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.

Declaring the Major
Advice on admission for freshmen and transfer students can be found on the Rausser College Admissions Guide (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/ admittedindex.html) or the Rausser College Prospective Student website (https://nature.berkeley.edu/prospective-students/). Freshman students may apply directly to the major, or they may select the Rausser College of Natural Resource's undeclared option and declare the major by the end of their fourth semester. Transfer students apply directly to the major, or they may select the Rausser College of Natural Resources Honors Program (H196) on registering for the Honors Symposium and on Honors requirements, please see the Rausser 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/undergraduate/degree-programs/conservation-resource-studies/) (Major and Minor)
Environmental Sciences (http://guide.berkeley.edu/undergraduate/degree-programs/environmental-sciences/) (Major)
Food Systems (https://nature.berkeley.edu/advising/minors/food-systems/) (Minor)
Ecosystem Management and Forestry (https://guide.berkeley.edu/undergraduate/degree-programs/ecosystem-management-forestry/) (Major and Minor)
Geospatial Information Science and Technology (https://nature.berkeley.edu/advising/minors/gist/) (Minor)
Society and Environment (https://guide.berkeley.edu/undergraduate/degree-programs/society-environment/) (Major)

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.

Structure of the MEB Major
The lower division coursework provides a strong foundation in biological principles, and the upper division areas introduce students to the organization and function of biological organisms at the molecular, cellular, organismal, and ecological levels. The major also offers specialization through six Areas of Concentration: (1) animal health and behavior, (2) biodiversity, (3) ecology, (4) environmental and human health, (5) global change biology, and (6) insect biology.

**The curriculum has been revised effective Fall 2016. Students admitted prior to Fall 16 and following the previous curriculum should refer to the 15-16 (http://guide.berkeley.edu/archive/2015-16/undergraduate/degree-programs/molecular-environmental-biology/#majorrequirementstext) Guide.

Lower Division Requirements

Breadth Requirement
Select courses from L&S “7 Breadth” Categories (https://ls.berkeley.edu/seven-course-breadth-requirement/)

* One course (3-4 units) in Arts & Literature, Historical Studies, or Philosophy & Values
* One course (3-4 units) in Social & Behavioral Sciences or International Studies

Honors Program
Students with a grade point average (GPA) of 3.6 or higher may enroll in the Rausser 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 Rausser College of Natural Resources website (http://nature.berkeley.edu/site/honors_program.php).
Reading & Composition Requirement

Students must complete Reading & Composition (http://guide.berkeley.edu/undergraduate/colleges-schools/letters-science/reading-composition-requirement/) by the end of sophomore year.

Core Requirement

ESPM Environmental Science Core

Select one of the following:

- ESPM 2 The Biosphere [3]
- ESPM 6 Environmental Biology [3]
- ESPM C10 Environmental Issues [4]
- ESPM 15 Introduction to Environmental Sciences [3]
- ESPM C46 Climate Change and the Future of California [4]

ESPM Social Science Core

Select one of the following:

- ESPM 5 FROM FARM TO TABLE: FOOD SYSTEMS IN A CHANGING WORLD [4]
- ESPM C11 Americans and the Global Forest [4]
- ESPM C22AC Fire: Past, Present and Future Interactions with the People and Ecosystems of California [4]
- ESPM 50AC Introduction to Culture and Natural Resource Management [4]
- ESPM 60 Environmental Policy, Administration, and Law [4]

Science Core

Complete all of the following:

- CHEM 1A & 1AL General Chemistry and General Chemistry Laboratory
- CHEM 3A & 3AL Chemical Structure and Reactivity and Organic Chemistry Laboratory
- CHEM 3B & 3BL Chemical Structure and Reactivity and Organic Chemistry Laboratory
- BIOLOGY 1A & 1AL General Biology Lecture and General Biology Laboratory
- BIOLOGY 1B General Biology Lecture and Laboratory [4]
- PHYSICS 8A Introductory Physics [4]

Quantitative Core (2 courses)

Select one of the following:

- MATH 1A Calculus [4]
- MATH 16A Analytic Geometry and Calculus [3]

Select one of the following:

- MATH 1B Calculus [4]
- MATH 16B Analytic Geometry and Calculus [3]
- STAT 2 Introduction to Statistics [4]
- STAT C8 Foundations of Data Science [4]
- PB HLTH 141 Introduction to Biostatistics [5]

Upper division Requirements

Select two courses from Area A and two courses from Area B. Also complete 12 units in Area of Concentration and two lab courses.

Area A: Genetics, Molecular, Cell, and Developmental Biology

- CHEM 135 Chemical Biology [3]
- ESPM 108B Environmental Change Genetics (lab included) [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 102 Survey of the Principles of Biochemistry and Molecular Biology [4]
- MCELLBI 104 Genetics, Genomics, and Cell Biology [4]
- MCELLBI 130 Cell and Systems Biology [4]
- MCELLBI 133L Physiology and Cell Biology Laboratory (lab included) [4]
- MCELLBI 137L Physical Biology of the Cell (lab included) [4]
- MCELLBI 140 General Genetics [4]
- PLANTBI C112 General Microbiology and General Microbiological Data Analysis Lab (lab course optional) [4]
- PLANTBI 135 Physiological and Biochemistry of Plants [3]
- PLANTBI 150 Plant Cell Biology [3]
- PLANTBI 160 Plant Molecular Genetics [3]
- PB HLTH 162A Public Health Microbiology [3]
- PB HLTH 162L Public Health Microbiology Laboratory (lab course optional) [2]

Area B: Ecology, Evolution, and Organismal Biology

- ESPM C105 Natural History Museums and Biodiversity Science (lab included) [3]
- ESPM 108A Trees: Taxonomy, Growth, and Structures (lab included) [3]
- ESPM 111 Ecosystem Ecology [4]
- ESPM 112 Microbial Ecology [3]
- ESPM 112L Microbial Metagenomic Data Analysis Lab (lab course optional) [3]
- ESPM 113 Insect Ecology [3]
Area of Concentration Requirement

Select 12 units from one concentration below. Up to four independent study units (research units numbered 192C, H196, or 199) may be applied to the concentration.

Animal Health & Behavior

ESPM C103  Principles of Conservation Biology 4
ESPM 114  Wildlife Ecology 3
ESPM C126  Animal Behavior 4
ESPM 142  Insect Behavior 3
ESPM C156  Animal Communication 3
ESPM 157  Data Science in Global Change Ecology (lab included) 4
ESPM 158  Biodiversity Conservation in Working Landscapes (lab included) 4
ESPM 186  Management and Conservation of Rangeland Ecosystems 4
ESPM C192  Molecular Approaches to Environmental Problem Solving 2
INTEGBI 104LF  Natural History of the Vertebrates with Laboratory 5
INTEGBI 135  The Mechanics of Organisms 4
INTEGBI C135L/BIO ENG C136L/EL ENG C145O  Laboratory in the Mechanics of Organisms 3
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 173LF  Mammalogy with Laboratory 5
INTEGBI 174LF  Ornithology with Laboratory 4
INTEGBI 175LF  Herpetology with Laboratory 4
INTEGBI 184L  Morphology of the Vertebrate Skeleton with Laboratory 4
PSYCH 121  Animal Cognition 3

Biodiversity

ESPM C103  Principles of Conservation Biology 4
ESPM C105  Natural History Museums and Biodiversity Science (lab included) 3
ESPM 108A  Trees: Taxonomy, Growth, and Structures (lab included) 3
ESPM C125  Biogeography 4
ESPM C126  Animal Behavior 4
ESPM 132  Spider Biology (lab included) 4
ESPM 140  General Entomology (lab included) 4
ESPM 142  Insect Behavior 3
ESPM 147  Field Entomology ("Ants," "Beetles," and "Spiders" (1 unit each) SP. All three courses must be completed to equal one "lab course") 1

Lab Requirement

Select two upper division courses which include a lab, as part of the Areas A or B or Area of Concentration requirements. Additionally, this requirement may be fulfilled by: (1) One 3-4 unit independent study lab (research units numbered 192C, H196, or 199); Summer Forestry Field Camp; or the Moorea Field Study course.
Global Change Biology

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>NUSCTX 166</td>
<td>Nutrition in the Community</td>
<td>3</td>
</tr>
<tr>
<td>PLANTBI C103</td>
<td>Bacterial Pathogenesis</td>
<td>3</td>
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<tr>
<td>PB HLTH 101</td>
<td>A Sustainable World: Challenges and Opportunities</td>
<td>3</td>
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<tr>
<td>PB HLTH 116</td>
<td>Seminar on Social, Political, and Ethical Issues in Health and Medicine</td>
<td>3</td>
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<tr>
<td>PB HLTH 150B</td>
<td>Human Health and the Environment in a Changing World</td>
<td>3</td>
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<tr>
<td>PB HLTH 196</td>
<td>Special Topics in Public Health (“Artificial Intelligence in Medicine and Health Policy”)</td>
<td>3</td>
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<tr>
<td>PSYCH 110</td>
<td>Introduction to Biological Psychology</td>
<td>3</td>
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**Insect Biology/Arthropod Science**

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<tr>
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<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>ESPM 140</td>
<td>General Entomology (ESP 140 required for Insect Biology concentration, Lab included.)</td>
<td>4</td>
</tr>
<tr>
<td>ESPM C105</td>
<td>Natural History Museums and Biodiversity Science (Lab included)</td>
<td>3</td>
</tr>
<tr>
<td>ESPM 113</td>
<td>Insect Ecology</td>
<td>3</td>
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<tr>
<td>ESPM 132</td>
<td>Spider Biology (Lab included)</td>
<td>4</td>
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<tr>
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<tbody>
<tr>
<td>ESPM 134</td>
<td>Fire, Insects, and Diseases in Forest Ecosystems</td>
<td>3</td>
</tr>
<tr>
<td>ESPM 142</td>
<td>Insect Behavior</td>
<td>3</td>
</tr>
<tr>
<td>ESPM 144</td>
<td>Insect Physiology</td>
<td>3</td>
</tr>
<tr>
<td>ESPM 147</td>
<td>Field Entomology (“Ants,” “Beetles,” and “Spiders” (1 unit each) SP. All three courses must be completed to equal one “lab course”)</td>
<td>1</td>
</tr>
<tr>
<td>ESPM C148/ NUSCTX C114</td>
<td>Pesticide Chemistry and Toxicology</td>
<td>3</td>
</tr>
<tr>
<td>ESPM 157</td>
<td>Data Science in Global Change Ecology (lab included)</td>
<td>4</td>
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<tr>
<td>ESPM 172</td>
<td>Remote Sensing of the Environment (lab included)</td>
<td>3</td>
</tr>
<tr>
<td>ESPM C192</td>
<td>Molecular Approaches to Environmental Problem Solving</td>
<td>2</td>
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Reading and Composition (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/reading-composition-requirement/)

In order to provide a solid foundation in reading, writing and critical thinking, all majors in the College require two semesters of lower division work in composition. Students must complete a first-level reading and composition course by the end of their second semester and a second-level course by the end of their fourth semester.

Foreign Language (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/foreign-language-requirement/): **EEP Majors only**

The Foreign Language requirement is only required by Environmental Economics and Policy (EEP) majors. It may be satisfied by demonstrating proficiency in reading comprehension, writing, and conversation in a foreign language equivalent to the second semester college level, either by passing an exam or by completing approved course work.

Quantitative Reasoning (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/quantitative-reasoning-requirement/): **EEP Majors only**

The Quantitative Reasoning requirement is only required by Environmental Economics and Policy (EEP) majors. The requirement may be satisfied by exam or by taking an approved course.

**Undergraduate Breadth**

Undergraduate breadth provide Berkeley students with a rich and varied educational experience outside of their major program and many students complete their breadth courses in their first two years. Breadth courses are built into the Rausser College major requirements and each major requires a different number of breadth courses and categories. The EEP major is the only college major that requires the entire 7 course breadth. Refer to the major snapshots on each Rausser College major page (https://nature.berkeley.edu/advising/majors-minors/) for for additional information.

**High School Exam Credit**

Unit Requirements
Students must complete at least 120 semester units of courses subject to certain guidelines:

- At least 36 units must be upper division courses, including a minimum of 15 units of upper division courses in the Rausser College.
- A maximum of 16 units of Special Studies coursework (courses numbered 97, 98, 99, 197, 198, or 199) is allowed towards the 120 units; a maximum of four is allowed in a given semester.
- A maximum of 4 units of Physical Education from any school attended will count towards the 120 units.
- Students may receive unit credit for courses graded P (including P/ NP units taken through EAP) up to a limit of one-third of the total units taken and passed on the Berkeley campus at the time of graduation.

Semester Unit Minimum
All Rausser College students must enroll in at least 12 units each fall and spring semester.

Semester Unit Maximum
To request permission to take more than 20.5 units in a semester, please see the major adviser.

Semester Limit
Students admitted as freshmen must graduate within 8 fall/spring semesters at UC Berkeley. Students admitted as transfer students must graduate within 4 fall/spring semesters at UC Berkeley. Students who go on EAP and UCDC can petition for additional semesters. Summer session, UC Extension and non-UC study abroad programs do not count towards this semester limit. Students approved for double majors or simultaneous degrees in two colleges may be granted an additional semester. Rausser College does not limit the number of total units a student can accrue.

Senior Residence Requirement
Once you achieve and exceed 90 units (senior status), you must complete at least 24 of the remaining 30 units in residence at the Rausser College of Natural Resources over at least 2 semesters. To count as residence, a semester must consist of at least 6 passed units taken while the student is a member of Rausser. At least one of the two terms must be a fall or spring semester. Senior residence terms do not need to be completed consecutively. All courses offered on campus for the fall, spring, and summer terms by Berkeley departments and programs and all Berkeley online (‘W’) courses count. Inter-campus Visitor, Education Abroad Program, UC Berkeley Washington Program, and UC Berkeley Extension units do not count toward this requirement. Students may use Summer Session to satisfy one semester of the Senior Residence Requirement, provided that 6 units of coursework are completed.

Modified Senior Residence Requirement
Participants in a fall, spring or summer UC Education Abroad Program (UCEAP), Berkeley Summer Abroad, or the UC Berkeley Washington Program may meet a modified Senior Residence Requirement by completing 24 of their final 60 semester units in residence (excluding UCEAP). At least 12 of these 24 units must be completed after senior status is reached. International travel study programs sponsored by Summer Sessions and education abroad programs offered outside of the UC system do not qualify for modified senior residence. Most students automatically satisfy the residence requirement by attending classes here for four years. In general, there is no need to be concerned about this requirement, unless students go abroad for a semester or year or want to take courses at another institution or through University Extension during their senior year. In these cases, students should make an appointment to see an adviser to determine how they can meet the Senior Residence Requirement.

Grade Requirements
- A 2.0 UC GPA is required for graduation.
- A 2.0 average in all upper division courses required of the major program is required for graduation.
- A grade of at least C- is required in all courses for the major

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: animal health and behavior, biodiversity, ecology, environmental and human health, insect biology, and global change biology.

Learning Goals for the Major
1. Holistic multidisciplinary thinking - understanding the “big picture”
   a. Interdisciplinarity & Crossdisciplinarity: The ability to understand and work across different disciplines (crossdisciplinarity) and to integrate the knowledge and methods from them (interdisciplinarity)
   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 logical 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, regulation of gene expression, heritability, measures of selection, etc.

e. Cell and developmental biology: Cell structure and function, cellular metabolic processes, embryonic and post-embryonic development and growth

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, global threats, how diversity is distributed, and the ecological and evolutionary processes that generate and maintain diversity.

h. Ecology: The nature of interactions, biotic or abiotic, that dictate organismal distributions in space and time, energy flows, or population dynamics

i. Laboratory experiences: Laboratory experiences allow students to gain hands-on experience in scientific approaches and methods

3. Analysis and application for students who 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 who 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 who 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.


6. Analysis and application for students who choose the Environment & Human Health area of concentration.


b. Disease: Environmental epidemiology and the impacts of disease.


7. Analysis and application for students who choose the Global Change Biology area of concentration.

a. Global change biology expertise: How changes to the global environment impact organisms and ecosystems, including impacts to spatial and temporal distributions of organisms, ecological processes, and ecosystem functions.

b. Global change and the environment: Global change biology in environmental science, including effects of human activities and impacts on human health and well-being.

c. Environmental problem solving: Conservation and mitigation strategies, ecological analysis, and natural resource economics

8. 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

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, and coherently.

c. Thinking critically: Critical thinking through the 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.

c. Problem solving: To develop and practice scientific thinking and problem-solving skills, through data analysis, hypothesis testing, and critical reasoning, that translate to future careers inside and outside of biology.

In the Rausser College of Natural Resources, we provide holistic, individual advising services to prospective and current students who are pursuing major and minors in our college. We assist with a range of topics including course selection, academic decision-making, achieving personal and academic goals, and maximizing the Berkeley experience.

If you are looking to explore your options, or you are ready to declare a major, double major, or minor, contact the undergraduate advisor for your intended major. Visit our website (https://nature.berkeley.edu/advising/meet-cnr-advisors/) to explore all of our advising services.

**Undergraduate Advisors, Molecular Environmental Biology**

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