

Learning Goals for Major in Molecular Environmental Biology
Undergraduate Student Learning Initiative / University of California, Berkeley

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. The MEB major is offered by the Department of Environmental Science, Policy, and Management (ESPM): <http://espm.berkeley.edu>.

When students graduate with a Molecular Environmental Biology (MEB) major from UC Berkeley, they will have the following knowledge and skills:

1. Holistic interdisciplinary thinking, that understanding the “big picture”
 - 1.1. Interdisciplinarity. The ability to understand and work across different disciplines.
 - 1.2. Multiple processes. Recognition that biology and the environment involve multiple processes, as do solutions to modern problems.
 - 1.3. Interconnectedness. Understanding that biology and the environment are interconnected at many spatial, temporal, and hierarchical levels.
 - 1.4. 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
 - 2.1. Fundamentals of Science. Training in the cores areas of physics, chemistry, biology, and mathematics.
 - 2.2. Quantitative skills. Necessary tools for addressing biological problems.
 - 2.3. Biochemistry. An understanding of the fundamentals of biological chemistry, including the properties of intermediary metabolites, the structure and function of biological macromolecules, the logic of metabolic pathways and the molecular basis of genetics and gene expression.
 - 2.4. 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.
 - 2.5. Cell and developmental biology. Cell structure and function, embryonic and post-embryonic development and growth, gene expression.
 - 2.6. Organismal physiology. Understanding of physiological function, whether microbial, animal or plant, or comparison between different systems.

3. Analysis and application for students that choose the Animal Health & Behavior area of concentration
 - 3.1. Interaction of health and environment. Understanding how the environment, whether internal or external, affects organism health and behavior.
 - 3.2. Expertise in health. Examination of the health of organisms, from either physiological or environmental perspectives.
 - 3.3. 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
 - 4.1. Biodiversity science. Detailed understanding of morphological and ecological diversity of a given organismic lineage.
 - 4.2. Origins and evolution of life. Basic understanding of systematics and phylogenetics.
 - 4.3. Quantifying biology. Knowledge of various sampling and species identification techniques to collect data.
 - 4.4. Informatics. Proficiency in database development and management.
5. Analysis and application for students that choose the Ecology area of concentration
 - 5.1. 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
 - 5.2. Ecological interactions. Interactions relevant to different organismic groups.
 - 5.3. Biodiversity. Understanding of the biology of communities and ecosystems.
6. Analysis and application for students that choose the Environment & Human Health area of concentration.
 - 6.1. Interaction of health and environment. Understanding of how the environment affects human health and well-being.
 - 6.2. Disease. Environmental epidemiology and the impacts of disease.
 - 6.3. Diet. Effects of nutrition and diet on human health.
7. Analysis and application for students who choose the Insect Biology area of concentration.
 - 7.1. Insects and biodiversity science. Understanding of major insects groups, relationships, and diversity.
 - 7.2. Insects and environmental science. Knowledge of the impacts of insects (positive and negative) in the environment.
 - 7.3. Quantifying insects and biology. Skills in collecting and identifying insects.
8. Analysis and application for students who choose the Microbiology area of concentration.
 - 8.1. Microbiology expertise. Expertise and competence in processes, patterns in microbiology, and the role of microbes in ecosystem function.

- 8.2. Biodiversity. Understanding of microbial genetic and functional diversity, ecological factors impacting microbial spatial and temporal distribution.
 - 8.3. Microbiology and the environment. Microbiology in environmental science, including impacts on human health & well-being.
9. Basic skills in research, analysis, communication.
- 9.1. Reading carefully. Ability to read for detail and comprehension.
 - 9.2. Writing accurately. Ability to write succinctly, clearly, with coherence.
 - 9.3. Thinking critically. Critical thinking through the exposure and synthesis of biological knowledge from courses and lab work.
 - 9.4. Using theoretical and empirical knowledge. Ability to synthesize and apply information obtained through theory and observations.
 - 9.5. Quantitative skills. Obtaining the quantitative skills necessary for the subdisciplines.
 - 9.6. Analysis. Ability to perceive, tackle, and solve problems in environmental science.
 - 9.7. Research experience. Research experience to practice scientific approaches and methods. Work with a faculty mentor while participating in an undergraduate research program or designing your own research project. Share your research results, or work in progress, in the form of a paper, report, research poster, or public presentation.
 - 9.8. Communication. Strong communication skills, both written and verbal, to prepare for independent research work or team projects.
- 10.0 Lifetime skills.
- 10.1 Continuing appreciation for biological systems. To develop a passion for biology and its interconnections with the environment.
 - 10.2. Representing science. To become an advocate for the training and knowledge of science, particularly the biological disciplines.

Communicating Learning Goals to MEB Undergraduates

The Department of ESPM provides the following ways of communicating with major and potential major students:

- ESPM Undergraduate website <http://espm.berkeley.edu/ugmajors/index.php>. This site includes information on the goals of the individual majors and career options, student planning options including areas of concentration, and major faculty advisors.
- Major Handbooks that are updated regularly and made available in hard copy or online (<http://espm.berkeley.edu/ugmajors/MEB/>). The same site also has information on the goals of the major and career options, student planning options including areas of concentration, and faculty advisors. This year we plan to incorporate a slightly longer and more narrative version of the learning goals into this material.

- Creation of a central page on the CNR website for all of the CNR majors to post their learning goals (in pdf. format for easy downloading), and corresponding links to the Departments websites.

Assessment of Majors' Attainment of These Goals

Students are trained and assessed in all of the skills mentioned above in the context of ESPM 192. 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. Students are tutored in the development of their own assessment of an environmental problem and thus gain unique experience in reading, writing, thinking and analysis of a variety of different types of science.

We plan to administer an exit survey of these goals and skills in the senior seminar, ESPM 192, and to initiate discussion with MEB majors on their level of satisfaction with the attainment of the goals. We will use the results to improve the major and the courses.

The large and diverse body of faculty advisors in MEB, coupled with the excellent staff of our Student Affairs Officer, Ms. Marjorie Ensor, help to ensure that our majors have a home in the department, and acquire the more affective learning goals we hope for after graduation.

What Is Needed to Successfully Implement these Goals

The MEB major is the largest and most rapidly growing major in the College of Natural Resources, presumably because of the concern about the environment, biodiversity, human health, and issues of climate change, coupled with the increasingly sophisticated molecular and other tools available to approach problems and address concerns of societal relevance. To meet the increasing demands on the program, MEB has the following needs for the future:

1. Additional student services personnel to meet with students and assist them in advising and curricular choices.
2. Additional Graduate Student Instructors (GSIs) to expand the lower and upper division core courses.
3. Additional funds for field trips, which are fundamental to the success of some of our most popular classes.
4. Increased involvement of all our faculty members in the primary goals of the major, both in terms of advising students and teaching classes.
5. More support for instructional equipment.