Department of Molecular Biology and Biochemistry

Christopher C.W. Hughes, Department Chair
Celia Goulding, Department Vice Chair
3205 McGaugh Hall
949-824-4915
http://mbb.bio.uci.edu/

Overview

The core discipline of Molecular Biology and Biochemistry is the understanding of the molecular mechanisms that underlie all fundamental biological processes. To that end the faculty of the Department of Molecular Biology and Biochemistry represent diverse research interests that include structure and synthesis of proteins and nucleic acids, gene organization and regulation, cell signaling, immunology and host pathogen interactions, biochemical genetics, cell and developmental biology, microbiology and virology.

Undergraduate Major in Biochemistry and Molecular Biology

Few areas of Biological Sciences remain that are not impacted by studies at the chemical and molecular level. The major in Biochemistry and Molecular Biology is designed to provide a comprehensive background in this modern, conceptual understanding of biology. Students who wish to begin in-depth study of the molecular basis in any of a variety of fields, including development, gene expression, immunology, pathogenesis, disease, virology, and evolution, can do so through this major. This program will be especially attractive to those students who intend to pursue an advanced degree in biological or medical sciences.

The Biochemistry and Molecular Biology major is based upon required courses in Advanced Biochemistry and Advanced Molecular Biology (BIO SCI M114 and BIO SCI M116). These courses, together with a wide variety of elective course offerings, provide majors the choice to either explore the breadth of the field or follow a more in-depth study of any of its subdisciplines. For students interested in the interface between biology and chemistry, this program articulates well with a second major in Chemistry.

The program of study emphasizes laboratory experience and its integration with basic theory. This is accomplished in three ways: first, through coordination between the advanced courses in Biochemistry (BIO SCI M114) and Molecular Biology (BIO SCI M116), and laboratory courses in Biochemistry (BIO SCI M114L) and Molecular Biology (BIO SCI M116L) which provide students with the basic laboratory skills and an appreciation for the experimental foundations of the field; second, through advanced laboratories in Immunology (BIO SCI M121L) and Virology (BIO SCI M127L) which provide students with the opportunity to develop cutting edge research skills; and third, by emphasizing independent research sponsored by a participating faculty member. The program encourages the research interests of students in subdisciplines other than immunology or virology by offering the opportunity to substitute one year of independent research for the advanced laboratory.

The major in Biochemistry and Molecular Biology is designed to provide students with the appropriate tools and training to successfully pursue graduate degrees that emphasize basic scientific research, including Ph.D. and M.S. training as well as combined M.D./Ph.D. programs. In addition, and particularly with the explosive growth in biotechnology and its significant influence in everyday life, graduates could use their backgrounds very effectively to pursue careers in business, education, law, and public affairs.

Requirements for the B.S. in Biochemistry and Molecular Biology

All students must meet the University Requirements.
All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>BIO SCI M114</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>BIO SCI M116</td>
<td>Advanced Molecular Biology</td>
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B. Upper-Division Laboratories:

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
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Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>BIO SCI M121L</td>
<td>Advanced Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M130L</td>
<td>Advanced Molecular Lab Techniques</td>
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</table>

C. Upper-Division Biology Electives:

Select three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>BIO SCI M119–M189</td>
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Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>BIO SCI D137</td>
<td>Eukaryotic and Human Genetics</td>
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<tr>
<td>BIO SCI D145</td>
<td>Genomics, Development, and Medicine</td>
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<tr>
<td>BIO SCI M119–M190</td>
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<tr>
<td>CHEM 128</td>
<td>Introduction to Chemical Biology</td>
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<tr>
<td>PHRMSCI 170A</td>
<td>Molecular Pharmacology I</td>
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<tr>
<td>PHRMSCI 171</td>
<td>Physical Biochemistry</td>
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Select two four-unit courses from the following:

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<th>Course Code</th>
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<tbody>
<tr>
<td>BIO SCI D103–D189, E106–E189, M119–M190, N110–N189</td>
<td></td>
</tr>
<tr>
<td>CHEM 128</td>
<td>Introduction to Chemical Biology</td>
</tr>
<tr>
<td>PHRMSCI 170A</td>
<td>Molecular Pharmacology I</td>
</tr>
<tr>
<td>PHRMSCI 171</td>
<td>Physical Biochemistry</td>
</tr>
</tbody>
</table>

No course may be used to satisfy more than one requirement.

**Application Process to Declare the Major:** The major in Biochemistry and Molecular Biology is open to junior- and senior-level students only. Applications to declare the major can be made at any time, but typically in the spring of the sophomore year. Review of applications submitted at that time and selection to the major by the Biochemistry and Molecular Biology Faculty Board is completed during the summer. Information can also be found at the UCI Change of Major Criteria website (http://www.changeofmajor.uci.edu). Double majors within the School of Biological Sciences or with Public Health Sciences, Biomedical Engineering; Preclinical, Nursing Science, or Pharmaceutical Sciences are not permitted.

**Sample Program — Biochemistry and Molecular Biology**

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<thead>
<tr>
<th>Freshman</th>
<th>Winter</th>
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<tr>
<td>Fall</td>
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<tr>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>MATH 2A or 5A</td>
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<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>CHEM 1C- 1LC</td>
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<tr>
<td>Lower-Division Writing 1</td>
<td>Lower-Division Writing 1</td>
<td>Lower-Division Writing 1</td>
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<tr>
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<tr>
<td>Sophomore</td>
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<td>BIO SCI 98</td>
<td>BIO SCI 99</td>
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<tr>
<td>CHEM 51A</td>
<td>CHEM 51B- 51LB</td>
<td>CHEM 51C- 51LC</td>
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<tr>
<td>CHEM 1LD</td>
<td>General Education</td>
<td>STATS 7, 8, MATH 2D, or MATH 3A</td>
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<tr>
<td>MATH 2B or 5B</td>
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<td>BIO SCI 194S</td>
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<td>Fall</td>
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<tr>
<td>Biochem./Mol. elective</td>
<td>BIO SCI M114</td>
<td>BIO SCI M116</td>
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<td>Research/Elective</td>
<td>Biochem./Mol. elective</td>
<td>Biochem./Mol. elective</td>
</tr>
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<td>BIO SCI 100</td>
<td>BIO SCI M114L</td>
<td>PHYSICS 3C- 3LC</td>
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<tr>
<td>PHYSICS 3A</td>
<td>PHYSICS 3B- 3LB</td>
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<td>Senior</td>
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<td>Fall</td>
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<tr>
<td>Biochem./Mol. elective</td>
<td>Bio. Sci. elective or lab</td>
<td>Bio. Sci. elective or lab</td>
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<tr>
<td>Research/Elective</td>
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<tr>
<td>BIO SCI M116L</td>
<td>General Education/Elective</td>
<td>General Education/Elective</td>
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<td>General Education/Elective</td>
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1 Students have the option of taking HUMAN 1AS, HUMAN 1BS, HUMAN 1CS or WRITING 39A, WRITING 39B, WRITING 39C in order to fulfill the lower-division writing requirement.

**Undergraduate Major in Microbiology and Immunology**

Microbiology and immunology are well-established disciplines within the life sciences. Microbiology addresses the biology of bacteria, viruses, and unicellular eukaryotes such as fungi and protozoa. Studies of microorganisms reveal basic information about processes in evolution, genetics, biochemistry, molecular biology, cell biology, structural biology, and ecology. Many bacteria, viruses, and protozoa cause disease in plants and animals. Hence, major areas of medicine and public health focus on these microorganisms.

Immunology encompasses efforts to understand how multicellular organisms have evolved to survive a variety of challenges to health and survival, including threats by pathogens and cancer cells. Basic questions of how immunity functions are entwined with a fundamental understanding of the consequences of microbial infection. Immunology also refers to the study of autoimmunity, the attack of the host by its own immune system.
The study of viruses (virology) is an important branch of microbiology that has contributed to our understanding of most of the fundamental processes in eukaryotic molecular biology, including the discovery of oncogenes. Viruses provide an excellent tool for the study of disease, cancer, and mechanisms of gene control. With the growing threat of emerging diseases and the potential for viral-based biological weapons, the study of virology was recently intensified and gained new perspectives.

The major is designed primarily for students who are serious about pursuing careers in microbiology and immunology and is intended to provide its graduates with the appropriate tools and training to successfully pursue professional and graduate degrees emphasizing these disciplines. These include Ph.D., M.D., and combined M.D./Ph.D. programs. Majoring in Microbiology and Immunology will also provide resources for serious students wishing to use a solid background in these disciplines for career goals in business, law, public and environmental policy, education, and other pursuits.

Requirements for the B.S. in Microbiology and Immunology

All students must meet the University Requirements.

All students must meet the School Requirements.

Major Requirements for Microbiology and Immunology

A. Required Major Courses:
   - BIO SCI M121: Immunology with Hematology
   - BIO SCI M122: General Microbiology
   - BIO SCI M124A: Virology

B. Upper-Division Laboratories:
   - BIO SCI M116L: Molecular Biology Laboratory
   - and either
     - BIO SCI M118L: Experimental Microbiology Laboratory
     - or BIO SCI M121L: Advanced Immunology Laboratory
     - or BIO SCI M127L: Virology and Immunology Laboratory

C. Upper-Division Biology Electives:
   Select at least four from the following:
   - BIO SCI E124: Infectious Disease Dynamics
   - BIO SCI M119: Advanced Topics in Immunology
   - BIO SCI M120: Signal Transduction in Mammalian Cells
   - BIO SCI M124B: Viral Pathogenesis and Immunity
   - BIO SCI M125: Molecular Biology of Cancer
   - BIO SCI M131: Innate Immunity, Infection, and Pathogenesis
   - BIO SCI M137: Microbial Genetics
   - BIO SCI M143: Human Parasitology
   - BIO SCI M180: Biotechnological Applications of Energy and Environmental Research
   - MOL BIO 205: Molecular Virology
   - and two can be selected from the following:
     - BIO SCI D103: Cell Biology
     - BIO SCI D137: Eukaryotic and Human Genetics
     - BIO SCI M114: Advanced Biochemistry
     - BIO SCI M116: Advanced Molecular Biology
     - BIO SCI M144: Cell Organelles and Membranes

Application Process to Declare the Major: The major in Microbiology and Immunology is open to junior- and senior-level students only. Applications to declare the major can be made at any time, but typically in the spring of the sophomore year. Review of applications submitted at that time and selection to the major by the Microbiology and Immunology Faculty Board is completed during the summer. Information can also be found at the UCI Change of Major Criteria website (http://www.changeofmajor.uci.edu). Double majors within the School of Biological Sciences or with Public Health Sciences, Biomedical Engineering, Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

Sample Program — Microbiology and Immunology

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### Graduate Program

The Department offers graduate study in conjunction with the program in Cellular and Molecular Biosciences (CMB) and the Interdepartmental Neuroscience Program (INP). Students admitted into a combined program who select a research advisor in the Department begin following the departmental requirements for the Ph.D. at the beginning of their second year. Participation in an advanced topics seminar series and completion of at least one course per year for three years are expected of all students. Students must advance to candidacy in their third year. The normative time for completion of the Ph.D. is five years, and the maximum time permitted is seven years.

### Graduate Gateway Program in Medicinal Chemistry and Pharmacology (MCP)

The one-year MCP graduate gateway program is designed to function in concert with selected graduate programs, including the Ph.D. in Biological Sciences. Detailed information is available on the Pharmaceutical Sciences website (http://www.cohs.uci.edu/pharm.shtml).

### Faculty

Dana W. Aswad, Ph.D. University of California, Berkeley, **Professor Emeritus of Molecular Biology and Biochemistry**

Hans-Ulrich Bernard, Ph.D. University of Goettingen, **Professor Emeritus of Molecular Biology and Biochemistry; Program in Public Health**

Alexander D. Boiko, Ph.D. University of Illinois at Urbana–Champaign, **Assistant Professor of Molecular Biology and Biochemistry**

Michael J. Buchmeier, Ph.D. McMaster University, **Professor of Medicine; Microbiology and Molecular Genetics; Molecular Biology and Biochemistry**

John Charles Chaput, Ph.D. University of California, Riverside, **Professor of Pharmaceutical Sciences; Molecular Biology and Biochemistry (chemical and synthetic biology)**

Melanie Cocco, Ph.D. Pennsylvania State University, **Associate Professor of Molecular Biology and Biochemistry; Pharmaceutical Sciences**

Michael G. Cumsky, Ph.D. University of California, Berkeley, **Senior Lecturer of Molecular Biology and Biochemistry**

Hung Y. Fan, Ph.D. Massachusetts Institute of Technology, **Professor Emeritus of Molecular Biology and Biochemistry**

Donald N. Forthal, M.D. University of California, Irvine, **Professor of Medicine; Molecular Biology and Biochemistry**

David A. Fruman, Ph.D. Harvard University, **Professor of Molecular Biology and Biochemistry**

Paul David Gershon, Ph.D. University of Liverpool, **Professor of Molecular Biology and Biochemistry**

Charles Glabe, Ph.D. University of California, Davis, **Professor of Molecular Biology and Biochemistry**

Celia Goulding, Ph.D. King’s College London, **Professor of Molecular Biology and Biochemistry; Pharmaceutical Sciences**

Michael T. Green, Ph.D. University of Chicago, **Professor of Molecular Biology and Biochemistry; Chemistry (chemical, biology, inorganic and organometallic, physical chemistry and chemical physics, theoretical and computational)**

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1 Students have the option of taking HUMAN 1AS, HUMAN 1BS, HUMAN 1CS or WRITING 39A, WRITING 39B, WRITING 39C in order to fulfill the lower-division writing requirement.
Barbara A. Hamkalo, Ph.D. University of Massachusetts, *Professor Emerita of Molecular Biology and Biochemistry*

Yilin Hu, Ph.D. Loma Linda University, *Assistant Professor of Molecular Biology and Biochemistry*

Christopher C. Hughes, Ph.D. University of London, *Interim Director of Edwards Lifesciences Center for Advanced Cardiovascular Technology and Professor of Molecular Biology and Biochemistry; Biomedical Engineering* (tissue engineering, growth and patterning of blood vessels)

Matthew Inlay, Ph.D. University of California, San Diego, *Assistant Professor of Molecular Biology and Biochemistry*

Anthony A. James, Ph.D. University of California, Irvine, *Donald Bren Professor of Microbiology and Molecular Genetics; Molecular Biology and Biochemistry*

Pavan Kadandale, Ph.D. Rutgers, The State University of New Jersey, *Lecturer with Potential Security of Employment of Molecular Biology and Biochemistry*

Mei Kong, Ph.D. McGill University, *Associate Professor of Molecular Biology and Biochemistry*

Young Jik Kwon, Ph.D. University of Southern California, *Professor of Pharmaceutical Sciences; Biomedical Engineering; Chemical Engineering and Materials Science; Molecular Biology and Biochemistry* (gene therapy, drug delivery, cancer-targeted therapeutics, combined molecular imaging and therapy, cancer vaccine)

Chang C. Liu, Ph.D. Scripps Research Institute, *Assistant Professor of Biomedical Engineering; Chemistry; Molecular Biology and Biochemistry* (genetic engineering, directed evolution, synthetic, chemical biology)

Melissa Lodoen, Ph.D. University of California, San Francisco, *Associate Professor of Molecular Biology and Biochemistry*

Hartmut Luecke, Ph.D. William Marsh Rice University, *Professor Emeritus of Molecular Biology and Biochemistry; Physiology and Biophysics*

Ray Luo, Ph.D. University of Maryland, College Park, *Professor of Molecular Biology and Biochemistry; Biomedical Engineering; Chemical Engineering and Materials Science* (protein structure, noncovalent associations involving proteins)

Andrej Luptak, Ph.D. Yale University, *Associate Professor of Pharmaceutical Sciences; Chemistry; Molecular Biology and Biochemistry* (chemical biology)

Jerry E. Manning, Ph.D. University of Utah, *Professor Emeritus of Molecular Biology and Biochemistry*

Rachel Martin, Ph.D. Yale University, *Professor of Chemistry; Molecular Biology and Biochemistry* (analytical, chemical biology, physical chemistry and chemical physics)

Maria J. Massimelli, Ph.D., *Lecturer with Potential Security of Employment of Molecular Biology and Biochemistry*

Alexander McPherson, Ph.D. Purdue University, *Professor Emeritus of Molecular Biology and Biochemistry*

Naomi Morrissette, Ph.D. University of Pennsylvania, *Associate Professor of Molecular Biology and Biochemistry*

Edward L. Nelson, M.D. University of Oregon, *Associate Professor of Medicine; Molecular Biology and Biochemistry*

Irene Pedersen, Ph.D. University of California, San Diego, *Assistant Professor of Molecular Biology and Biochemistry*

Thomas L. Poulos, Ph.D. University of California, San Diego, *UCI Distinguished Professor of Molecular Biology and Biochemistry; Chemistry; Pharmaceutical Sciences; Physiology and Biophysics* (chemical biology)

Ilhem Messaoudi Powers, Ph.D. Cornell University, *Associate Professor of Molecular Biology and Biochemistry*

Jennifer A. Prescher, Ph.D. University of California, Berkeley, *Associate Professor of Chemistry; Molecular Biology and Biochemistry; Pharmaceutical Sciences* (chemical biology, organic and synthetic)

Olga Razorenova, Ph.D. Institute of Molecular Genetics, *Assistant Professor of Molecular Biology and Biochemistry*

Elizabeth L. Read, Ph.D. University of California, Berkeley, *Assistant Professor of Chemical Engineering and Materials Science; Molecular Biology and Biochemistry* (dynamics of complex biochemical systems, regulation of immune responses)

Markus W. Ribbe, Ph.D. University of Bayreuth, *UCI Chancellor's Professor of Molecular Biology and Biochemistry; Chemistry* (chemical biology, inorganic and organometallic)

Brian Sato, Ph.D. University of California, San Diego, *Lecturer with Security of Employment of Molecular Biology and Biochemistry*

Donald F. Senear, Ph.D. University of Washington, *Professor of Molecular Biology and Biochemistry*
Albert Siryaporn, Ph.D. University of Pennsylvania, Assistant Professor of Physics and Astronomy; Molecular Biology and Biochemistry

Robert Spitale, Ph.D. University of Rochester, Assistant Professor of Pharmaceutical Sciences; Molecular Biology and Biochemistry (chemistry, chemical biology, RNA biology)

Andrea Tenner, Ph.D. University of California, San Diego, Professor of Molecular Biology and Biochemistry; Neurobiology and Behavior

Shiou-Chuan (Sheryl) Tsai, Ph.D. University of California, Berkeley, Professor of Molecular Biology and Biochemistry; Chemistry; Pharmaceutical Sciences

Luis P. Villarreal, Ph.D. University of California, San Diego, Professor Emeritus of Molecular Biology and Biochemistry

Craig Walsh, Ph.D. University of California, Los Angeles, Professor of Molecular Biology and Biochemistry

Gregory A. Weiss, Ph.D. Harvard University, Professor of Chemistry; Molecular Biology and Biochemistry (analytical, chemical biology, organic and synthetic, polymer, materials, nanoscience)

Katrine Whiteson, Ph.D. University of Chicago, Assistant Professor of Molecular Biology and Biochemistry

Clifford A. Woolfolk, Ph.D. University of Washington, Professor Emeritus of Molecular Biology and Biochemistry

Courses

MOL BIO 200A. Research in Molecular Biology and Biochemistry. 2-12 Units.
Individual research with Molecular Biology and Biochemistry faculty.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

MOL BIO 200B. Research in Molecular Biology and Biochemistry. 2-12 Units.
Individual research with Molecular Biology and Biochemistry faculty.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

MOL BIO 200C. Research in Molecular Biology and Biochemistry. 2-12 Units.
Individual research with Molecular Biology and Biochemistry faculty.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

MOL BIO 200R. Research in Developmental & Cell Biology for First-year Students. 2-12 Units.
Independent research within the laboratories of graduate training faculty in the Department of Molecular Biology and Biochemistry for first-year Ph.D. students.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be taken for credit 3 times.

MOL BIO 201A. Seminars in Molecular Biology & Biochemistry. 2 Units.
Presentation of research from department laboratories or, when pertinent, of other recent developments.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 201B. Seminars in Molecular Biology & Biochemistry. 2 Units.
Presentation of research from department laboratories or, when pertinent, of other recent developments.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
MOL BIO 201C. Seminars in Molecular Biology & Biochemistry. 2 Units.
Presentation of research from department laboratories or, when pertinent, of other recent developments.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 202A. Tutorial in Molecular Biology and Biochemistry. 2 Units.
Tutorials in the area of research of a particular professor which relate current research to the literature. May be conducted as journal clubs.
Repeatability: Unlimited as topics vary.

MOL BIO 202B. Tutorial in Molecular Biology and Biochemistry. 2 Units.
Tutorials in the area of research of a particular professor which relate current research to the literature. May be conducted as journal clubs.
Repeatability: Unlimited as topics vary.

MOL BIO 202C. Tutorial in Molecular Biology and Biochemistry. 2 Units.
Tutorials in the area of research of a particular professor which relate current research to the literature. May be conducted as journal clubs.
Repeatability: Unlimited as topics vary.

MOL BIO 203. Nucleic Acid Structure and Function. 4 Units.
Structure and chemistry of nucleic acids. Relationship between these properties and the mechanisms of fundamental processes such as replication and repair, RNA-mediated catalysis, formation and regulation of higher order chromatin structure and recombination.
Prerequisite: BIO SCI 98 and BIO SCI 99 and CHEM 51A and CHEM 51B and CHEM 51C

MOL BIO 204. Protein Structure and Function. 4 Units.
The structure and properties of proteins, enzymes, and their kinetic properties.
Prerequisite: BIO SCI 98 and BIO SCI 99 and CHEM 51C

MOL BIO 205. Molecular Virology. 4 Units.
Primary research data on the major DNA and RNA viruses emphasizing strategies of regulation of gene expression. Utilization of viruses as molecular biological tools. Graduate-level knowledge of the biochemistry and molecular biology of macromolecules is required.
Prerequisite: MOL BIO 203 and MOL BIO 204
Restriction: Graduate students only.

MOL BIO 211. High-Resolution Structures: NMR and X-ray. 4 Units.
Basic principles of magnetic resonance and x-ray crystallography toward the determination of high-resolution biomolecular structures.
Prerequisite: MATH 2B
Restriction: Graduate students only.
Concurrent with BIO SCI M133.

MOL BIO 213. Literature in Nucleic Acid Structure and Function. 2 Units.
Exploration and critical analysis of recent primary scientific literature in structure, properties, and biological mechanisms involving nucleic acids.
Corequisite: MOL BIO 203
Grading Option: Satisfactory/unsatisfactory only.

MOL BIO 214. Literature in Protein Structure and Function. 2 Units.
Exploration and critical analysis of recent primary scientific literature in structure and properties of proteins, enzymes, and their kinetic properties.
Corequisite: MOL BIO 204
Grading Option: Satisfactory/unsatisfactory only.
MOL BIO 215. Integrative Immunology. 4 Units.
Lectures and student presentations of primary literature. The main goal is to achieve a basic understanding of the cellular and molecular basis of innate and adaptive immunity, and how immune function is coordinated at a systems level.

Same as M&MG 215.

MOL BIO 217A. Principles of Cancer Biology I. 4 Units.
Oncogenes and tumor suppressor genes are studied from molecular viewpoints. Also studies their role in cancer; viral carcinogenesis. Designed for graduate students interested in cancer research. Format includes lectures and student-led discussions.

Prerequisite: MOL BIO 203 and MOL BIO 204
Restriction: Graduate students only.

MOL BIO 217B. Principles of Cancer Biology II. 4 Units.
Topics include cancer cell growth and metastasis, chemical carcinogenesis, and cancer genetics and epidemiology. Designed for graduate students interested in cancer research. Format includes lectures and student-led discussions.

Prerequisite: MOL BIO 203 and MOL BIO 204
Restriction: Graduate students only.

MOL BIO 218. Clinical Cancer. 3 Units.
Designed to acquaint students in basic life science with clinical cancer.

Restriction: Graduate students only.

MOL BIO 220. Structure & Synthesis of Biological Macromolecules Journal Club. 2 Units.
Advanced topics in macromolecular structure and synthesis as related to biological problems.

Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

MOL BIO 221. Advanced Topics in Immunology. 4 Units.
Literature-based, interactive discussions focused on review of seminal historic and recent immunology literature. Student responsibilities include reading, critical evaluation, and discussion of manuscripts.

Prerequisite: M&MG 215
Restriction: Graduate students only.

MOL BIO 221L. Advanced Immunology Laboratory. 4 Units.
An advanced course in immunology for graduate students enrolled in the Biotechnology master's program. Emphasis is placed on learning modern techniques in immunology such as ELISAs, western blotting, immunofluorescent staining assays.

Restriction: Graduate students only.
Concurrent with BIO SCI M121L.

MOL BIO 223. Introduction to Computational Biology. 4 Units.

Same as BME 232.
Restriction: Graduate students only.
Concurrent with BIO SCI M123 and COMPSCI 183 and BME 132.
MOL BIO 227. Immunology Journal Club. 2 Units.
Advanced topics in immunology as related to an understanding of human disease.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be taken for credit 15 times.
Restriction: Graduate students only.

MOL BIO 227L. Virology and Immunology Laboratory. 5 Units.
Introductory laboratory course in virology and immunology designed for Biological Sciences graduate students. Curriculum includes plasmid preparation, plasmid characterization, microscopy, cell culture, transfection and infection of cells, cell counting, plaque assays, ELISA, Western blot, mixed lymphocyte reactions.
Restriction: Graduate students only.

MOL BIO 229. Research-in-Progress Seminars. 1 Unit.
Two half-hour presentations by graduate students and postdoctorals to the department on their current research projects.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be taken for credit 15 times.
Restriction: Graduate students only.

MOL BIO 235. Literature in Chemical and Structural Biology. 1 Unit.
Exploration and critical analysis of recent primary scientific literature in chemical and structural biology.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 244. Principles of Genomics. 4 Units.
A survey course of the principal subfields of genomics and their applications to biological and health sciences that will cover genome assembly and annotation, genome structure, comparative genomics, population genomics, functional genomics, and medical genomics.
Same as DEV BIO 214.
Restriction: Graduate students only.

MOL BIO 248. Metallobiochemistry. 4 Units.
A review of the biochemistry of metallic elements emphasizing: methods for studying metals in biological systems; the chemical basis for nature's exploitation of specific elements; structures of active sites; mechanisms; solid-state structures and devices; metals in medicine.
Prerequisite or corequisite: CHEM 131C or CHEM 132C
Same as CHEM 218.

MOL BIO 250. Advanced Topics in Biotechnology - Nucleic Acids. 2 Units.
Supplements laboratory curriculum with scientific background behind experimental methods. Format consists of lectures and the presentation and analysis of relevant papers from the scientific literature.
Corequisite: MOL BIO 250L
Restriction: Graduate students only. Biotechnology Majors only.

MOL BIO 250L. Biotechnology Laboratory - Nucleic Acids. 8 Units.
Nucleic acid techniques and recombinant DNA technology. Extraction and purification of nucleic acids, cloning and subcloning, PCR, site-directed mutagenesis, nucleic acid hybridization, additional associated procedures. Students must demonstrate accurate documentation of data (laboratory notebook) detailing experience and results.
Corequisite: MOL BIO 250
Restriction: Graduate students only. Biotechnology Majors only.
MOL BIO 251. Advanced Topics in Biotechnology - Protein Purification and Characterization. 2 Units.
Supplements laboratory curriculum with scientific background behind experimental methods. Format consists of lectures and the presentation and analysis of relevant papers from the scientific literature.

Corequisite: MOL BIO 251L
Prerequisite: MOL BIO 250L and MOL BIO 250

Restriction: Graduate students only. Biotechnology Majors only.

MOL BIO 251L. Biotechnology Laboratory - Protein Purification and Characterization. 8 Units.
Major techniques of handling proteins and antibodies. Protein engineering, expression and large-scale purification of recombinant proteins from bacteria, HPLC, antibody purification, western blotting, additional associated procedures. Students must demonstrate accurate documentation of data (laboratory notebook) detailing experience and results.

Corequisite: MOL BIO 251
Prerequisite: MOL BIO 250L and MOL BIO 250

Restriction: Graduate students only. Biotechnology Majors only.

MOL BIO 252L. Biotechnology Management Laboratory. 8 Units.
Overview of current methods in biotechnology, designed specifically for biotechnology graduate students. Organized into four distinct sections (nucleic acids, proteins, virology, and immunology). Students must demonstrate accurate documentation of data (laboratory notebooks) detailing experience and results.

Restriction: Graduate students only. Biotechnology Majors only.

MOL BIO 253. Biotech Management . 5 Units.
Taught jointly by Bio Sci and Merage School faculty, the course addresses fundamental aspects within, and associated with, the biotechnology industry. Curriculum is focused largely on management issues, including finance, product development, pharmaceuticals, project management, regulatory affairs, and ethics.

Same as MGMTMBA 293.

Restriction: Graduate students only. Biotechnology Majors only.

MOL BIO 253L. Stem Cell Laboratory. 4 Units.
Designed to prepare M.S. Biotechnology program students for a career in stem cell research. Laboratory training utilizes tissue culture, mouse and human embryonic stem cells, and is enhanced with didactic material and discussion.

Prerequisite: MOL BIO 250L and MOL BIO 251L

Restriction: Graduate students only. Biotechnology Majors only.

MOL BIO 268. Seminar in Systems Microbiology Research. 1 Unit.
A research and journal club seminar that covers topics on bacteria and phage using approaches and principles from biology, engineering, and physics.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Same as CBEMS 268, MBB 268.

Restriction: Upper-division students only. Graduate students only.

MOL BIO 270. Science Communication Skills. 2 Units.
Development of effective communication skills, oral and written presentations. Topics range from the art of creating keynote slides to strategically crafting a personal story, culminating in a live presentation to an invited audience.

MOL BIO 270. Science Communication Skills. 2 Units.
Development of effective communication skills, oral and written presentations. Topics range from the art of creating keynote slides to strategically crafting a personal story, culminating in a live presentation to an invited audience.

MOL BIO 291. Graduate School Fundamentals. 2 Units.
Lectures and discussions providing basic skills needed for success in Ph.D. graduate studies. Topics include formulating a hypothesis, experimental design, literature review, grant writing, oral communication, biostatistics, time management, and professional development.

Grading Option: Satisfactory/unsatisfactory only.

Restriction: Graduate students only. Cellular and Molecular Biosci Majors only.
MOL BIO 292A. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 292B. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 292C. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 293A. Cancer Biology Journal Club. 1 Unit.
Focuses on molecular mechanisms that underlie the development and progression of cancers. Covers a variety of cancer-related research areas, such as cell cycle control, apoptosis, DNA repair, metastasis, angiogenesis, and others.
Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only.

MOL BIO 293B. Cancer Biology Journal Club. 1 Unit.
Focuses on molecular mechanisms that underlie the development and progression of cancers. Covers a variety of cancer-related research areas, such as cell cycle control, apoptosis, DNA repair, metastasis, angiogenesis, and others.
Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only.

MOL BIO 293C. Cancer Biology Journal Club. 1 Unit.
Focuses on molecular mechanisms that underlie the development and progression of cancers. Covers a variety of cancer-related research areas, such as cell cycle control, apoptosis, DNA repair, metastasis, angiogenesis, and others.
Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only.

MOL BIO 295. Biomedical Research Methods. 2 Units.
Lectures and interactive discussions of research methods in modern biomedical science. Each week will focus on a different class of techniques, including molecular, biochemical, immunological, genomic, bioinformatics, microscopy, cancer biology, genome editing. One hour per week, grading based on attendance.
Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only. Cellular and Molecular Biosci Majors only.

MOL BIO 399. University Teaching. 4 Units.
Limited to Teaching Assistants.
Restriction: Graduate students only.