

## MICROBIOLOGY GRADUATE PROGRAM

### Doctoral Program in Microbial Science and Engineering

The Microbiology Graduate Program (<http://microbiology.mit.edu>)—an interdepartmental and interdisciplinary initiative at MIT—integrates educational resources across the participating departments to build connections among faculty with shared interests and to build an educational community for training students in the study of microbial systems.

The study of microbes has been critical in our current understanding of basic biological processes, evolution, and the functions of the biosphere, and has contributed to numerous fields of engineering. Microbes have the amazing ability to grow in extreme conditions, to grow slowly or rapidly, and to readily exchange DNA. They are essential for life as we know it, but can also be agents of disease. They are instrumental in shaping the environment, in evolution, and in modern biotechnology. Microbes are amenable to virtually all modern approaches in science and engineering. As such, they provide natural engineering laboratories for creating new capabilities for industry (e.g., pharmaceuticals, chemicals, energy) and are the foundation of pioneering efforts in synthetic biology, i.e., building life from its component parts. Effective study of microbes and their applications demands multiple interdisciplinary approaches that cross all scales of biological organization, from molecules to vast ecosystems.

Research in microbiology takes place throughout MIT and involves more than 50 faculty. These faculty are from several departments in both the Schools of Science and Engineering, including Biology; Biological Engineering; Chemical Engineering; Chemistry; Civil and Environmental Engineering; Earth, Atmospheric and Planetary Sciences; Electrical Engineering and Computer Science; Materials Sciences and Engineering; and Physics. Many labs take multiple approaches to studying and manipulating microbial systems and the expertise and research covers a wide range of areas, including biochemistry, biofuels, biotechnology, cell and molecular biology, chemical and biological engineering, computational biology, ecology, environmental biology, evolutionary biology, genetics, genomics, geobiology, immunology, pathogenesis, structural biology, synthetic biology, systems biology, and virology.

Interdisciplinary training in microbiology is in increasing demand in both public and private sectors. This program provides a broad exposure to underlying elements of modern microbiological research and engineering as well as in-depth research experience in specific areas of microbiology. Program graduates will be prepared to work in a range of fields in microbial science and engineering, and will have excellent career options in academia, industry, and government.

### Curriculum

The major components of the training program are required coursework, elective coursework, rotations and thesis research, teaching, training in the ethical conduct of research, and qualifying exams.

#### Required Subjects

7.492[[]]	Methods and Problems in Microbiology	12
7.493[[]]	Microbial Genetics and Evolution	12
7.499	Research Rotations in Microbiology	
7.571 & 7.572	Quantitative Analysis of Biological Data and Quantitative Measurements and Modeling of Biological Systems	12
7.51 or 7.80	Principles of Biochemical Analysis Fundamentals of Chemical Biology	12

#### Elective Subjects

Students must take three elective subjects, totaling 36 units, from the following list. Electives can be chosen to provide depth in a specific area of interest or additional breadth in training. Subjects from some other areas may also fulfill the requirement, with the approval of the Graduate Education committee.

1.89	Environmental Microbial Biogeochemistry	12
5.062	Principles of Bioinorganic Chemistry	6
5.52	Tutorial in Chemical Biology	12
5.64[[]]	Advances in Interdisciplinary Science in Human Health and Disease	12
5.78	Biophysical Chemistry Techniques	6
6.8710[[]]	Computational Systems Biology: Deep Learning in the Life Sciences	12
7.58	Molecular Biology	12
7.62	Microbial Physiology	12
7.63[[]]	Immunology	12
7.66	Molecular Basis of Infectious Disease	12
7.70	Regulation of Gene Expression	12
7.77	Nucleic Acids, Structure, Function, Evolution, and Their Interactions with Proteins	12
8.591[[]]	Systems Biology	12
10.542	Biochemical Engineering and Biomanufacturing Principles	9
10.544	Metabolic and Cell Engineering	12
10.546[[]]	Statistical Thermodynamics	12

20.420[[]]	Principles of Molecular Bioengineering	12
20.440	Analysis of Biological Networks	15
20.450	Applied Microbiology	12
20.490	Computational Systems Biology: Deep Learning in the Life Sciences	12
HST.508[[]]	Evolutionary and Quantitative Genomics	12

### **Rotations and Thesis Research**

During the first year, students will rotate through three labs of MIT faculty that participate in the Microbiology Graduate Program. These rotations will help provide students broad exposure to microbiology research and will be used to select a lab for their thesis research by the end of the first year. Given the interdisciplinary nature of the program and many research programs, students may be able to work jointly with more than one research supervisor.

### **Teaching Experience**

Learning to effectively communicate scientific ideas is an important skill. Students in the Microbiology program will have an opportunity to improve their communication skills through teaching. Each student will serve as a teaching assistant for one term in an undergraduate or graduate subject related to microbiology. This will typically take place in the second year.

### **Training in the Ethical Conduct of Research**

All students will participate in a course on the ethical conduct of research.

### **Qualifying Exams**

Students will proceed to PhD candidacy after successful completion of a qualifying exam, typically during the second year. Students will submit a written research proposal in the style of a grant or fellowship application based on their planned thesis project. Students will then present and discuss the research proposal with a small committee of faculty.

### **Student Advising**

In the first year, students will be advised by members of the graduate committee. Once students join a thesis lab, the research mentor will be the primary advisor. Early in the second year, students will form a thesis committee and meet at least annually. The committee will consist of faculty with expertise in the student's area of research and collectively provide the breadth expected by the program. The thesis committee will primarily provide advice on research. In addition, in students' early years the thesis committee will also provide advice on coursework to ensure that students have the appropriate breadth and depth for their educational program. In later years, the graduate and thesis committees will also provide students with advice on career options.

### **Financial Support and Fellowships**

Students in the program will be financially supported throughout their training. This support includes tuition, stipend or salary, and health insurance. All students in the program will receive a stipend or salary that is sufficient to support living in the Cambridge/Boston area. The stipend or salary will be approximately the same as for graduate students in other MIT departments.

During the first year, students are supported by the Microbiology program. In subsequent years, students will be supported as research assistants in their thesis lab.

Although students will be supported, they are strongly encouraged to apply for fellowships.

### **Inquiries**

For further information, email the Microbiology Graduate Program ([microbiology@mit.edu](mailto:microbiology@mit.edu)), Room 68-230A.