DEPARTMENT OF BIOLOGY

The Department of Biology (https://biology.mit.edu) offers undergraduate, graduate, and postdoctoral training in basic biology, and in a variety of biological fields of specialization. The quantitative aspects of biology, including molecular biology, biochemistry, genetics, and cell biology, represent the core of the program. Students in the department are encouraged to acquire a solid background in the physical sciences not only to master the applications of mathematics, physics, and chemistry to biology, but also to develop an integrated scientific perspective. The various programs, which emphasize practical experimentation, combine a minimum of formal laboratory exercises with ample opportunities for research work both in project-oriented laboratory subjects and in the department's research laboratories. Students at all levels are encouraged to acquire familiarity with advanced research techniques and to participate in seminar activities.

Undergraduate Study

Bachelor of Science in Biology (Course 7)
The curriculum leading to the Bachelor of Science in Biology (http://catalog.mit.edu/degree-charts/biology-course-7) is designed to prepare students for a professional career in the area of the biological sciences. Graduates of this program are well prepared for positions in industrial or research institutes. However, experience has shown that many graduates choose to continue their education at a graduate school in order to obtain a PhD in an area such as biochemistry, microbiology, genetics, biophysics, cell biology, or physiology, followed by research or teaching in one of those areas. The undergraduate curriculum is also excellent preparation for students who wish to continue their education toward an MD, particularly if their career plans include laboratory investigations bearing on human disease.

Bachelor of Science in Biology (Course 7-A)
Course 7-A (http://catalog.mit.edu/degree-charts/biology-course-7-a) is designed for students who wish to obtain a background in biology as preparation for careers without laboratory research. Course 7-A has the same core requirements as Course 7, but does not require a 30-unit laboratory subject within its Restricted Electives.

Students are encouraged to use their elective subjects for more advanced subjects in their field and for additional study in basic and advanced subjects offered in various departments.

Bachelor of Science in Chemistry and Biology (Course 5-7)
The Departments of Biology and Chemistry jointly offer a Bachelor of Science in Chemistry and Biology (http://catalog.mit.edu/degree-charts/chemistry-biology-course-5-7). A detailed description of the requirements for this degree program can be found in the section on Interdisciplinary Programs (http://catalog.mit.edu/interdisciplinary/undergraduate-programs/degrees/chemistry-biology).

Bachelor of Science in Computer Science and Molecular Biology (Course 6-7)
The Department of Biology jointly offers a Bachelor of Science in Computer Science and Molecular Biology (http://catalog.mit.edu/degree-charts/computer-science-molecular-biology-course-6-7) with the Department of Electrical Engineering and Computer Science. A detailed description of the requirements for this degree program can be found in the section on Interdisciplinary Programs (http://catalog.mit.edu/interdisciplinary/undergraduate-programs/degrees/computer-science-molecular-biology).

Minor in Biology
The department offers a Minor in Biology; the requirements are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.12</td>
<td>Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>7.03</td>
<td>Genetics</td>
<td>12</td>
</tr>
<tr>
<td>7.05</td>
<td>General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 5.07</td>
<td>Biological Chemistry I</td>
<td>12</td>
</tr>
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</table>

Select two of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.02</td>
<td>Introduction to Experimental Biology and Communication</td>
<td>8</td>
</tr>
<tr>
<td>or 20.109</td>
<td>Laboratory Fundamentals in Biological Engineering</td>
<td>8</td>
</tr>
<tr>
<td>7.06</td>
<td>Cell Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.08</td>
<td>Biological Chemistry II</td>
<td>12</td>
</tr>
<tr>
<td>7.09</td>
<td>Quantitative and Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.20</td>
<td>Human Physiology</td>
<td>12</td>
</tr>
<tr>
<td>7.21</td>
<td>Microbial Physiology</td>
<td>12</td>
</tr>
<tr>
<td>7.22</td>
<td>Developmental Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.23</td>
<td>Immunology</td>
<td>12</td>
</tr>
<tr>
<td>7.26</td>
<td>Molecular Basis of Infectious Disease</td>
<td>12</td>
</tr>
<tr>
<td>7.27</td>
<td>Principles of Human Disease</td>
<td>12</td>
</tr>
<tr>
<td>7.28</td>
<td>Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.29</td>
<td>Cellular and Molecular Neurobiology</td>
<td>12</td>
</tr>
<tr>
<td>7.31</td>
<td>Current Topics in Mammalian Biology: Medical Implications</td>
<td>12</td>
</tr>
<tr>
<td>7.32</td>
<td>Systems Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.33</td>
<td>Evolutionary Biology: Concepts, Models and Computation</td>
<td>12</td>
</tr>
<tr>
<td>7.37</td>
<td>Molecular and Engineering Aspects of Biotechnology</td>
<td>12</td>
</tr>
</tbody>
</table>

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or 7.371 Biological and Engineering Principles Underlying Novel Biotherapeutics
7.41 Principles of Chemical Biology
7.45 The Hallmarks of Cancer
7.49[J] Developmental Neurobiology

Total Units 60

For a general description of the minor program, see Undergraduate Education (http://catalog.mit.edu/mit/undergraduate-education/academic-programs/minors).

Inquiries
Additional information regarding undergraduate academic programs and research opportunities may be obtained from the Biology Education Office (undergradbio@mit.edu), Room 68-120, 617-253-4718.

Graduate Study
The Department of Biology offers graduate work leading to the Doctor of Philosophy. Students may choose from among the following fields of specialization.

Biochemistry, Biophysics, and Structural Biology focus on improving our understanding of molecular processes central to life. Using in vitro approaches, biochemists and biophysicists analyze the mechanisms of biological information transfer, from maintenance and replication of the genome to protein synthesis, sorting, and processing. Structural biologists elucidate the molecular shapes of biological macromolecules and complexes and determine how structure enables function. Applying principles and tools from chemistry and physics, biochemists and biophysicists elaborate the details of protein and nucleic acid folding and interactions, biomolecular dynamics, catalysis, and macromolecular assembly.

Cancer Biology involves the discovery of genes implicated in cancer, the identification of cell biological processes affected during tumorigenesis, and the development of potential new therapeutic targets. Cancer biologists employ genetic approaches, including classical genetics, to determine the components of growth control pathways in model organisms, cloning of human oncogenes and tumor suppressor genes, and generating mutant mouse strains to study these and other cancer-associated genes. They also perform biochemical and cell biological studies to elucidate the function of cancer genes, the details of proliferation, cell cycle and cell death pathways, the nature of cell-cell and cell-matrix interactions, and the mechanisms of chromosome stability and of DNA repair, replication, and transcription.

Cell Biology is the study of processes carried out by individual cells, such as cell division, organelle inheritance and biogenesis, signal transduction, and motility. These processes are often affected by components in the environment, including nutrients, growth signals, and cell-cell contact. Cell biologists study these processes using single-celled organisms, such as bacteria and yeast; multicellular organisms, such as zebrafish and mice; established mammalian tissue culture lines; and primary cell cultures derived from recombinant animals.

Computational Biology applies quantitative methods to the study of molecular, cellular, and organismal biology. Computational biologists develop and apply models, analyze data, and run simulations to study nucleic acid and protein sequences, biomolecular structures and functions, cellular information processing, tissue morphogenesis, and emergent behaviors.

Genetics is the study of genes, genetic variation, and heredity in living organisms that range in complexity from viruses to single-celled organisms to multicellular organisms, including humans. Geneticists seek to understand the transmission of genes by analyzing DNA replication, DNA repair, chromosome segregation, and cell division. They also use genetic and genomic tools to identify and analyze the genes and gene regulators required for normal biological processes, including development, sex determination, and aging, as well as for the etiology of disease.

Human Disease applies molecular genetics to the problems of human disease. The range of disease areas includes developmental defects, cancer, atherosclerosis and heart disease, neuromuscular diseases, and diseases of other organ systems. Researchers use genetic and genomic strategies to identify, isolate, and characterize genes that cause and contribute to the etiology of human diseases. They explore the mechanisms underlying developmental defects and diseases through the comparison of the genetic pathways in humans and model organisms. They also isolate cells from affected patients to generate novel assay systems to examine gene-function-pathology relationships.

Immunology focuses on the genetic, cellular, and molecular mechanisms by which organisms respond to and eliminate infections by a large number of pathogens. The immune response requires an elaborate collaboration of different cells of the immune system, including macrophages, B lymphocytes, and T lymphocytes. Immunologists study the role of the immune system not just in response to infection but also in a range of human diseases, including cancer.

Microbiology is the study of microscopic organisms, such as bacteria, viruses, archaea, fungi, and protozoa. Exploiting sophisticated genetic, molecular biological, and biochemical systems available for microorganisms, microbiologists obtain high-resolution insights into the fundamental processes necessary for life and explore ways to manipulate microorganisms to achieve particular desired ends. They also determine how aspects of the microbial life cycle and lifestyle enable their survival within particular biological niches and facilitate interactions with their environment.
Neurobiology seeks to understand how the remarkable diversity in neuronal cell types and their connections are established and how changes in them underlie learning and thinking. Neurobiologists identify and characterize the molecules involved in specifying neuronal cell fate in vertebrates and invertebrates, and in guiding axons to their correct targets.

Stem Cell and Developmental Biology explores how a germ line stem cell develops into a multicellular organism, which requires that cells divide, differentiate, and assume their proper positions relative to one another as they produce organ systems and entire organisms. Stem cells are unusual cells in the body that retain the capacity to both self-renew and differentiate. Stem cell researchers identify the molecular mechanisms underlying stem cell renewal and differentiation, and use stem cells for disease modeling and regenerative medicine.

Admission Requirements for Graduate Study
In the Department of Biology, the Master of Science is not a prerequisite for a program of study leading to the doctorate.

The department modifies the General Institute Requirements for admission to graduate study as follows: 18.01 Calculus, 18.02 Calculus; one year of college physics; 5.12 Organic Chemistry I; professional subjects including general biochemistry, genetics, and physical chemistry. However, students may make up some deficiencies over the course of their graduate work.

Doctor of Philosophy
The General Degree Requirements for the Doctor of Philosophy are listed under Graduate Education (http://catalog.mit.edu/mit/graduate-education/general-degree-requirements). In the departmental program, each graduate student is expected to acquire a solid background in four fundamental areas of biology: biochemistry, genetics, cell biology, and molecular biology. Most students take subjects in these areas during the first year. All students are required to take three subjects:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.50</td>
<td>Method and Logic in Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.51</td>
<td>Principles of Biochemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>7.52</td>
<td>Genetics for Graduate Students</td>
<td>12</td>
</tr>
</tbody>
</table>

7.50 is a seminar designed specifically to introduce graduate students to in-depth discussion and analysis of topics in molecular biology.

Students have a choice of several elective subjects, which have been designed for the entering graduate student. One of the elective subjects must focus on computational and quantitative approaches to biology. Typically students choose one of the following subjects:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.57</td>
<td>Quantitative Biology for Graduate Students</td>
<td>12</td>
</tr>
</tbody>
</table>

Master of Engineering in Computer Science and Molecular Biology (Course 6-7P)
The Departments of Biology and Electrical Engineering and Computer Science jointly offer a Master of Engineering in Computer Science and Molecular Biology (6-7P) (http://catalog.mit.edu/degree-charts/master-computer-science-molecular-biology-course-6-7p). A detailed description of the program requirements may be found under the section on Interdisciplinary Programs (http://catalog.mit.edu/interdisciplinary/graduate-programs/computer-science-molecular-biology).

Financial Support
Students who are accepted into the graduate program are provided with support from departmental training grants, departmental funds for teaching assistants, and research grants. In addition, some students bring National Science Foundation and other competitive fellowships. Through these sources, full tuition plus a stipend for living expenses are provided.

Students are encouraged to apply for outside fellowships for which they are eligible, such as the NSF Fellowships. Information regarding graduate student fellowships is available at most colleges from the career planning office.

Inquiries
Additional information regarding graduate academic programs, research activities, admissions, financial aid, and assistantships may be obtained from the Biology Education Office (gradbio@mit.edu), Room 68-120, 617-253-3717.
Faculty and Teaching Staff

Alan D. Grossman, PhD
Praecis Professor
Head, Department of Biology

Michael T. Laub, PhD
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Associate Head, Department of Biology

Jacqueline Lees, PhD
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Professor of Biology
Associate Head, Department of Biology

Peter Reddien, PhD
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Associate Head, Department of Biology

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Professor of Biology

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E.C. Whitehead Professor
Professor of Biology

David Bartel, PhD
Professor of Biology

Stephen P. Bell, PhD
Uncas (1923) and Helen Whitaker Professor
Professor of Biology

Christopher B. Burge, PhD
Professor of Biology
Professor of Biological Engineering

Iain Cheeseman, PhD
Professor of Biology

Jianzhu Chen, PhD
Professor of Biology

Sallie W. Chisholm, PhD
Institute Professor
Professor of Civil and Environmental Engineering
Professor of Biology

Martha Constantine-Paton, PhD
Professor of Neuroscience
Professor of Biology

Catherine L. Drennan, PhD
Professor of Biology
Professor of Chemistry

Gerald R. Fink, PhD
Professor of Biology

Frank Gertler, PhD
Professor of Biology
(On leave, fall)

Leonard Pershing Guarente, PhD
Novartis Professor of Biology

H. Robert Horvitz, PhD
David H. Koch Professor
Professor of Biology

David E. Housman, PhD
Virginia and Daniel K. Ludwig Professor for Cancer Research
Professor of Biology

Richard O. Hynes, PhD
Daniel K. Ludwig Professor for Cancer Research

Barbara Imperiali, PhD
Class of 1922 Professor
Professor of Biology
Professor of Chemistry

Rudolf Jaenisch, MD
Professor of Biology

Leonard Pershing Guarente, PhD
Professor of Biology

Eric S. Lander, PhD
Professor of Biology

Chris Kaiser, PhD
Amgen Professor
Professor of Biology

Amy E. Keating, PhD
Professor of Biology
Professor of Biological Engineering

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Professor of Biology

Monty Krieger, PhD
Whitehead Professor
Professor of Biology

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Professor of Biological Engineering
Professor of Chemical Engineering
Professor of Biology

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Menicon Professor in Neuroscience
Professor of Biology

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Professor of Biology
Professor of Biological Engineering

Elly Nedivi, PhD
Professor of Neuroscience
Professor of Biology

Terry L. Orr-Weaver, PhD
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(On leave)

David C. Page, MD
Professor of Biology
Member, Health Sciences and Technology Faculty

Uttam L. RajBhandary, PhD
Lester Wolfe Professor of Molecular Biology

Aviv Regev, PhD
Professor of Biology

David M. Sabatini, MD, PhD
Professor of Biology

Robert T. Sauer, PhD
Salvador E. Luria Professor
Professor of Biology

Thomas Schwartz, PhD
Boris Magasanik Professor of Biology

Phillip A. Sharp, PhD
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Professor of Biology
Member, Health Sciences and Technology Faculty

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Frank Solomon, PhD
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Professor of Immunology

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Picower Professor
Professor of Biology
Professor of Neuroscience

Graham C. Walker, PhD
Professor of Biology

Robert A. Weinberg, PhD
Daniel K. Ludwig Professor for Cancer Research

Matthew A. Wilson, PhD
Sherman Fairchild Professor
Professor of Neuroscience
Professor of Biology

Michael B. Yaffe, MD, PhD
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Professor of Biology
Professor of Biological Engineering

Richard A. Young, PhD
Professor of Biology
(On leave)

**Associate Professors**

Laurie Boyer, PhD
Associate Professor of Biological Engineering
Associate Professor of Biology

Mary Gehring, PhD
Associate Professor of Biology

Piyush Gupta
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Michael Hemann, PhD
Associate Professor of Biology

Adam C. Martin, PhD
Associate Professor of Biology

Matthew G. Vander Heiden, MD, PhD
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**Assistant Professors**

Eliezer Calo, PhD
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Assistant Professor of Biology

Joseph Davis, PhD
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Ankur Jain, PhD
Assistant Professor of Biology

Rebecca Lamason, PhD
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Assistant Professor of Biology

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Assistant Professor of Biology

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Assistant Professor of Biology

Omer Yilmaz, PhD
Eisen and Chang Career Development Professor
Assistant Professor of Biology

Lecturers
Mandana Sassanfar, PhD
Lecturer in Biology

Mary Ellen Wiltrout, PhD
Lecturer in Biology

Instructors
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Instructor of Biology

Technical Instructors
Vanessa J. Cheung, PhD
Technical Instructor of Biology

Anthony Fuccione, BS
Technical Instructor of Biology

Diviya Sinha, PhD
Technical Instructor of Biology

Meredith Sweeney, PhD
Technical Instructor of Biology

Ayce Yesilaltay, PhD
Technical Instructor of Biology

Research Staff

Research Scientists
Vincent Butty, MD, PhD
Research Scientist of Biology

Huiming Ding, PhD
Research Scientist of Biology

Robert A. Grant, PhD
Research Scientist of Biology

Vera V. Koledova, PhD
Research Scientist of Biology

Janet L. Smith, PhD
Research Scientist of Biology

Alexei Stortchevoi, PhD
Research Scientist of Biology

Mohan Viswanathan, PhD
Research Scientist of Biology

Professors Emeriti

David Baltimore, PhD
Professor Emeritus of Biology

Gene M. Brown, PhD
Professor Emeritus of Biochemistry

Arnold L. Demain, PhD
Professor Emeritus of Industrial Microbiology

Maurice S. Fox, PhD
Professor Emeritus of Molecular Biology

Malcolm L. Gefter, PhD
Professor Emeritus of Biochemistry

Nancy Haven Hopkins, PhD
Amgen Professor Emerita
Professor Emerita of Biology

Jonathan Alan King, PhD
Professor Emeritus of Molecular Biology

Mary-Lou Pardue, PhD
Boris Magasanik Professor Emerita
Professor Emerita of Biology

Sheldon Penman, PhD
Professor Emeritus of Cell Biology

William G. Quinn, PhD
Professor Emeritus of Neurobiology
Professor Emeritus of Biology

Phillips W. Robbins, PhD
Professor Emeritus of Biochemistry

Robert Daniel Rosenberg, MD, PhD
Professor Emeritus of Biology
Undergraduate Subjects

Introductory Biology
All five subjects cover the same core material, comprising about 50% of the course, while the remaining material is specialized for each version as described below. Core material includes fundamental principles of biochemistry, genetics, molecular biology, and cell biology. These topics address structure and regulation of genes, structure and synthesis of proteins, how these molecules are integrated into cells and how cells communicate with one another.

7.012 Introductory Biology
Prereq: None
U (Fall)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.013, 7.014, 7.015, 7.016, ES.7012, ES.7013

Exploration into areas of current research in molecular and cell biology, immunology, neurobiology, human genetics, biochemistry, and evolution. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.

E. Lander, C. Drennan

7.013 Introductory Biology
Prereq: None
U (Spring)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.014, 7.015, 7.016, ES.7012, ES.7013

Genomic approaches to human biology, including neuroscience, development, immunology, tissue repair and stem cells, tissue engineering, and infectious and inherited diseases, including cancer. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.

A. Amon, S. Bell, H. Sive

7.014 Introductory Biology
U (Spring)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.015, 7.016, ES.7012, ES.7013

Studies the fundamental principles of biology and their application towards understanding the Earth as a dynamical system shaped by life. Focuses on molecular ecology in order to show how processes at the molecular level can illuminate macroscopic properties, including evolution and maintenance of biogeochemical cycles, and ecological interactions in ecosystems ranging from the ocean to the human gut. Includes quantitative analysis of population growth, community structure, competition, mutualism and predation; highlights their role in shaping the biosphere. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.

G. C. Walker, S. W. Chisholm, M. Polz

7.015 Introductory Biology
Prereq: High school course covering cellular and molecular biology or permission of instructor
U (Fall)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.016, ES.7012, ES.7013

Emphasizes the application of fundamental biological principles to modern, trending topics in biology. Specific modules focus on antibiotic resistance, the microbiome, biotechnology (e.g., genetically-modified organisms and CRISPR-based genome editing), personal genetics and genomics, neurodegenerative diseases, and metabolism (the science behind making wine, cheese, and natural product drugs). Includes discussion of the social and ethical issues surrounding modern biology. Limited to 60; admittance may be controlled by lottery.

M. Laub, J. K. Weng
7.016 Introductory Biology
Prereq: None
U (Fall)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.015, ES.7012, ES.7013

Introduction to fundamental principles of biochemistry, molecular biology and genetics for understanding the functions of living systems. Covers examples of the use of chemical biology, the use of genetics in biological discovery, principles of cellular organization and communication, and engineering biological systems. In addition, includes 21st-century molecular genetics in understanding human health and therapeutic intervention. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.

B. Imperiali, A. Martin

7.002 Fundamentals of Experimental Molecular Biology (New)
Prereq: None
U (Fall, Spring)
1-4-1 units. Partial Lab

Introduces the experimental concepts and methods of molecular biology. Covers basic principles of experimental design and data analysis, with an emphasis on the acquisition of practical laboratory experience. Satisfies 6 units of Institute Laboratory credit. Enrollment limited.

D. Kim

7.02[J] Introduction to Experimental Biology and Communication
Same subject as 10.702[J]
Prereq: Biology (GIR)
U (Fall, Spring)
4-8-6 units. Institute LAB

Introduction to the experimental concepts and methods of molecular biology, biochemistry, and genetic analysis. Emphasis on experimental design, critical data analysis, and the development of written communications skills. 12 units may be applied to the General Institute Laboratory Requirement. Enrollment limited.

E. Calo-Velazquez, M. Gehring, T. Schwartz, O. Yilmaz, K. D. Wittrup

7.03 Genetics
Prereq: Biology (GIR)
U (Fall, Spring)
4-0-8 units. REST

The principles of genetics with application to the study of biological function at the level of molecules, cells, and multicellular organisms, including humans. Structure and function of genes, chromosomes, and genomes. Biological variation resulting from recombination, mutation, and selection. Population genetics. Use of genetic methods to analyze protein function, gene regulation, and inherited disease.

P. Reddien, M. Hemann, A. Regev

7.05 General Biochemistry
Prereq: Biology (GIR), 5.12, or permission of instructor
U (Spring)
5-0-7 units. REST
Credit cannot also be received for 5.07[J], 20.507[J]

Contributions of biochemistry toward an understanding of the structure and functioning of organisms, tissues, and cells. Chemistry and functions of constituents of cells and tissues and the chemical and physical-chemical basis for the structures of nucleic acids, proteins, and carbohydrates. Basic enzymology and biochemical reaction mechanisms involved in macromolecular synthesis and degradation, signaling, transport, and movement. General metabolism of carbohydrates, fats, and nitrogen-containing materials such as amino acids, proteins, and related compounds.

M. Vander Heiden, M. Yaffe

7.06 Cell Biology
Prereq: 7.03 and 7.05
U (Fall, Spring)
4-0-8 units

Presents the biology of cells of higher organisms. Studies the structure, function, and biosynthesis of cellular membranes and organelles; cell growth and oncogenic transformation; transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix, and cell movements; cell division and cell cycle; functions of specialized cell types. Emphasizes the current molecular knowledge of cell biological processes as well as the genetic, biochemical, and other experimental approaches that resulted in these discoveries.

A. Martin, F. Solomon, I. Cheeseman, R. Lamason
7.08[J] Biological Chemistry II
Same subject as 5.08[J]
Subject meets with 7.80
Prereq: 5.12 and (5.07[J] or 7.05)
U (Spring)
4-0-8 units
See description under subject 5.08[J].
L. Kiessling, R. Raines

7.09 Quantitative and Computational Biology
Prereq: 7.03 and 7.05
U (Spring)
3-0-9 units
Quantitative and computational analysis of biological systems at the molecular and cellular level. Includes models of biological processes across different time scales, from steady-state to kinetics of gene expression, circadian clock, cell growth, and evolutionary dynamics. Methods include physical, systems, and synthetic biology. Also covers second-generation sequencing technologies, and topics in computational analysis of genomes, including sequence alignment, motif finding, information theory and RNA secondary structure prediction.
C. Burge, G. W. Li

7.102 Laboratory in Molecular Biology
Prereq: None
U (IAP)
0-5-1 units. Partial Lab
Designed for first- and second-year students with little or no biology lab experience. Introduces basic methods of experimental molecular biology. Specific experiments vary from year-to-year, but will focus on the identification and characterization of bacteria from the wild using an array of basic methods in molecular biology and microbiology. Biology GIR or Chemistry GIR recommended. Satisfies 6 units of Institute Laboratory credit. Limited to 24; admittance may be controlled by lottery.
A. Martin

7.11 Biology Teaching
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.
For qualified undergraduate students interested in gaining some experience in teaching. Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview.
Consult Biology Education Office

7.18 Topics in Experimental Biology
Subject meets with 7.19
Prereq: (7.06, an approved research experience, and (5.362, 7.02[J], or 20.109)) or permission of instructor
U (Fall, Spring)
4-16-10 units
Independent experimental study under the direction of a member of the Biology Department faculty. Allows students with a strong interest in independent research to fulfill the project laboratory requirement for the Biology Department Program in the context of a research laboratory at MIT. The research must be conducted on the MIT campus and be a continuation of a previous 12-unit UROP project or full-time work over the summer. Written and oral presentation of the research results is required. Journal club discussions are used to help students evaluate and write scientific papers. Instruction and practice in written and oral communication is provided. Permission of the faculty research supervisor and the Biology Education Office must be obtained in advance.
J. Chen, A. J. Sinskey, C. Kaiser

7.19 Communication in Experimental Biology
Subject meets with 7.18
Prereq: (7.06 and (5.362, 7.02[J], or 20.109)) or permission of instructor
U (Fall, Spring)
4-4-4 units
Students carry out independent literature research. Meets with the seminar and writing tutorial portions of 7.18. Journal club discussions are used to help students evaluate and write scientific papers. Instruction and practice in written and oral communication is provided. Permission of the instructor and the Biology Education Office must be obtained in advance.
J. Chen, A. J. Sinskey, C. Kaiser

7.20[J] Human Physiology
Same subject as HST.540[J]
Prereq: 7.05
U (Fall)
5-0-7 units
Comprehensive exploration of human physiology, emphasizing the molecular basis and applied aspects of organ function and regulation in health and disease. Includes a review of cell structure and function, as well as the mechanisms by which the endocrine and nervous systems integrate cellular metabolism. Special emphasis on examining the cardiovascular, pulmonary, gastrointestinal, and renal systems, as well as liver function, drug metabolism, and pharmacogenetics.
M. Krieger, D. Sabatini
7.21 Microbial Physiology
Subject meets with 7.62
Prereq: 7.03 and 7.05
U (Fall)
4-0-8 units

Biochemical properties of bacteria and other microorganisms that enable them to grow under a variety of conditions. Interaction between bacteria and bacteriophages. Genetic and metabolic regulation of enzyme action and enzyme formation. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis. Additional topics include bioenergetics, symbiosis, quorum sensing, global responses to DNA damage, and biofilms. Students taking the graduate version are expected to explore the subject in greater depth.

G. C. Walker, A. J. Sinskey

7.22 Developmental Biology
Prereq: 7.06
Acad Year 2018-2019: Not offered
Acad Year 2019-2020: U (Fall)
5-0-7 units

Topics include development of animal body plans, tissue patterning, cell type determination, organogenesis, morphogenesis, stem cells, and the evolution of developmental diversity and processes. Covers experimental approaches to problems of development and evolution, such as the study of vertebrate (mouse, chick, frog, fish) and invertebrate (fly, worm) models.

R. O. Hynes, P. Reddien

7.23[J] Immunology
Same subject as 20.230[J]
Subject meets with 7.63[J], 20.630[J]
Prereq: 7.06
U (Spring)
5-0-7 units

Comprehensive survey of molecular, genetic, and cellular aspects of the immune system. Topics include innate and adaptive immunity; cells and organs of the immune system; hematopoiesis; immunoglobulin, T cell receptor, and major histocompatibility complex (MHC) proteins and genes; development and functions of B and T lymphocytes; immune responses to infections and tumors; hypersensitivity, autoimmunity, and immunodeficiencies. Particular attention to the development and function of the immune system as a whole, as studied by modern methods and techniques. Students taking graduate version explore the subject in greater depth, including study of recent primary literature.

S. Spranger, M. Birnbaum

7.26 Molecular Basis of Infectious Disease
Subject meets with 7.66
Prereq: 7.06
U (Spring)
4-0-8 units

Focuses on the principles of host-pathogen interactions with an emphasis on infectious diseases of humans. Presents key concepts of pathogenesis through the study of various human pathogens. Includes critical analysis and discussion of assigned readings. Students taking the graduate version are expected to explore the subject in greater depth.

S. Lourido

7.27 Principles of Human Disease
Prereq: 7.06
U (Spring)
4-0-8 units

Covers current understanding of and modern approaches to human disease, emphasizing the molecular and cellular basis of both genetic disease and cancer. Topics include the genetics of simple and complex traits; karyotypic analysis and positional cloning; genetic diagnosis; the roles of oncogenes and tumor suppressors in tumor initiation, progression, and treatment; the interaction between genetics and environment; animal models of human disease; cancer; aging and disease; and conventional and gene therapy treatment strategies.

D. Housman, L. Guarente

7.28 Molecular Biology
Subject meets with 7.58
Prereq: 7.03; Coreq: 7.05
U (Spring)
5-0-7 units

Detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. Topics covered in lecture and readings of relevant literature include: gene regulation, DNA replication, genetic recombination, and mRNA translation. Logic of experimental design and data analysis emphasized. Presentations include both lectures and group discussions of representative papers from the literature. Students taking the graduate version are expected to explore the subject in greater depth.

S. Bell, E. Calo
7.29[J] Cellular and Molecular Neurobiology  
Same subject as 9.09[J]  
Prereq: 7.05 or 9.01  
U (Spring)  
4-0-8 units  

Introduction to the structure and function of the nervous system. Emphasizes the cellular properties of neurons and other excitable cells. Includes the structure and biophysical properties of excitable cells, synaptic transmission, neurochemistry, neurodevelopment, integration of information in simple systems, and detection and information coding during sensory transduction.  
T. Littleton, M. Heiman

Same subject as 1.018A[J], 12.031A[J]  
Prereq: None  
U (Fall; first half of term)  
2-0-4 units  

See description under subject 1.018A[J].  
O. Cordero, M. Follows

Same subject as 1.018B[J], 12.031B[J]  
Prereq: 1.018A[J]  
U (Fall; second half of term)  
2-0-4 units  

See description under subject 1.018B[J].  
O. Cordero, M. Follows

7.31 Current Topics in Mammalian Biology: Medical Implications  
Prereq: 7.06 or permission of instructor  
Acad Year 2018-2019: Not offered  
Acad Year 2019-2020: U (Fall)  
4-0-8 units  

Covers recent advances in mammalian cell and developmental biology with particular emphasis on approaches that utilize mouse genetics. Combines formal lectures on selected topics with readings of original papers which are discussed in class. Major emphasis on the implications of mechanisms of human genetic diseases. Topics include early mammalian development; genomic imprinting; X inactivation; embryonic stem cells; nuclear reprogramming of somatic cells; cell migration; nervous system development; and central nervous system degenerative diseases such as Alzheimer's and Huntington's disease. Limited to 20.  
F. Gertler, R. Jaenisch

7.32 Systems Biology  
Subject meets with 7.81[J], 8.591[J]  
Prereq: (18.03 and 18.05) or permission of instructor  
U (Fall)  
3-0-9 units  

Introduction to cellular and population-level systems biology with an emphasis on synthetic biology, modeling of genetic networks, cell-cell interactions, and evolutionary dynamics. Cellular systems include genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making. Population-level systems include models of pattern formation, cell-cell communications, and evolutionary systems biology. Students taking graduate version explore the subject in more depth.  
J. Gore

Same subject as 6.049[J]  
Prereq: 7.03 and (6.0001 or permission of instructor)  
U (Spring)  
3-0-9 units  

Explores and illustrates how evolution explains biology, with an emphasis on computational model building for analyzing evolutionary data. Covers key concepts of biological evolution, including adaptive evolution, neutral evolution, evolution of sex, genomic conflict, speciation, phylogeny and comparative methods, life's history, coevolution, human evolution, and evolution of disease.  
R. Berwick, D. Bartel

7.340-7.344 Advanced Undergraduate Seminar  
Prereq: 7.06 or 7.28  
U (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  

Seminars covering topics of current interest in biology with a focus on how to understand experimental methods and design and how to critically read the primary research literature. Small class size facilitates discussions and interactions with an active research scientist. Students visit research laboratories to see firsthand how biological research is conducted. Contact Biology Education Office for topics.  
H. R. Horvitz
7.345-7.349 Advanced Undergraduate Seminar
Prereq: 7.06 or 7.28
U (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Seminars covering topics of current interest in biology with a focus on how to understand experimental methods and design and how to critically read the primary research literature. Small class size facilitates discussions and interactions with an active research scientist. Students visit research laboratories to see firsthand how biological research is conducted. Contact Biology Education Office for topics.

H. R. Horvitz

7.37[J] Molecular and Engineering Aspects of Biotechnology
Same subject as 10.441[J], 20.361[J]
Prereq: (7.06 and (2.005, 3.012, 5.60, or 20.110[J])) or permission of instructor
U (Spring)
Not offered regularly; consult department
4-0-8 units
Credit cannot also be received for 7.371

Covers biological and bioengineering principles underlying the development and therapeutic use of recombinant proteins and stem cells; glycoengineering of recombinant proteins; normal and pathological signaling by growth factors and their receptors; receptor trafficking; monoclonal antibodies as therapeutics; protein pharmacology and delivery; stem cell-derived tissues as therapeutics; RNA therapeutics; combinatorial protein engineering; and new antitumor drugs.

H. Lodish, L. Griffith

7.371 Biological and Engineering Principles Underlying Novel Biotherapeutics
Prereq: 7.06
U (Fall)
4-0-8 units
Credit cannot also be received for 7.37[J], 10.441[J], 20.361[J]

Covers biological and bioengineering principles underlying the development and therapeutic use of recombinant proteins and immune cells. Special attention to monoclonal antibodies and engineered immune system cells as therapeutics; protein- and glyco- engineering to enhance protein function; protein pharmacology and delivery; nucleic acid- based biotherapeutics; generation of functional cells and tissues from embryonic stem cells and iPS cells; and immune cell-cancer cell interactions in cancer immunotherapy.

J. Chen, H. Lodish

7.41 Principles of Chemical Biology
Subject meets with 7.73
Prereq: 7.05
Acad Year 2018-2019: Not offered
Acad Year 2019-2020: U (Spring)
3-0-9 units

Spanning the fields of biology, chemistry and engineering, class addresses the principles of chemical biology and its application of chemical and physical methods and reagents to the study and manipulation of biological systems. Topics include bioorthogonal reactions and activity-based protein profiling, small molecule inhibitors and chemical genetics, fluorescent probes for biological studies, and unnatural amino acid mutagenesis. Also covers chemical biology approaches for studying dynamic post-translational modification reactions, natural product biosynthesis and mutasynthesis, and high-throughput drug screening. Students taking the graduate version are expected to explore the subject in greater depth

B. Imperiali, J. K. Weng

7.45 The Hallmarks of Cancer
Subject meets with 7.85
Prereq: None. Coreq: 7.06
U (Fall)
4-0-8 units

Provides a comprehensive introduction to the fundamentals of cancer biology and cancer treatment. Topics include cancer genetics, genomics, and epigenetics; familial cancer syndromes; signal transduction, cell cycle control, and apoptosis; cancer metabolism; stem cells and cancer; metastasis; cancer immunology and immunotherapy; conventional and molecularly-targeted therapies; and early detection and prevention. Students taking graduate version complete additional assignments.

T. Jacks, M. Vander Heiden

7.46 Building with Cells (New)
Subject meets with 7.86
Prereq: 7.06
U (Fall)
4-0-8 units

Addresses how principles of developmental biology inform understanding of organ formation, repair, and disease. Focuses on the pivotal role of stem cells in normal development, and their use to address anomalies. Students taking graduate version complete additional assignments.

H. Sive, Staff
**7.458[J] Advances in Biomanufacturing**
Same subject as 10.03[J]
Subject meets with 7.548[J], 10.53[J]
Prereq: None
U (Spring; second half of term)
1-0-2 units

Seminar examines how biopharmaceuticals, an increasingly important class of pharmaceuticals, are manufactured. Topics range from fundamental bioprocesses to new technologies to the economics of biomanufacturing. Also covers the impact of globalization on regulation and quality approaches as well as supply chain integrity. Students taking graduate version complete additional assignments.

*J. C. Love, A. Sinskey, S. Springs*

**7.49[J] Developmental Neurobiology**
Same subject as 9.18[J]
Subject meets with 7.69[J], 9.181[J]
Prereq: 7.03, 7.05, 9.01, or permission of instructor
U (Spring)
3-0-9 units

Considers molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. Students taking graduate version complete additional readings that will be addressed in their mid-term and final exams.

*E. Nedivi, M. Heiman*

**7.391 Independent Study in Biology**
Prereq: None
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Program of study or research to be arranged with a department faculty member.

*Staff*

**7.392 Independent Study in Biology**
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Program of study or research to be arranged with a department faculty member.

*Staff*

**7.393 Independent Study in Genetics**
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Program of study or research to be arranged with a department faculty member.

*Staff*

**7.394 Independent Study in Biochemistry**
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Program of study or research to be arranged with a department faculty member.

*Staff*

**7.395 Independent Study in Cell and Molecular Biology**
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Program of study or research to be arranged with a department faculty member.

*Staff*

**7.396 Independent Study in Experimental Biology**
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Program of study or research to be arranged with a department faculty member.

*Staff*

**7.591 Special Subject in Biology**
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.

*Staff*
7.S392 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.S399 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.UR Undergraduate Research
Prereq: Permission of department
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Undergraduate research opportunities in the Department of Biology. For further information, consult departmental coordinator, Gene Brown.
Staff

7.URG Undergraduate Research
Prereq: Permission of department
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Undergraduate research opportunities in the Department of Biology. For further information, consult departmental coordinator, Gene Brown.
Staff

Graduate Subjects

MIT-WHOI Joint Program in Oceanography

7.410 Applied Statistics
Prereq: Permission of instructor
G (Spring)
3-o-9 units
Can be repeated for credit.
Provides an introduction to modern applied statistics. Topics include likelihood-based methods for estimation, confidence intervals, and hypothesis-testing; bootstrapping; time series modeling; linear models; nonparametric regression; and model selection. Organized around examples drawn from the recent literature.
A. Solow

7.411 Seminars in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Selected topics in biological oceanography.
WHOI Staff

7.421 Problems in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Advanced problems in biological oceanography with assigned reading and consultation.
Information: M. Neubert (WHOI)

7.430 Topics in Quantitative Marine Science
Prereq: Permission of instructor
G (Fall, Spring)
2-o-4 units
Can be repeated for credit.
Lectures and discussions on quantitative marine ecology. Topics vary from year to year.
WHOI Staff
7.431 Topics in Marine Ecology  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussions on ecological principles and processes in marine populations, communities, and ecosystems. Topics vary from year to year.  
WHOI Staff  

7.432 Topics in Marine Physiology and Biochemistry  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussions on physiological and biochemical processes in marine organisms. Topics vary from year to year.  
WHOI Staff  

7.433 Topics in Biological Oceanography  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussions on biological oceanography. Topics vary from year to year.  
WHOI Staff  

7.434 Topics in Zooplankton Biology  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussions on the biology of marine zooplankton. Topics vary from year to year.  
WHOI Staff  

7.435 Topics in Benthic Biology  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussions on the biology of marine benthos. Topics vary from year to year.  
WHOI Staff  

7.436 Topics in Phytoplankton Biology  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussion on the biology of marine phytoplankton. Topics vary from year to year.  
WHOI Staff  

7.437 Topics in Molecular Biological Oceanography  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussion on molecular biological oceanography. Topics vary from year to year.  
WHOI Staff  

7.438 Topics in the Behavior of Marine Animals  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussion on the behavioral biology of marine animals. Topics vary from year to year.  
WHOI Staff  

7.439 Topics in Marine Microbiology  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Lectures and discussion on the biology of marine prokaryotes. Topics vary from year to year.  
WHOI Staff  

7.440 An Introduction to Mathematical Ecology  
Prereq: Calculus I (GIR), 1.018B[J], or permission of instructor  
Acad Year 2018-2019: Not offered  
Acad Year 2019-2020: G (Spring)  
3-0-9 units  
Covers the basic models of population growth, demography, population interaction (competition, predation, mutualism), food webs, harvesting, and infectious disease, and the mathematical tools required for their analysis. Because these tools are also basic to the analysis of models in biochemistry, physiology, and behavior, subject also broadly relevant to students whose interests are not limited to ecological problems.  
M. Neubert (WHOI)
**7.470 Biological Oceanography**  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  

Intended for students with advanced training in biology. Intensive overview of biological oceanography. Major paradigms discussed, and dependence of biological processes in the ocean on physical and chemical aspects of the environment examined. Surveys the diversity of marine habitats, major groups of taxa inhabiting those habitats, and the general biology of the various taxa: the production and consumption of organic material in the ocean, as well as factors controlling those processes. Species diversity, structure of marine food webs, and the flow of energy within different marine habitats are detailed and contrasted.  

*WHOI Staff*

**7.491 Research in Biological Oceanography**  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  

Directed research in biological oceanography not leading to graduate thesis and initiated prior to the qualifying exam.  

*WHOI Staff*

**Microbiology (MICRO)**

**7.492[J] Methods and Problems in Microbiology**  
Same subject as 1.86[J], 20.445[J]  
Prereq: None  
G (Fall)  
3-0-9 units  

Students will read and discuss primary literature covering key areas of microbial research with emphasis on methods and approaches used to understand and manipulate microbes. Preference to first-year Microbiology and Biology students.  

*M. Laub*

**7.493[J] Microbial Genetics and Evolution**  
Same subject as 1.87[J], 12.493[J], 20.446[J]  
Prereq: 7.03, 7.05, or permission of instructor  
G (Fall)  
4-0-8 units  

Covers aspects of microbial genetic and genomic analyses, central dogma, horizontal gene transfer, and evolution.  

*A. D. Grossman, O. Cordero*

**7.494 Research Problems in Microbiology**  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  

Directed research in the fields of microbial science and engineering.  

*Staff*

**7.498 Teaching Experience in Microbiology**  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  

For qualified graduate students in the Microbiology graduate program interested in teaching. Classroom or laboratory teaching under the supervision of a faculty member.  

*Staff*

**7.499 Research Rotations in Microbiology**  
Prereq: None. Coreq: 7.492[J] or 7.493[J]; permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  

Introduces students to faculty participating in the interdepartmental Microbiology graduate program through a series of three lab rotations, which provide broad exposure to microbiology research at MIT. Students select a lab for thesis research by the end of their first year. Given the interdisciplinary nature of the program and the many research programs available, students may be able to work jointly with more than one research supervisor. Limited to students in the Microbiology graduate program.  

*Staff*

**7.MTHG Microbiology Graduate Thesis**  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  

Program of research leading to the writing of a PhD thesis. To be arranged by the student and the appropriate MIT faculty member.  

*Staff*
**Biology**

**7.50 Method and Logic in Molecular Biology**  
Prereq: None. Coreq: 7.51 and 7.52; or permission of instructor  
G (Fall)  
4-0-8 units  
Logic, experimental design and methods in biology, using discussions of the primary literature to discern the principles of biological investigation in making discoveries and testing hypotheses. In collaboration with faculty, students also apply those principles to generate a potential research project, presented in both written and oral form. Limited to Course 7 graduate students.  
I. Cheeseman, M. Gehring, M. Hemann, J. Lees, D. Sabatini, F. Solomon

**7.51 Principles of Biochemical Analysis**  
Prereq: Permission of instructor  
G (Fall)  
6-0-6 units  
Principles of biochemistry, emphasizing structure, equilibrium studies, kinetics, informatics, single-molecule studies, and experimental design. Topics include macromolecular binding and specificity, protein folding and unfolding, allosteric systems, transcription factors, kinases, membrane channels and transporters, and molecular machines.  
A. Keating, R. T. Sauer

**7.52 Genetics for Graduate Students**  
Prereq: Permission of instructor  
G (Fall)  
4-0-8 units  
Principles and approaches of genetic analysis, including Mendelian inheritance and prokaryotic genetics, yeast genetics, developmental genetics, neurogenetics, and human genetics.  
H. R. Horvitz, C. Kaiser

**7.540[J] Frontiers in Chemical Biology**  
Same subject as 5.54[J], 20.554[J]  
Prereq: 5.07[J], 5.13, 7.06, and permission of instructor  
G (Fall)  
3-0-9 units  
See description under subject 5.54[J].  
L. Kiessling, M. Shoulders

**7.546[J] Science and Business of Biotechnology**  
Same subject as 15.480[J], 20.586[J]  
Prereq: None. Coreq: 15.401; permission of instructor  
G (Spring)  
3-0-6 units  
See description under subject 15.480[J].  
A. Lo, H. Lodish

**7.547[J] Principles and Practice of Drug Development**  
Same subject as 10.547[J], 15.136[J], HST.920[J], IDS.620[J]  
Prereq: Permission of instructor  
G (Fall)  
3-0-6 units  
See description under subject 15.136[J].  
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

**7.548[J] Advances in Biomanufacturing**  
Same subject as 10.53[J]  
Subject meets with 7.458[J], 10.03[J]  
Prereq: None  
G (Spring; second half of term)  
1-0-2 units  
Seminar examines how biopharmaceuticals, an increasingly important class of pharmaceuticals, are manufactured. Topics range from fundamental bioprocesses to new technologies to the economics of biomanufacturing. Also covers the impact of globalization on regulation and quality approaches as well as supply chain integrity. Students taking graduate version complete additional assignments.  
J. C. Love, A. Sinskey, S. Springs

**7.549[J] Case Studies and Strategies in Drug Discovery and Development**  
Same subject as 15.137[J], 20.486[J], HST.916[J]  
Prereq: None  
G (Spring)  
2-0-4 units  
See description under subject 20.486[J].  
A. W. Wood
7.55 **Case Studies in Modern Experimental Design**  
Prereq: Permission of instructor  
G (Spring)  
2.0-7 units  
Focuses on enhancing students’ ability to analyze, design and present experiments, emphasizing modern techniques. Class discussions begin with papers that developed or utilized contemporary approaches (e.g., quantitative microscopy, biophysical and molecular genetic methods) to address important problems in biology. Each student prepares one specific aim of a standard research proposal for a project that emphasizes research strategy, experimental design, and writing.  
*L. Guarente, F. Solomon*

7.57 **Quantitative Biology for Graduate Students**  
Prereq: Permission of instructor  
G (Spring)  
4.0-8 units  
Introduces the fundamental concepts and tools of quantitative approaches to molecular and cellular biology. Covers a wide range of mathematical, computational, and statistical methods, although no previous expertise in these areas is required. Focuses on understanding quantitative approaches through the analysis of particular problems and examples drawn from classical genetics, molecular biology, cell biology, genomics, and systems biology.  
*J. Davis, G. W. Li*

7.58 **Molecular Biology**  
Subject meets with 7.28  
Prereq: 7.03, 7.05, and permission of instructor  
G (Spring)  
5.0-7 units  
Detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. Topics covered in lecture and readings of relevant literature include: gene regulation, DNA replication, genetic recombination, and mRNA translation. Logic of experimental design and data analysis emphasized. Presentations include both lectures and group discussions of representative papers from the literature. Students taking the graduate version are expected to explore the subject in greater depth.  
*S. Bell, E. Calo*

7.59[J]** Teaching College-Level Science and Engineering**  
Same subject as 1.95[J], 5.95[J], 8.395[J], 18.094[J]  
Subject meets with 2.978  
Prereq: None  
Acad Year 2018-2019: Not offered  
Acad Year 2019-2020: G (Fall)  
2.0-2 units  
See description under subject 5.95[J].  
*J. Rankin*

7.60 **Cell Biology: Structure and Functions of the Nucleus**  
Prereq: 7.06 or permission of instructor  
G (Spring)  
3.0-9 units  
Eukaryotic genome structure, function, and expression, processing of RNA, and regulation of the cell cycle. Emphasis on the techniques and logic used to address important problems in nuclear cell biology. Lectures on broad topic areas in nuclear cell biology and discussions on representative recent papers.  
*L. Boyer*

7.61 **Eukaryotic Cell Biology: Principles and Practice**  
Prereq: Permission of instructor  
G (Fall)  
4.0-8 units  
Emphasizes methods and logic used to analyze structure and function of eukaryotic cells in diverse systems (e.g., yeast, fly, worm, mouse, human; development, stem cells, neurons). Combines lectures and in-depth roundtable discussions of literature readings with the active participation of faculty experts. Focuses on membranes (structure, function, traffic), organelles, the cell surface, signal transduction, cytoskeleton, cell motility and extracellular matrix. Ranges from basic studies to applications to human disease, while stressing critical analysis of experimental approaches. Enrollment limited.  
*R. Hynes, M. Krieger*
7.62 Microbial Physiology
Subject meets with 7.21
Prereq: 7.03, 7.05, and permission of instructor
G (Fall)
4-0-8 units
Biochemical properties of bacteria and other microorganisms that enable them to grow under a variety of conditions. Interaction between bacteria and bacteriophages. Genetic and metabolic regulation of enzyme action and enzyme formation. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis. Additional topics include bioenergetics, symbiosis, quorum sensing, global responses to DNA damage, and biofilms. Students taking the graduate version are expected to explore the subject in greater depth.
G. C. Walker, A. J. Sinskey

7.63[J] Immunology
Same subject as 20.630[J]
Subject meets with 7.23[J], 20.230[J]
Prereq: 7.06 and permission of instructor
G (Spring)
5-0-7 units
Comprehensive survey of molecular, genetic, and cellular aspects of the immune system. Topics include innate and adaptive immunity; cells and organs of the immune system; hematopoiesis; immunoglobulin, T cell receptor, and major histocompatibility complex (MHC) proteins and genes; development and functions of B and T lymphocytes; immune responses to infections and tumors; hypersensitivity, autoimmunity, and immunodeficiencies. Particular attention to the development and function of the immune system as a whole, as studied by modern methods and techniques. Students taking graduate version explore the subject in greater depth, including study of recent primary literature.
S. Spranger, M. Birnbaum

7.64 Molecular Mechanisms, Pathology and Therapy of Human Neuromuscular Disorders
Prereq: Permission of instructor
Acad Year 2018-2019: Not offered
Acad Year 2019-2020: G (Spring)
3-0-9 units
Investigates the molecular and clinical basis of central nervous system and neuromuscular disorders with particular emphasis on strategies for therapeutic intervention. Considers the in-depth analysis of clinical features, pathological mechanisms, and responses to current therapeutic interventions. Covers neurodegenerative diseases, such as Huntington's disease, Parkinson's disease, Alzheimer's disease, Amyotrophic Lateral Sclerosis, Frontal Temporal Dementia, and neuromuscular disorders, such as Myotonic Dystrophy, Facio Scapular Humoral Dystrophy, and Duchenne Muscular Dystrophy.
D. Housman

7.65[J] Molecular and Cellular Neuroscience Core I
Same subject as 9.015[J]
Prereq: None
G (Fall)
3-0-9 units
See description under subject 9.015[J].
J. T. Littleton, H. Sive

7.66 Molecular Basis of Infectious Disease
Subject meets with 7.26
Prereq: 7.06 and permission of instructor
G (Spring)
4-0-8 units
Focuses on the principles of host-pathogen interactions with an emphasis on infectious diseases of humans. Presents key concepts of pathogenesis through the study of various human pathogens. Includes critical analysis and discussion of assigned readings. Students taking the graduate version are expected to explore the subject in greater depth.
D. Kim, S. Lourido

7.68[J] Molecular and Cellular Neuroscience Core II
Same subject as 9.013[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 9.013[J].
G. Feng, L.-H. Tsai
7.69[J] Developmental Neurobiology
Same subject as 9.181[J]
Subject meets with 7.49[J], 9.18[J]
Prereq: 9.011 or permission of instructor
G (Spring)
3.0-9 units
See description under subject 9.181[J].
E. Nedivi, M. Heiman

7.70 Regulation of Gene Expression
Prereq: Permission of instructor
Acad Year 2018-2019: Not offered
Acad Year 2019-2020: G (Spring)
4.0-8 units
Seminar examines basic principles of biological regulation of gene expression. Focuses on examples that underpin these principles, as well as those that challenge certain long-held views. Topics covered may include the role of transcription factors, enhancers, DNA modifications, non-coding RNAs, and chromatin structure in the regulation of gene expression and mechanisms for epigenetic inheritance of transcriptional states. Limited to 40.
Staff

7.71 Structural and Biophysical Analysis of Biological Macromolecules
Subject meets with 5.78
Prereq: 5.13, 5.60, (5.07[J] or 7.05), and permission of instructor
G (Spring)
5.0-7 units
Studies theory and practice of 3-D analysis of macromolecules, using X-ray crystallography and EM analysis. Covers biophysical methods to characterize molecular properties and interactions. Includes discussion of current literature and, importantly, practical exercises in crystallization, model building, and the use of shared instrumentation available at MIT. Meets with 5.78 when offered concurrently.
C. Drennan, T. Schwartz

7.72 Stem Cells, Regeneration, and Development
Prereq: Permission of instructor
G (Spring)
4.0-8 units
Topics include diverse stem cells, such as muscle, intestine, skin, hair and hematopoietic stem cells, as well as pluripotent stem cells. Topics address cell polarity and cell fate; positional information and patterning of development and regeneration; limb, heart and whole body regeneration; stem cell renewal; progenitor cells in development; responses to wounding; and applications of stem cells in development of therapies. Discussions of papers supplement lectures.
R. Hynes, P. Reddien

7.73 Principles of Chemical Biology
Subject meets with 7.41
Prereq: 7.05 and permission of instructor
Acad Year 2018-2019: Not offered
Acad Year 2019-2020: G (Spring)
3.0-9 units
Spanning the fields of biology, chemistry and engineering, class addresses the principles of chemical biology and its application of chemical and physical methods and reagents to the study and manipulation of biological systems. Topics include bioorthogonal reactions and activity-based protein profiling, small molecule inhibitors and chemical genetics, fluorescent probes for biological studies, and unnatural amino acid mutagenesis. Also covers chemical biology approaches for studying dynamic post-translational modification reactions, natural product biosynthesis and mutasynthesis, and high-throughput drug screening. Students taking the graduate version are expected to explore the subject in greater depth.
B. Imperiali, J. K. Weng

7.74[J] Topics in Biophysics and Physical Biology
Same subject as 8.590[J], 20.416[J]
Prereq: None
G (Fall)
2.0-4 units
See description under subject 20.416[J].
I. Cisse, N. Fakhri, M. Guo
7.76 Topics in Macromolecular Structure and Function
Prereq: Permission of instructor
G (Spring)
3-0-6 units
In-depth analysis and discussion of classic and current literature, with an emphasis on the structure, function, and mechanisms of proteins and other biological macromolecules.
*T. Baker, R. T. Sauer*

7.77 Nucleic Acids, Structure, Function, Evolution and Their Interactions with Proteins
Prereq: 7.05, 7.51, or permission of instructor
G (Spring)
3-0-9 units
Surveys primary literature, focusing on biochemical, biophysical, genetic, and combinatorial approaches for understanding nucleic acids. Topics include the general properties, functions, and structural motifs of DNA and RNA; RNAs as catalysts and as regulators of gene expression; RNA editing and surveillance, and the interaction of nucleic acids with proteins, such as zinc-finger proteins, modification enzymes, aminoacyl-tRNA synthetases and other proteins of the translational machinery. Includes some lectures but is mostly analysis and discussion of current literature in the context of student presentations.
*D. Bartel, U. RajBhandary*

7.80 Biological Chemistry II
Subject meets with 5.08[J], 7.08[J]
Prereq: 5.12 and (5.07[J] or 7.05)
G (Spring)
4-0-8 units
More advanced treatment of biochemical mechanisms that underlie biological processes. Topics include macromolecular machines such as the ribosome, the proteosome, fatty acid synthases as a paradigm for polyketide synthases and non-ribosomal polypeptide synthases, and polymerases. Emphasis is on experimental methods used to unravel these processes and how these processes fit into the cellular context and coordinate regulation. Students taking the graduate version are expected to explore the subject in greater depth.
*E. Nolan, R. Raines*

7.81[J] Systems Biology
Same subject as 8.591[J]
Subject meets with 7.32
Prereq: (18.03 and 18.05) or permission of instructor
G (Fall)
3-0-9 units
See description under subject 8.591[J].
*J. Gore*

7.82 Topics of Mammalian Development and Genetics
Prereq: Permission of instructor
Acad Year 2018-2019: Not offered
Acad Year 2019-2020: G (Spring)
3-0-9 units
Seminar covering embryologic, molecular, and genetic approaches to development in mice and humans. Topics include preimplantation development; gastrulation; embryonic stem cells, gene targeting and nuclear reprogramming of somatic cells; genomic imprinting; X-inactivation; sex determination; and germ cells.
*R. Jaenisch, R. Young*

7.85 The Hallmarks of Cancer
Subject meets with 7.45
Prereq: None. Coreq: 7.06; permission of instructor
G (Fall)
4-0-8 units
Provides a comprehensive introduction to the fundamentals of cancer biology and cancer treatment. Topics include cancer genetics, genomics, and epigenetics; familial cancer syndromes; signal transduction, cell cycle control, and apoptosis; cancer metabolism; stem cells and cancer; metastasis; cancer immunology and immunotherapy; conventional and molecularly-targeted therapies; and early detection and prevention. Students taking graduate version complete additional assignments.
*T. Jacks, M. Vander Heiden*

7.86 Building with Cells (New)
Subject meets with 7.46
Prereq: 7.06
G (Fall)
4-0-8 units
Addresses how principles of developmental biology inform understanding of organ formation, repair, and disease. Focuses on the pivotal role of stem cells in normal development, and their use to address anomalies. Students taking graduate version complete additional assignments.
*H. Sive, Staff*
7.89[J] Topics in Computational and Systems Biology
Same subject as CSB.100[J]
Prereq: Permission of instructor
G (Fall)
2.0-10 units
See description under subject CSB.100[J]. Preference to first-year CSB PhD students.
C. Burge

7.930[J] Research Experience in Biopharma
Same subject as 20.930[J]
Prereq: None
G (Fall)
2.0-10 units
See description under subject 20.930[J].
S. Clarke

7.931 Independent Study in Biology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.932 Independent Study in Biology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.933 Research Rotations in Biology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Introduces students to faculty participating in the Biology graduate program through a series of lab rotations, which provide broad exposure to biology research at MIT. Students select a lab for thesis research by the end of their first year. Limited to students in the Biology graduate program.
Staff

7.934 Teaching Experience in Biology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
For qualified graduate students in the Biology graduate program interested in teaching. Classroom or laboratory teaching under the supervision of a faculty member.
Staff

7.935 Responsible Conduct in Biology
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]
Sessions focus on the responsible conduct of science. Considers recordkeeping and reporting; roles of mentor and mentee; authorship, review, and confidentiality; resolving conflicts; misfeasance and malfeasance; collaborations, competing interests, and intellectual property; and proper practices in the use of animal and human subjects. Limited to second-year graduate students in Biology.
Staff

7.941 Research Problems
Prereq: Permission of instructor
G (Fall, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Directed research in a field of biological science, but not contributory to graduate thesis.
Consult Biology Education Office

7.942 Research Problems
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Directed research in a field of biological science, but not contributory to graduate thesis.
Consult Biology Education Office
7.95 Cancer Biology
Prereq: 7.85 and permission of instructor
G (Spring)
3-0-9 units

Advanced seminar involving intensive analysis of historical and current developments in cancer biology. Topics address principles of apoptosis, principles of cancer biology, cancer genetics, cancer cell metabolism, tumor immunology, and therapy. Detailed analysis of research literature, including important reports published in recent years. Enrollment limited.
R. Weinberg, O. Yilmaz

7.98[J] Neural Plasticity in Learning and Memory
Same subject as 9.301[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units

See description under subject 9.301[J]. Juniors and seniors require instructor’s permission.
S. Tonegawa

7.5930 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.5931 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.5932 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.5939 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.THG Graduate Biology Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a Ph.D. thesis; to be arranged by the student and an appropriate MIT faculty member.
Staff