a sympathetic but critical audience and to familiarize the faculty with the research.

MBIO 703a and MBIO 704b, Microbiology Seminar Series  Walther Mothes
All students are required to attend all Microbiology seminars scheduled throughout the academic year. Microbiologists from around the world are invited to describe their research.

MBIO 734b / GENE 734b / MB&B 734b, Molecular Biology of Animal Viruses  Brett Lindenbach
Lecture course with emphasis on mechanisms of viral replication, oncogenic transformation, and virus-host cell interactions.