To be adopted:

Proposal for an Interdepartmental Major, B.S. in Microbiology

I. Overview and Academic Rationale
II. Mission of the Major and Learning Outcomes
III. Course Framework
IV. Entry of Students into the Major
V. Advising and Mentoring of Students
VI. Relationships with and Impact on Other Majors
VII. New Courses developed for the Major
VIII. Organizational and Governance Considerations

Prepared by the Microbiology Major Steering Committee:

James Borneman (Chair)
Katherine Borkovich (member)
Marylynn Yates (member)

Approved by:

Microbiology Participating Faculty Members 3-5-2010
CNAS Dean Baldwin: 2-11-11
CNAS Executive Committee: 11-16-10
Committee on Educational Policy: 4-12-11
I. Overview and Academic Rationale

The College of Natural and Agricultural Sciences proposes the establishment of a Bachelor of Science degree titled “Microbiology.” This proposal is responding to both enrollment increases in microbiology courses at UCR and the importance of microbiology in science, technology and society. Enrollment in microbiology courses at UCR has doubled over the last eight years. Students applying for admission to professional schools are required to take certain undergraduate microbiology courses. After taking the introductory lecture and laboratory courses, many of these students are so interested in microbiology that they take several additional microbiology courses as electives in the Biological Sciences major. The proposed major will expose and train students in a myriad of areas in microbiology including human and animal pathogenesis, molecular genetics, physiology, environmental sciences, food science, plant pathology, biotechnology, and epidemiology, among others.

II. Mission of the Major and Learning Outcomes

The mission of the major is to train students in microbiology using a structured curriculum that will allow students to be competitive after graduating from UCR. The curriculum is designed to provide suitable flexibility to allow students to prepare for a broad range of research, education and health-related careers encompassed by the discipline.

Learning Outcomes:

Objective 1: Students demonstrate an understanding of fundamental microbiology concepts and principles.

Method 1: Examination.
The evaluation will be the grade of the comprehensive final exam from MCBL 121, which is an introductory class that covers fundamental microbiology concepts and principles. All students will be required to take the class.

Objective 2: Students demonstrate the ability to apply critical thinking skills to evaluate existing knowledge and to formulate methods for generating new knowledge. When faced with a problem or the unknown, students can formulate a hypothesis and design an experiment to test it. They are able to draw on existing knowledge in the form of scientific literature, other published materials and online content, judge the relative quality of these sources and use this knowledge to answer questions and set a foundation for generating new knowledge.

Method 1: Capstone Course.
A new class titled Experimental Microbiology (MCBL 125) was developed. This is a laboratory class designed to train students in the formulation of hypotheses and the development of experiments to test them. Students will also be required to organize and present their work in both written and oral formats. The evaluation will include the final grade in the course and a summary of the student’s performance in the various components of the class (using a standardized evaluation form to be developed). All students will be required to take the class.

As an example, faculty member Dr. Katherine Borkovich has been involved with a summer research program at UCLA utilizing the eukaryotic microbe *Neurospora crassa*. Plans are underway for this program to be taught as an undergraduate laboratory course at Texas A&M University and the same
could be done at UCR. Students use bioinformatics techniques to select a group of *Neurospora* genes and then analyze the corresponding mutants (generated during a high-throughput gene knockout project) for growth and developmental defects. They upload the data to a website at the Broad Institute at MIT. Each student selects one mutant for more detailed analysis during the last few weeks of the quarter. They develop a hypothesis, design and perform the experiment and analyze the results. They write a research paper on their results and also prepare a PowerPoint presentation to give to the class. In many cases, the data generated by the students has been published in peer-reviewed scientific papers.

**Method 2: Research with Faculty.**

Students have the option to participate in undergraduate research using the MCBL 197 course. This course will require a written proposal to be completed at the start of the research program along with a final report written in the standard format of a research paper. This course will enable evaluation of both critical thinking and communication skills. Evaluations will be made by the participating faculty members using a standardized evaluation form (to be developed).

**Objective 3: Students demonstrate the ability to communicate scientific ideas clearly in both written and oral formats.** They can draw on existing knowledge to write a synthetic paper using citations from the scientific literature and are able to summarize scientific information to a lay audience. They can also present new knowledge through oral and written scientific reports and research papers. These skills are developed through classroom and laboratory experiences as well as undergraduate research symposia or workshops.

**Method 1: Capstone Course.**

A new class titled Experimental Microbiology (MCBL 125) was developed. This is a laboratory class designed to train students in the formulation of hypotheses and the development of experiments to test them. Students will also be required to organize and present their work in both written and oral formats. The evaluation will include a summary of the student’s performance on the communication components of the class using a standardized evaluation form (to be developed). All students will be required to take the class. See above for an example of specific content.

**Method 2: Research with Faculty.**

Students have the option to participate in undergraduate research using MCBL 197. This course will require a written proposal to be completed at the start of the research program and a final report written in the standard format of a research paper. This course will enable evaluation of both critical thinking and communication skills. Evaluations of the communication components of the class will be made by the participating faculty members using a standardized evaluation form (to be developed).

**Method 3: Portfolio.**

A portfolio of selected course work items will be collected as each student progresses through the program. These items will have been graded in the context of the course in which they originated and will also be evaluated in toto by a committee of faculty using a rubric (to be developed). Items will be drawn principally from upper-division courses (MCBL 121, 121L, 125) that require written research papers.

**Objective 4: Students demonstrate the ability to apply technical, analytical and computational skills.** Students can perform experiments described in laboratory protocols and operate basic laboratory equipment and explain the basis for their function. They can evaluate quantitative and qualitative experimental data and present the data in tabular or graphical form as appropriate. They
are familiar with standard computer software and can analyze datasets through application of appropriate basic formulae and interpret the results relative to biological principles.

**Method 1: Laboratory Courses.**
Students will be required to take two laboratory courses (MCBL 121L and 125). Evaluations of the components of this objective (described above) will be made by the participating faculty members using a standardized evaluation form (to be developed).

**Objective 5: Students identify appropriate career objectives and successfully pursue them.**
Typical objectives would include employment in industry, government, land management, or teaching as well as advanced training in graduate or professional school.

**Method 1: Survey of Graduating Students.**
Just prior to graduation, students will complete an exit survey (to be developed) of their opinions regarding their undergraduate experience and their continuing career goals and plans. A similar alumni survey will be conducted at two years after graduation.

**III. Course Framework**

**Proposed catalog copy including academic requirements and sample programs.** The following catalog description is designed to replace the current Microbiology Biological Sciences track description.

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<thead>
<tr>
<th>Present</th>
<th>Proposed Major</th>
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<tr>
<td>none</td>
<td>Microorganisms play key roles in ecosystems and human civilization. They can both cause and prevent a wide array of diseases in animals and plants. They are key components in the manufacturing of bread, cheese, and other food products. Microbes are involved in soil formation, global environmental processes and detoxifying contaminated environments. In addition, they contain a wealth of useful compounds and enzymes for biotechnology.</td>
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Students earning a degree will be prepared to continue studies at the graduate level, earn teaching credentials, or enter professional schools in medicine, pharmacy, optometry, dentistry, and veterinary medicine, among others. Students will also be trained for technical careers in medicine, agriculture,
biotechnology and environmental fields. For information on how to select elective coursework for specific career paths, visit the CNAS Undergraduate Academic Advising Center.

Students in the Microbiology major can obtain either B.A. or B.S. degrees. The B.S. degree offers students with a strong interest in the natural sciences an opportunity to emphasize this aspect of their education. The B.A. degree is available to students who wish to obtain a broader background in the humanities and social sciences than is required of students in the B.S. program.

**Degree Requirements**

a. *University Requirements*

See the Undergraduate Studies section for requirements that all students must satisfy.

b. *College Requirements*

See Degree Requirements, College of Natural and Agricultural Sciences, in the Undergraduate Studies Section, for requirements that students must satisfy.

c. *Major Requirements*

Some of the following requirements for the Microbiology major may also fulfill the College’s breadth requirements. Consult with an advisor for course planning.

1. **Core Curriculum (72-77 units)**

   a) BIOL 005A, BIOL 05LA, BIOL 005B, BIOL 005C
   b) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC
   c) CHEM 112A, CHEM 112B, CHEM 112C
   d) PHYS 002A, PHYS 002B, PHYS 02LA, PHYS 02LB, PHYS 002C,
2. Upper-Division Requirements (36 units)

a) Major Core (18 units):
   BIOL 102, BIOL 107A, MCBL 121, MCBL 121L, MCBL 125

b) Major Electives. A minimum of 18 units from the following to be selected in consultation with a faculty advisor:
   BIOL 128, BIOL 157, BIOL 158, CBNS 101, ENSC 120, MCBL 120, MCBL 120L, MCBL 122, MCBL 123, MCBL 124, MCBL 141, MCBL 188, MCBL 197^2, PLPA 134, PLPA 134L

3. Other Requirements

For the Bachelor of Science degree, an additional 16 units in upper-division microbiology courses and/or substantive courses in a field or fields related to the major. Acceptable courses include BCH 102, BCH 110C, BIOL 107B, BIOL 109, BIOL 119, ENSC 133, MCBL 190^3, MCBL 198-I^3; a more complete list of acceptable courses is available at the CNAS Undergraduate Academic Advising Center.

For the Bachelor of Arts degree, the foreign language requirement may be fulfilled by completing level four coursework or by demonstrating the equivalent proficiency in one foreign language.
4. Bachelor of Science Sample Program

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Notes:

1 Some students will take courses in summer session to (i) reduce the unit load during the normal academic year (ii) complete the degree requirements in less than four years or (iii) enable the acquisition of a minor or double major in four years.

2 No more than 4 units can be applied toward the Major Electives unit requirement, unless approved by the Microbiology Steering Committee.
IV. Entry of Students into the Major

Students may enter the major at any time provided they meet the "Change in Major Criteria" for Microbiology.

V. Advising of Students and Assessing Success

Faculty advising. Combined with the professional advisors in the CNAS Undergraduate Academic Advising Center, we propose assigning to participating faculty members small (5-10) numbers of students that they will advise from the time they enter the program until they graduate.

Health profession advising. It is also important that those students who indicate an interest in medical school or related professions get advising early concerning what it will take for them to be competitive. We will use existing resources on campus to help steer students towards extracurricular health-related activities that will be a necessary component of their health professional school application.

Other advising activities. The Career Center will be asked to align particular jobs with a completed Microbiology major. In addition, a list will be developed of available laboratories for students in the major who wish to participate in undergraduate research.

Assessing student success in the major. Microbiology recognizes that it has a responsibility to provide a rich and nurturing environment that facilitates student success. To assess performance of the major, data on several attributes associated with success will be gathered and evaluated:

- Each year, overall statistics on success will be examined including retention rate, graduation rate (including time-to-degree), and average GPA at graduation.
- Student learning outcomes will be evaluated by examining performance as described above.
- Soon before graduation, students will be provided with a survey to assess their satisfaction with their experience in the Microbiology major.
- Approximately two years after graduation, students will be contacted again with a new survey. This will allow them to re-assess their satisfaction with the Microbiology major and provide information on their career paths.

VI. Relationships with and Impact on other Majors

We believe that the creation of a Microbiology major will help to manage enrollment growth in the College, help to serve the large number of students interested in this field, and aid in retaining and servicing a high-quality population of students at UCR.
VII. New Courses Developed for the Major

MCBL 125. Experimental Microbiology.

Units: 3
Hours: 1 hr of lecture per week and 6 hours of laboratory per week

Prerequisites: A major in MCBL or permission of the instructor and BIOL 102, BIOL 107A, MCBL 121, MCBL 121L

Course description (<50 words): This class will guide students through the process of performing experimental research in a microbiology laboratory. Students will acquire skills in formulating hypotheses, designing experiments, performing laboratory experiments, analyzing data as well as preparing and presenting the results of these efforts in written and oral forms. The experimental system(s) used for the course will vary with the instructor. The example presented here is a course designed by Katherine Borkovich that utilizes the nonpathogenic microbial eukaryote Neurospora crassa.

Grading: Letter grade only

Justification: Research in microbiology and most areas of biology involve a process including formulating hypotheses, designing and performing experiments to test hypotheses, data analysis and written and oral forms of communicating the results of such efforts. This class is designed to guide students through this process.

This will be a research-based course, incorporating analysis of uncharacterized gene deletion mutants for the model filamentous fungus Neurospora crassa. There are currently 7000 genes for which knockout mutants are available and mutants for all 10,000 genes will be completed within the next four years in the Borkovich laboratory. Only 1000 of the mutants have been analyzed for phenotypes to date. The data generated during the course will be uploaded to the Neurospora database at the Broad Institute/MIT and will be presented in research publications with student authors.

Note: Because Neurospora grows on a simple defined medium, the supplies for this laboratory course will be relatively inexpensive. All of the media can be prepared in advance and stored at 4ºC, further streamlining the course.

Syllabus:

Specific topics: Overview of fungal growth, development, metabolism, genomics
Ethical reporting of scientific results and the publication process
Basic bioinformatics techniques used to analyze genes
Sterile technique and microbial growth
Phenotypic analysis of 20 mutants
Uploading data to functional genomics database
Development and testing of a hypothesis based on current results
Writing a scientific paper
Poster or brief oral presentations
Sample Schedule:

Week 1  Students will learn the basics of the lifecycle, genome sequence and how the gene deletion mutants are being generated. They will learn sterile technique and will inoculate their 20 assigned mutants from master stocks. They will analyze wild-type Neurospora in all assays, in order to become familiar with “normal” growth and development. Assays include extension rate of basal hyphae; colony morphology and asexual sporulation on minimal and rich medium; length of spore-forming structures; formation and fertilization of female reproductive structures, and production of sexual spores.


Weeks 3-6  Continue phenotypic analysis of 20 mutants. Develop a hypothesis based on phenotypic and bioinformatics data for 1-2 mutants. Design an experiment to test the hypothesis.

Week 7  Prepare special media needed for experiment. Perform experiment to test hypothesis.

Week 8  Finish experiment. Begin writing scientific paper and preparing Powerpoint file.

Week 9  Upload all data to Broad Institute website. Have draft of scientific paper checked by instructor. Participate in small group activity (2-3 students/group): Electroporation of a knockout construct into Neurospora.

Week 10  Poster or oral presentations in lab. Turn in final scientific paper. Examine electroporation plates for colonies.

Finals Week  Cumulative Final Exam

Representative assignments:
Use bioinformatics tools at NCBI and other genome databases to analyze 20 genes
Analyze 20 mutants for phenotypes
Keep a laboratory notebook with experimental results
Develop and test a hypothesis based on one or two mutants
Write a 4-page scientific paper that summarizes data for mutants
Prepare a Powerpoint file (~10 slides) for poster or oral presentation of data
Upload all phenotypic data to Broad/MIT database

Possible Text(s):
“Neurospora: Contributions of a Model Organism”, by Rowland H. Davis, Oxford University Press, USA, 2000. Additional papers from the current scientific literature will be assigned as required reading.

Grading basis:
Bioinformatics Analysis:  15%
Laboratory Notebook:  30%
Written Report:  20%
Presentation:  10%
Final Exam:  25%

MCBL 190. Special Studies (1-5). Prerequisite(s): consent of instructor and major chairperson. To be taken as a means of meeting special curricular needs. Grading basis to be selected in consultation with the instructor and major chairperson. Course is repeatable.
MCBL 198-I. Individual Internship in Microbiology.
Units: 1-12.
Hours: Written work, 1-12 hours; internship, 2-24 hours.
Prerequisites: Consent of instructor.
Course description (<50 words): Career development within the context of microbiology. Students are co-supervised by an off-campus sponsor and on-campus faculty. Requires a written final report. Repeatable to a maximum of 12 units; up to 4 units may be used to satisfy major requirements.
Grading: S/NC
Justification: Internships play valuable roles in the professional and personal development of students. They provide an opportunity to gain relevant experience and a realistic perspective on what work is like within a given field. They can also expose students to aspects of careers that they had not considered previously. On the practical side, experience is one of the most important attributes employers and professional schools look for in applicants.
Syllabus: An internship is a structured agreement between a student, the faculty sponsor, and an internship site supervisor. Students will:
- Secure approvals from the off-site internship supervisor and the UCR faculty member before starting the work.
- Keep a journal or log of interactions, experiences, techniques, etc. relevant to the work experience.
- Submit a paper summarizing their experience following completion of the internship. The paper (minimum of four double-spaced pages) will include a detailed description of the internship activities and assess the value and relationship of the internship to their career goals. These two components of the paper are equally important.

VIII. Organization and Governance

Anticipated start date of the major. We are hopeful that administrative approval can be obtained by spring of 2011. We propose initiating the major in Fall 2011.

Anticipated Size of Major. We anticipate that the enrollment will comprise 50-100 students each year.

Faculty resources required. For MCBL 125, we will need instructors, laboratory space, and laboratory support staff. We will also need a means of acquiring the necessary supplies and equipment, which could simply come from the fees associated with registering for the class, assuming that they can be set at the appropriate level.

Other resources required. The major will utilize the Professional Academic Advisors at the CNAS Undergraduate Academic Advising Center.

Plan for administering the major. The major will be governed by a steering committee and a group of Participating Faculty Members.

Steering committee. This committee will bear primary responsibility for governing the major, and communicate with the Participating Faculty Members on issues in the major.

Three individuals will serve as voting members on the steering committee, representing a minimum of two academic departments. A department chairperson (Plant Pathology and Microbiology) will also
serve in an *ex officio* capacity (see below). Their responsibilities will include periodic re-evaluation of curriculum requirements and courses appropriate for electives; handling of special cases, appeals and exceptions; recruitment of advisors; and so on. The steering committee may set up other committees as needed such as a curriculum committee, committees for each track in the major, etc., or recommend to the Participating Faculty Members that the size of the steering committee be increased.

Current members of the steering committee are:

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<th>Role*</th>
<th>Name</th>
<th>Department</th>
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<tbody>
<tr>
<td>Chair</td>
<td>James Borneman</td>
<td>Plant Pathology &amp; Microbiology</td>
<td><a href="mailto:borneman@ucr.edu">borneman@ucr.edu</a></td>
</tr>
<tr>
<td>Member 1</td>
<td>Marylynn Yates</td>
<td>Environmental Sciences</td>
<td><a href="mailto:marylynn.yates@ucr.edu">marylynn.yates@ucr.edu</a></td>
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<tr>
<td>Member 2</td>
<td>Kathy Borkovich</td>
<td>Plant Pathology &amp; Microbiology</td>
<td><a href="mailto:katherine.borkovich@ucr.edu">katherine.borkovich@ucr.edu</a></td>
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*As the governance structure of the Life Science majors at UCR evolves, steering committee members are expected to serve on several CNAS committees.*

Once the major is approved, a schedule will be established to allow replacement or renewal of steering committee members at staggered intervals. Nominations for such positions will be solicited by the Steering Committee from the Participating Faculty Members. In the case of more than one nomination per position, the Participating Faculty Members will elect the member.

**Role of department chairperson.** The major will operate as an interdepartmental entity. Nevertheless, a mechanism is required to ensure that it has parity with department-based Life Science majors at the college level, and authority to carry out its mission. Therefore, a department chairperson (Plant Pathology and Microbiology) will represent the major at the appropriate college major meetings. This will ensure information transfer between CNAS and the major, and enable the coordination of teaching assignments.

The Chair of the Microbiology steering committee will work with the Divisional Dean for Life Sciences to nominate the appropriate departmental chairperson. That selection must then be approved by a majority of the steering committee. Although frequent changes are not anticipated, the appointment will be re-evaluated annually.

**Participating faculty members:** Thirty-three faculty members have identified themselves as being interested in the major. They are: Adaskaveg, Jim; Allen, Michael; Borkovich, Katherine; Borneman, James; Coffey, Michael; Cooksey, Donald; Crowley, David; Ding, Shou-Wei; Douhan, Greg; Euglem, Thomas; Federici, Brian; Gill, Sarjeet; Jin, Hailing; Judelson, Howard; Kaloshian, Isogouhi; LeRoch, Karine; Liu, Renyi; Ma, Wenbo; Maslov, Dmitri; Miller, Thomas; Ng, James; Nunney, Leonard; Pedra, Joao; Platzer, Edward; Rao, ALN; Roberts, Philip; Roper, Caroline; Sachs, Joel; Schiller, Neal; Stanghellini, Michael; Walter, Jan; Wilson, Emma; Yates, Marylynn.

These participants were identified through a college-wide poll. To continue as a Participating Faculty Member, at least one of the following will be required: serving as an instructor in one of the upper-division science courses satisfying a requirement of the major; or serving as a faculty advisor to undergraduates in the Microbiology program; or serving as a member on any Microbiology program committee. The Steering Committee may solicit new or existing members of campus to participate in the program, and may delete non-active members from this list.
February 11, 2011

To: James Borneman, Chair, Microbiology Major Committee
   James Baldwin, Chair, Department of Plant Pathology and Microbiology

Fr: Thomas O. Baldwin, Dean

Re: The proposed Microbiology Major

The College of Natural and Agricultural Sciences is pleased to support your proposal for the new Microbiology major. This new major proposal presents strong learning outcomes and meets the needs of many of our students who have shown strong interest in this field in the past few years.

This new major will replace the existing Microbiology track in the Biological Sciences major and will be administered by faculty in the Plant Pathology and Microbiology Department. The undergraduate major, along with the recently revived graduate program in Microbiology, builds on the strong research and teaching expertise of faculty from many of our life science departments.

It is understood that the closure of the redundant Microbiology track in Biological Sciences will occur at the time this major is approved by the appropriate Senate committees.

cc. Richard A. Cardullo, Divisional Dean
    David Parker, Chair of the CNAS faculty
April 11, 2011

To: Jose Wudka, Chair, Committee on Educational Policy (CEP)

From: James Borneman, Chair, Microbiology Steering Committee

Microbiology Response: Although the microbiology undergraduate major will operate as an interdepartmental entity, a mechanism is required to ensure that it has parity with department-based Life Science majors at the college level. Therefore, the Plant Pathology and Microbiology (PLMB) departmental chairperson, a non-voting member of the major’s steering committee, will represent the major at the college level as needed. In addition, the PLMB chairperson will also ensure that his/her department’s representatives on the College Executive Committee and Teaching Assistant Assignment Committee represent the microbiology major at these venues.

Approved by CEP 4/12/11