Molecular Environmental Biology

Bachelor of Science (BS)

The Molecular Environmental Biology (MEB) major is designed to expose students to the organization and function of biological organisms. Molecular approaches are expected to play an increasing role in environmental problem-solving in the near future, and their success will depend upon a sound understanding of biological principles from molecular through ecological levels. The program trains students in the organization and function of biological organisms and their integration into the environment.

Admission to the Major

Freshman students may apply directly to the major, or they may select the College of Natural Resource's undeclared option and declare the major by the end of their fourth semester. For further information regarding how to declare the major after admission including information on a change of major of change of college, students should see the College of Natural Resources Undergraduate Student Handbook (http://www.cnr.berkeley.edu/site/forms/oisa/undergrad_handbook.pdf) .

Honors Program

Students with a grade point average (GPA) of 3.6 or higher may enroll in the College of Natural Resources Honors Program (H196) once they have reached upper division standing. To fulfill the program requirements, students design, conduct, and report on an individual research project working with a faculty sponsor. For further information on registering for the Honors Symposium and on Honors requirements, please see the College of Natural Resources website (http://nature.berkeley.edu/site/honors_program.php) .

Minor Program

There is no minor program in Molecular Environmental Biology.

Other Majors and Minors Offered by the Department of Environmental Science, Policy, and Management

Conservation and Resource Studies (http://guide.berkeley.edu/archive/2015-16/undergraduate/degree-programs/conservation-resource-studies) (Major and Minor)
Environmental Sciences (http://guide.berkeley.edu/archive/2015-16/undergraduate/degree-programs/environmental-sciences) (Major only)
Forestry and Natural Resources (http://guide.berkeley.edu/archive/2015-16/undergraduate/degree-programs/forestry-natural-resources) (Major and Minor)
Society and Environment (http://guide.berkeley.edu/archive/2015-16/undergraduate/degree-programs/society-environment) (Major only)

In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program.

General Guidelines

1. All courses taken to fulfill the major requirements below must be taken for graded credit, other than courses listed which are offered on a *Pass/No Pass* basis only. Other exceptions to this requirement are noted as applicable.
2. A minimum cumulative grade point average (GPA) of 2.0 is required.
3. A minimum GPA of 2.0 in upper division major requirements is required.
4. At least 15 of the 36 required upper division units must be taken in the College of Natural Resources (except for students majoring in Environmental Economics and Policy; please see the EEP major adviser for further information).
5. A maximum of 16 units of Independent Study (courses numbered 97, 98, 99, 197, 198, and 199) may count toward graduation, with a maximum of 4 units of Independent Study per semester.
6. No more than 1/3 of the total units attempted at UC Berkeley may be taken *Pass/No Pass*. This includes units in the Education Abroad Program and UC Intercampus Visitor or Exchange Programs.
7. A maximum of 4 units of Physical Education courses will count toward graduation.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

Areas of Concentration

1. Animal Health & Behavior
2. Biodiversity
3. Ecology
4. Environment & Human Health
5. Insect Biology/Anthropod Science
6. Microbiology

Summary of Major Requirements

Lower division Requirements	
Upper division Requirements	
Biological Core: Seven courses	
Lab Requirement: Two courses, selected as part of either the Biological Core or Area of Concentration requirements	
Area of Concentration: 12 units	

Please see below for the specific details regarding these requirements.

Lower division Requirements

ESPM Environmental Science Core

Select one of the following:	
ENV SCI 10	Introduction to Environmental Sciences
ESPM 2	The Biosphere
ESPM 6	Environmental Biology
ESPM C10	Environmental Issues
ESPM 15	Introduction to Environmental Sciences

ESPM Social Science Core		
Select one of the following:		
ESPM C11	Americans and the Global Forest	4
ESPM C12/ ENGLISH C77	Introduction to Environmental Studies	4
or ESPM 50AC	Introduction to Culture and Natural Resource Management	
or ESPM 60	Environmental Policy, Administration, and Law	
CHEM 1A & 1AL	General Chemistry and General Chemistry Laboratory	4
CHEM 3A & 3AL	Chemical Structure and Reactivity and Organic Chemistry Laboratory	5
CHEM 3B & 3B	Chemical Structure and Reactivity and Chemical Structure and Reactivity	6
BIOLOGY 1A & 1AL	General Biology Lecture and General Biology Laboratory	5
BIOLOGY 1B	General Biology Lecture and Laboratory	4
MATH 16A	Analytic Geometry and Calculus [1]	3
MATH 16B	Analytic Geometry and Calculus [1]	3
PHYSICS 8A	Introductory Physics [2]	4

1 For students in areas of concentration 2 (Biodiversity), 3 (Ecology), or 5 (Insect Biology/Anthropod Science), MATH 1A and MATH 1B can be substituted for MATH 16A and MATH 16B.

2 For pre-med students, PHYSICS 8B is required in addition to PHYSICS 8A.

Upper division Requirements, Biological Core

15 upper division units must be taken in the College of Natural Resources

Select one course from each of the seven categories below. With the exception of the lab courses, each course can be used to satisfy only one requirement; courses selected for the Biological Core requirement cannot overlap with those selected for the Area of Concentration requirement.

Biochemistry		
CHEM 135	Chemical Biology	3
MCELLBI 102	Survey of the Principles of Biochemistry and Molecular Biology	4
MCELLBI 110	Molecular Biology: Macromolecular Synthesis and Cellular Function	4
Molecular Biology/Genetics		
PLANTBI 160	Plant Molecular Genetics	3
INTEGBI 141	Human Genetics	3
INTEGBI 161	Population and Evolutionary Genetics	4
INTEGBI 162	Ecological Genetics	4
INTEGBI 164	Human Genetics and Genomics (lab included)	4
MCELLBI 140	General Genetics	4
MCELLBI 110	Molecular Biology: Macromolecular Synthesis and Cellular Function	4
MCELLBI 104	Genetics, Genomics, and Cell Biology	4
Cell & Developmental Biology		
MCELLBI 130A	Course Not Available	
MCELLBI 133L	Physiology and Cell Biology Laboratory	4
MCELLBI 141	Developmental Biology	4
MCELLBI 135E	Course Not Available	3
MCELLBI 137	Computer Simulation in Biology	3
PLANTBI/ MCELLBI C112	General Microbiology	4
PLANTBI C112L	General Microbiology Laboratory	2
PLANTBI 150	Plant Cell Biology	3
PB HLTH 162A	Public Health Microbiology	3
PB HLTH 162L	Public Health Microbiology Laboratory	1
Organismal Physiology		
ESPM 144	Insect Physiology	3
INTEGBI 132	Survey of Human Physiology	4
INTEGBI 140	Biology of Human Reproduction	4
INTEGBI 148	Comparative Animal Physiology	3
MCELLBI 136	Physiology	4
NUSCTX 103	Nutrient Function and Metabolism	3
PLANTBI/ MCELLBI C116	Microbial Diversity	3
PLANTBI 135	Physiology and Biochemistry of Plants	3
Organismal Diversity		
ESPM 106	American Wildlife: Identification and Conservation (lab included)	3
ESPM 108A	Trees: Taxonomy, Growth, and Structures (lab included)	3
ESPM 115B	Biology of Aquatic Insects	2
ESPM 132	Spider Biology (lab included)	4
ESPM C138/ PLANTBI C114/ MCELLBI C114	Introduction to Comparative Virology	4
ESPM 140	General Entomology (lab included)	4
INTEGBI 102LF	Introduction to California Plant Life with Laboratory	4
INTEGBI 103LF	Invertebrate Zoology with Laboratory	5
INTEGBI 104LF	Natural History of the Vertebrates with Laboratory	5
INTEGBI 168 & 168L	Systematics of Vascular Plants and Systematics of Vascular Plants with Laboratory	6
PLANTBI C102	Course Not Available	
or PLANTBI C102L	Course Not Available	
PLANTBI 113	California Mushrooms (lab included)	3
PLANTBI C110L	Biology of Fungi with Laboratory (lab included)	4
PLANTBI/ MCELLBI C116	Microbial Diversity	3
PLANTBI 120 & 120L	Biology of Algae and Laboratory for Biology of Algae	4
Ecology		
ESPM 102A	Terrestrial Resource Ecology (lab included)	4
ESPM 110	Primate Ecology	4
ESPM 111	Ecosystem Ecology	4
ESPM 112	Microbial Ecology	3
ESPM 113	Insect Ecology	3
ESPM 114	Wildlife Ecology	3
ESPM 115C	Fish Ecology (lab included)	3
ESPM 116B	Range Ecology, Improvements, and Management	3
ESPM 116C	Tropical Forest Ecology	3

ESPM 119	Chemical Ecology	2
ESPM 131	Soil Microbial Ecology	3
ESPM/INTEGBI C149	Molecular Ecology	4
INTEGBI 153	Ecology	3
INTEGBI 154 & 154L	Plant Ecology and Plant Ecology Laboratory	5
Senior Seminar		
ESPM C192	Molecular Approaches to Environmental Problem Solving	2

Lab Requirement

Select two upper division courses which include a lab, as part of the Biological Core or Area of Concentration requirements.

Additionally, this requirement many be fulfulled by: (1) One 3-4 unit independent study lab (course numbered H196 or 199); Summer Forestry Field Camp; or the Moorea Field Study course.

Area of Concentration Requirement

Select 12 units from one concentration below. Up to four independent study units (e.g., ESPM 199, ESPM H196) may be applied to the concentration.

1. Animal Health & Behavior

ESPM C103/ INTEGBI C156	Principles of Conservation Biology	4
ESPM 106	American Wildlife: Identification and Conservation (lab included)	3
ESPM 110	Primate Ecology	4
ESPM 114	Wildlife Ecology	3
ESPM C126/ INTEGBI C144	Animal Behavior	4
ESPM 142	Insect Behavior	3
ESPM 146L	Medical and Veterinary Entomology Laboratory	1
ESPM 186	Management and Conservation of Rangeland Ecosystems	4
ESPM 188	Case Histories in Wildlife Management	2
INTEGBI 104LF	Natural History of the Vertebrates with Laboratory	5
INTEGBI C143A/ PSYCH C113	Biological Clocks: Physiology and Behavior	3
INTEGBI C143B/ PSYCH C116	Hormones and Behavior	3
INTEGBI 146LF	Behavioral Ecology with Laboratory	5
INTEGBI 148	Comparative Animal Physiology	3
INTEGBI 184L	Morphology of the Vertebrate Skeleton with Laboratory	4
PSYCH 121	Animal Cognition	3

2. Biodiversity

ESPM C103/ INTEGBI C156	Principles of Conservation Biology	4
ESPM C105	Natural History Museums and Biodiversity Science	3
ESPM 106	American Wildlife: Identification and Conservation (lab included)	3
ESPM 108A	Trees: Taxonomy, Growth, and Structures (lab included)	3
ESPM 115B	Biology of Aquatic Insects	2
ESPM 132	Spider Biology (lab included)	4
ESPM 140	General Entomology (lab included)	4
ESPM 147	Field Entomology (“Ants,” “Beetles,” and “Spiders” (1 unit each) SP. All three courses must be completed to equal one “lab course”)	1
INTEGBI 102LF	Introduction to California Plant Life with Laboratory	4
INTEGBI 103LF	Invertebrate Zoology with Laboratory	5
INTEGBI 104LF	Natural History of the Vertebrates with Laboratory	5
INTEGBI 160	Evolution	4
INTEGBI 166	Evolutionary Biogeography	4
INTEGBI 168 & 168L	Systematics of Vascular Plants and Systematics of Vascular Plants with Laboratory	6
INTEGBI 173LF	Mammalogy with Laboratory	5
INTEGBI 174LF	Ornithology with Laboratory	4
INTEGBI 175LF	Herpetology with Laboratory	4
INTEGBI 183L	Evolution of the Vertebrates with Laboratory	4
PLANTBI C102	Course Not Available	4
PLANTBI C110L	Biology of Fungi with Laboratory	4
PLANTBI 113	California Mushrooms	3
PLANTBI/ MCELLBI C116	Microbial Diversity	3
PLANTBI 120 & 120L	Biology of Algae and Laboratory for Biology of Algae	4

3. Ecology

ESPM 105A	Sierra Nevada Ecology	4
ESPM 102A	Terrestrial Resource Ecology	4
ESPM C103/ INTEGBI C156	Principles of Conservation Biology	4
ESPM 110	Primate Ecology	4
ESPM C104/ ENVECON C115	Modeling and Management of Biological Resources	4
ESPM 111	Ecosystem Ecology	4
ESPM 112	Microbial Ecology	3
ESPM 113	Insect Ecology	3
ESPM 114	Wildlife Ecology	3
ESPM 115B	Biology of Aquatic Insects	2
ESPM 115C	Fish Ecology	3
ESPM 116B	Range Ecology, Improvements, and Management	3
ESPM 116C	Tropical Forest Ecology	3
ESPM 117	Urban Garden Ecosystems	4
ESPM 118	Agricultural Ecology	3
ESPM 119	Chemical Ecology	2
ESPM C130/ GEOG C136	Terrestrial Hydrology	4
ESPM 131	Soil Microbial Ecology	3
ESPM 134	Fire, Insects, and Diseases in Forest Ecosystems	3
ESPM 146L	Medical and Veterinary Entomology Laboratory	1
ESPM 147	Field Entomology	1

ESPM/INTEGBI C149	Molecular Ecology	4
ESPM 152	Global Change Biology	3
ESPM 172	Photogrammetry and Remote Sensing	3
ESPM 173	Introduction to Ecological Data Analysis	3
ESPM 174	Design and Analysis of Ecological Research	4
ESPM C180	Air Pollution	3
ESPM 181A	Fire Ecology	3
ESPM 188	Case Histories in Wildlife Management	2
PLANTBI 180	Environmental Plant Biology	2
INTEGBI 102LF	Introduction to California Plant Life with Laboratory	4
INTEGBI 151	Plant Physiological Ecology	4
INTEGBI 153	Ecology	3
INTEGBI 154 & 154L	Plant Ecology and Plant Ecology Laboratory	5
INTEGBI C155/ ANTHRO C129D	Holocene Paleoecology: How Humans Changed the Earth	3

4. Environment & Human Health

ANTHRO 135	Paleoethnobotany: Archaeological Methods and Laboratory Techniques (lab included)	4
ESPM C126/ INTEGBI C144	Animal Behavior	4
ESPM C138/ PLANTBI C114/ MCELLBI C114	Introduction to Comparative Virology	4
ESPM C148/ NUSCTX C114	Pesticide Chemistry and Toxicology	3
ESPM 152	Global Change Biology	3
ESPM 158	Biodiversity Conservation in Working Landscapes	4
ESPM/NUSCTX C159	Human Diet	4
ESPM 162	Bioethics and Society	4
ESPM C167	Environmental Health and Development	4
INTEGBI 116L	Medical Parasitology	4
INTEGBI 117	Medical Ethnobotany	2
INTEGBI 117LF	Medical Ethnobotany Laboratory	2
INTEGBI 131	General Human Anatomy	3
INTEGBI 131L	General Human Anatomy Laboratory	2
INTEGBI 137	Human Endocrinology	4
INTEGBI 140	Biology of Human Reproduction	4
INTEGBI C143A/ PSYCH C113	Biological Clocks: Physiology and Behavior	3
INTEGBI C143B/ PSYCH C116	Hormones and Behavior	3
MCELLBI 135A	Topics in Cell and Developmental Biology: Molecular Endocrinology	3
MCELLBI 150	Molecular Immunology	4
MCELLBI 165	Neurobiology of Disease	3
NUSCTX 103	Nutrient Function and Metabolism	3
NUSCTX 108A	Introduction and Application of Food Science	3
NUSCTX 110	Toxicology	4
NUSCTX 160	Metabolic Bases of Human Health and Diseases	4
NUSCTX 166	Nutrition in the Community	3
PLANTBI/ MCELLBI C103	Bacterial Pathogenesis	3
PLANTBI 180	Environmental Plant Biology	2
PB HLTH 103	Drugs, Health, and Society	2
PB HLTH 104A	Health Promotion in a College Setting	2
PB HLTH 105	Policy, Planning, and Evaluation of Health Promotion in a College Setting	3
PB HLTH 116	Seminar on Social, Political, and Ethical Issues in Health and Medicine	3
PB HLTH 150B	Introduction to Environmental Health Sciences	3
PSYCH 110	Introduction to Biological Psychology	3

5. Insect Biology/Arthropod Science

ESPM 140	General Entomology (ESPM 140 required for Insect Biology concentration.)	4
ESPM C105	Natural History Museums and Biodiversity Science	3
ESPM 113	Insect Ecology	2
ESPM 132	Spider Biology	4
ESPM 134	Fire, Insects, and Diseases in Forest Ecosystems	3
ESPM 142	Insect Behavior	3
ESPM 144	Insect Physiology	3
ESPM 147	Field Entomology	1
ESPM C148	Pesticide Chemistry and Toxicology	3
ESPM 172	Photogrammetry and Remote Sensing	3

6. Microbiology

CIV ENG 114	Environmental Microbiology	3
ESPM 112	Microbial Ecology	3
ESPM 131	Soil Microbial Ecology	3
ESPM C138	Introduction to Comparative Virology	4
MCELLBI C148	Microbial Genomics and Genetics	4
PLANTBI C103	Bacterial Pathogenesis	3
PLANTBI C112	General Microbiology	4
PLANTBI C112L	General Microbiology Laboratory	2
PLANTBI C116	Microbial Diversity	3
PB HLTH 162A	Public Health Microbiology	3
PB HLTH 162L	Public Health Microbiology Laboratory	1

For College Requirements, please refer to the College of Natural Resources (http://guide.berkeley.edu/archive/2015-16/undergraduate/colleges-schools/natural-resources/#collegerequirementstext) .

Mission

Molecular Environmental Biology (MEB) focuses on biological organisms and the hierarchy of life, from molecules and genes through cells, organisms, communities and ecosystems. The breadth of this biological science program provides an important perspective for students who have a passion for biology and are interested in the application of biological principles to understand how organisms function in their environment. Also a pre-medical or pre-health science major, the discipline offers an array of six areas of concentration within biology: microbiology, animal health and behavior, insect biology, ecology, biodiversity, and environmental and human health.

Learning Goals for the Major

1. Holistic interdisciplinary thinking, that understanding the “big picture"
    a. Interdisciplinarity: The ability to understand and work across different disciplines
    b. Multiple processes: Recognition that biology and the environment involve multiple processes as do solutions to modern problems
    c. Interconnectedness: Understanding that biology and the environment are interconnected at many spatial, temporal, and hierarchical levels
    d. Global and international approaches: Appreciating that the environment is necessarily global in nature and solutions to problems require international approaches
2. Training in the hierarchy of biology
    a. Fundamentals of Science: Training in the cores areas of physics, chemistry, biology, and mathematics
    b. Quantitative skills: Necessary tools for addressing biological problems
    c. Biochemistry: An understanding of the fundamentals of biological chemistry including the properties of intermediary metabolites, the structure and function of biological macromolecules, and the logic of basis of genetics and gene expression
    d. Molecular biology/Genetics: The molecular biology of bacterial, archaeal and eukaryotic cells and their viruses, mechanisms of DNA replication, transcription, translation, nuclear and organellar genome structure and function and regulation of gene expression heritability, measures of selection, etc.
    e. Cell and developmental biology: Cell structure and function, embryonic and post-embryonic development and growth, and gene expression
    f. Organismal physiology: Understanding of physiological function whether microbial, animal or plant, or comparison between different systems
    g. Organismal diversity: Emphasis on the nature of diversity whether plant, animal, fungus, protist, bacteria, or virus, the history of the lineages and life itself, and how diversity is distributed, global threats, etc.
    h. Ecology: The nature of interactions, biotic or abiotic, that dictate organismal distributions in space and time
    i. Laboratory experiences: Laboratory experiences allow students to gain hands-on experience in scientific approaches and methods
    j. Capstone seminar: The major ends with a senior seminar in Molecular Approaches to Environmental Problem-Solving. This course is highly interdisciplinary and is specifically intended to illustrate how all of the levels and approaches to biology are complementary and applicable to assessing or solving real-world problems especially as it relates to environmental issues
3. Analysis and application for students that choose the Animal Health & Behavior area of concentration
    a. Interaction of health and environment: Understanding how the environment, whether internal or external, affects organism health and behavior
    b. Expertise in health: Examination of the health of organisms from either physiological or environmental perspectives
    c. Epizootics: An appreciation of the potential for diseases in animal populations to spill over into humans as is the case in avian influenza or even the origins of HIV
4. Analysis and application for students that choose the Biodiversity area of concentration
    a. Biodiversity science: Detailed understanding of morphological and ecological diversity of a given organismic lineage
    b. Origins and evolution of life: Basic understanding of systematics and phylogenetics
    c. Quantifying biology: Knowledge of various sampling and species identification techniques to collect data
    d. Informatics: Proficiency in database development and management
5. Analysis and application for students that choose the Ecology area of concentration
    a. Principles of Ecology: Detailed understanding of ecological principles including energy flow, hydrologic, and mineral cycles, factors limiting species distribution and population size, and characteristics of species, populations, and communities
    b. Ecological interactions: Interactions relevant to different organismic groups.
    c. Biodiversity: Understanding of the biology of communities and ecosystems.
6. Analysis and application for students that choose the Environment & Human Health area of concentration.
    a. Interaction of health and environment: Understanding of how the environment affects human health and well-being.
    b. Disease: Environmental epidemiology and the impacts of disease.
    c. Diet: Effects of nutrition and diet on human health.
7. Analysis and application for students who choose the Insect Biology area of concentration.
    a. Insects and biodiversity science: Understanding of major insects groups, relationships, and diversity.
    b. Insects and environmental science: Knowledge of the impacts of insects (positive and negative) in the environment.
    c. Quantifying insects and biology: Skills in collecting and identifying insects.
8. Analysis and application for students who choose the Microbiology area of concentration.
    a. Microbiology expertise: Expertise and competence in processes, patterns in microbiology, and the role of microbes in ecosystem function.
    b. Biodiversity: Understanding of microbial genetic and functional diversity, ecological factors impacting microbial spatial and temporal distribution.
    c. Microbiology and the environment: Microbiology in environmental science, including impacts on human health & well-being.
9. Basic skills in research, analysis, communication.
    a. Reading carefully: Ability to read for detail and comprehension.
    b. Writing accurately: Ability to write succinctly, clearly, with coherence.

c. Thinking critically: Critical thinking through the exposure and synthesis of biological knowledge from courses and lab work.
d. Using theoretical and empirical knowledge: Ability to synthesize and apply information obtained through theory and observations.
e. Quantitative skills: Obtaining the quantitative skills necessary for the subdisciplines.
f. Analysis: Ability to perceive, tackle, and solve problems in environmental science.
g. Research experience: Research experience to practice scientific approaches and methods. Work with a faculty mentor while participating in an undergraduate research program or designing an individual research project. Share research results or work in progress in the form of a paper, report, research poster, or public presentation.
h. Communication: Strong communication skills, both written and verbal, to prepare for independent research work or team projects.

10. Lifetime skills.
    a. Continuing appreciation for biological systems: To develop a passion for biology and its interconnections with the environment.
    b. Representing science: To become an advocate for the training and knowledge of science, particularly the biological disciplines.