

# **Undergraduate Student Learning Initiative**

## **Microbial Biology Major**

### **Department of Plant and Microbial Biology**

#### ***Background***

The Microbial Biology undergraduate program is an interdisciplinary effort, involving faculty in the PMB Department, The Joint Genome Institute, The Molecular and Cellular Biology Department and affiliations with the Lawrence Berkeley National Laboratories and Environmental Science and Policy Management.

#### ***Goals***

Students should be able to:

- I. Demonstrate a solid grasp of the fundamentals of biology, chemistry, and math that are necessary for understanding the more advanced concepts that are presented in upper-division major coursework.
- II. Have the skills to evaluate scientific information as a result of receiving adequate training in statistics, computational biology and genomics.
- III. Have an understanding and appreciation of microbial diversity in various ecosystems.
- IV. Have an understanding of the importance of microbes as related to biotechnology and human health.
- V. Have an understanding of the scientific method and the microbial research process.
- VI. Demonstrate proficiency in scientific writing and presentation.
- VII. Have exposure to an undergraduate research experience. Our goal is to give every microbial biology undergraduate the opportunity to do research in either a laboratory or field research setting. This experience would include reading and evaluating primary literature, critical thinking and the development of a hypothesis to test and other aspects of the scientific method including data analysis, as well as oral and written presentation of their research.
- VIII. Appreciate the relationship between a Microbial Biology major and the community at large.

#### ***How the Learning Goals Intersect with the Curriculum***

- I. *Demonstrate a solid grasp of the fundamentals of biology, chemistry, and math.*  
This goal is met by the current lower division requirements (59 to 66 units), which includes basic training in mathematics, physics, chemistry, biology, as well as reading and composition.
- II. *Skills to evaluate scientific information as a result of receiving adequate training in statistics, computational biology and analyses.*  
This goal is currently being met by a lower division statistics course and an introduction to computational biology and comparative genomics in PMB C148, an upper division requirement. In addition, PMB C145 and PMB C146 (Genomics and Computational Biology and Genomics, respectively) are upper division electives. We will be expanding this goal with the recent inclusion of two computational biologists to our program,

Adjunct Assistant Professor Dr. Cheryl Kerfield (Joint Genome Institute), who studies structural and functional characterization of bacterial microcompartments, and Associate Professor Dr. Kimmen Sjolander (BioEngineering Department), who is a computational biologist focusing on algorithm development for protein homolog identification.

III. *An understanding and appreciation of microbial diversity in various ecosystems*

This goal is a focus of our required undergraduate courses within the microbial biology major, including PMB C112 and PMB C148. In addition, we have a wide range of diversity classes as our upper division electives, including Microbial Diversity (PMB C116), Comparative Virology (PMB C114), Biology of the Fungi (PMB 110), California Mushrooms (PMB 113), Biology of Algae (PMB 120), Microbial Ecology and Soil Microbiology (ESPM 112 and ESPM 131) and Environmental Microbiology (CE 114).

IV. *An understanding of the importance of microbes as related to biotechnology and human health.*

Microbes are important from both an industrial and human health perspective. These topics are overviewed in PMB C112. We have upper division electives that students can take that focus on these areas of study in more detail, including Bacterial Pathogenesis (PMB C103), Molecular Immunology (MCB 150), Public Health Microbiology and laboratory (PH162A), Food Microbiology (Nutri Sci 113), Medical Parasitology and lab (IB 116), and Applied Microbiology and Biochemistry (MCB 113).

V. *An understanding the scientific method and the microbial research process.*

Our required undergraduate course PMB C112 has a rigorous laboratory component. In addition, many of our upper division diversity courses also have a laboratory component to the course (PMB 110, PMB 120, ESPM 112, PMB C102, IB 116 and PH 162A). Also, many of the computational/genomics courses that are offered to undergraduate have a substantial computer laboratory component (PMB C145, PMB C146 and BioEng 144). Microbial biology majors are required to take at least one additional laboratory class in addition to PMB C112L in order to successfully complete the major requirements.

VI. *Proficiency in scientific writing and presentation.*

Although this is an important goal of the undergraduate Microbial Biology major, it is unclear whether this goal is adequately met in terms of the existing core curriculum. It may be that a specific requirement for the major in terms of evaluation of a written proposal could be considered.

VII. *Exposure to an undergraduate research experience.*

This goal is achievable by offering students the opportunity to carry out research in PMB laboratories under the rubric of Honors Research (PMB H196) and Supervised Independent Study and Research (PMB 99 and PMB 199) and by having students prepare written/oral evaluations of the research which they carried out under the supervision of a faculty member (or other competent person, postdoctoral student, GSI, etc.). It is the goal of our program to provide an opportunity for all students within the major to have access to an undergraduate laboratory experience.

VIII. *Training students to appreciate the relationship of the Microbial Biology major to the community at large.*

We hope to provide instruction in Microbial Biology that will enable our students to make informed evaluations of scientific research that they may encounter in any aspect of their lives. However, achievement of this goal is difficult to assess. We are considering developing an on-line exit survey of our Microbial Biology undergraduates, both for

specific feedback on our program and also more general feedback about whether the above goal has been met or achievable.

Also, for the past several years, our department has sponsored a Decal Course called “Teaching Mad Science”. This program provides all UCB Students (including Microbial Biology majors) an excellent opportunity to give back to the community by preparing and teaching science lessons for after-school programs at local middle schools.

## **Communicating Goals**

The PMB department employs a number of strategies to inform undergraduates about the Microbial Biology major. These include:

- 1) The PMB website,  
<http://plantbio.berkeley.edu/newpmb/academic/undergraduate.shtml>
- 2) The PMB Microbial Biology Undergraduate Program Handbook, and
- 3) A one-page Microbial Biology major checklist.

In addition, the program information is listed in the College of Natural Resources Undergraduate Program Announcement, and on [www.assist.org](http://www.assist.org), which is a site for California community college students wishing to transfer to a 4-year institution. Although general information on the Microbial Biology major is readily accessible, we will be updating our literature to make sure that our program goals are highlighted.

Students may also receive guidance about learning goals by contacting the undergraduate advisor and undergraduate programs staff for the Microbial Biology program.

## **Assessment**

The eight learning goals listed above are addressed by the completion of the required lower division and upper division core courses for Microbial Biology and the exposure to undergraduate research that our students receive. A variety of tools are used to assess students in these different courses and in the laboratories, including problem sets, quizzes, exams, written proposals and oral presentations.

In order to ensure that our program objectives are successful, it is essential to continue to provide top-notch laboratory and computer laboratories for our courses. The Microbial Biology major has grown considerably over the past five years. During the 2002-2003 academic year, there were 30 students enrolled in the Microbiology major, and the current registrar’s data shows that we are expecting approximately 165 Microbiology majors to be enrolled for Fall 2008.

The interest of undergraduates for the Microbial Biology major is an excellent trend for us. However, the number of students in our major severely impacts our laboratory offering for the required Microbial Biology core course PMB C112. Of the approximately 105 students enrolled in PMB C112 each fall, currently only 48 can be accommodated in the laboratory in the fall and only 24 in the spring. Thus, approximately 1/3 of the students are unable to take the laboratory the year they take the lecture section of C112. To accommodate all of our students and provide an excellent laboratory experience for all of our Microbial Biology undergraduate majors, we require additional laboratory support for C112. This objective is an essential introduction to our goal number 7, which is to provide an opportunity to work on a research project in either the

field or the laboratory. This goal would be severely compromised unless the students have laboratory experience associated with course work in Microbial Biology.

There has also been difficulty in procuring a computer laboratory classroom for the core course Microbial Genomics and Genetics (PMB C148) and the electives Genomics and Computational Biology and Genomics (PMB C145 and C146).

In order to equip our majors with the ability to excel in oral and written presentation of scientific material (Goal VI) and in carrying out independent research (Goal VII), it is essential that students progress in attaining these goals be adequately monitored. At present, there are not specific guidelines for students or faculty in achieving these goals. We hope to develop a checklist for students and faculty for evaluation of students that choose to take independent research (Honors Research (PMB H196) or Supervised Independent Study and Research (PMB 99 and PMB 199). We envision use this checklist as a guide for both students and faculty in their expectations of independent research and for developing more uniform standards for the undergraduate research experience.

Regarding the ability to excel in written presentation of scientific material, we are considering the possibility of a course addition. For example, ESPM students majoring in Conservation and Resource Studies (ESPM 194) take a seminar in their senior year where they orally present their undergraduate research project or present a literature-based research problem and approach and also write a scientific paper on their research (abstract, intro, methods, results and discussion).

Alternatively, an additional credit to a required or elective course could be envisioned, where students would write an essay by presenting a scientific argument, synthesizing scientific material, assessing the data and evaluating the strength of the scientific process. If this latter course is taken, objectives, guidelines and checklists must be developed to guarantee some level of uniformity across the courses.

Finally, we are discussing the possibility of an interactive website whereby Microbial Biology undergraduate students completing the major can suggest improvements to the curriculum and provide feedback on the learning goals. However, an obstacle to the attainment of many of the learning goals we have outlined for the Microbial Biology major is lack of adequate resources.