PROPOSAL FOR A BACHELOR OF SCIENCE DEGREE IN
MOLECULAR CELL BIOLOGY

IN THE

DEPARTMENT OF MICROBIOLOGY
COLLEGE OF NATURAL SCIENCES
UNIVERSITY OF HAWAI‘I AT MANOA

Locus (Unit School/College): College of Natural Sciences
Chair/Conveners of Planning Committee: Paul Patek and Sean Callahan
Program Category: New
Department Unit/Program: Microbiology
Level of Program or Major: Undergraduate
Degree and Certificates Proposed: Bachelor of Science in Molecular Cell Biology
Proposed Date of Implementation: January 2011
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1. Program Objectives and Learning Outcomes

1A. Program Objectives. The primary objective of the proposed program in Molecular Cell Biology is to prepare students for careers in fields that require advanced knowledge of molecular biology, in particular those that relate to human health and welfare. Examples of such fields include, but are not limited to, medicine, pharmacology, pathology, genetic testing and counseling, biotechnology, nanotechnology, teaching, and basic research. The proposed program will focus on the molecular biology of eukaryotic organisms (animals, plants, fungi and protists), which sets it apart from the current program in Microbiology, which focuses on prokaryotic organisms (bacteria and archaea). It will emphasize our understanding of the molecular biology of human health, disease and treatment, differentiating it from the existing Biology program. The second objective and natural consequence of a program in Molecular Cell Biology is human resource support for the medical school, UH graduate programs, and biotechnology businesses that provide services and economic opportunities to communities throughout the state of Hawai‘i.

1B. Learning Outcomes. The seven learning outcomes for the MCB program can be grouped into three broad categories: cognitive, skills-based and values-based.

i. Cognitive outcomes.

SLO 1 - Graduates of the MCB program will be able to explain and discuss how processes are integrated at the molecular level to create a functional eukaryotic cell:
- Heredity
- Transcription
- Translation
- Post-translational regulation.
- Messenger RNA turnover and silencing
- Transport in, out, and within cells
- Biogenesis of organelles
- Mutation and DNA repair
- Catalysis
- Cell division
- Cell cycle control
- Generation, storage, and use of energy
- Motility
- Cell – cell signaling
- Cellular differentiation
- Integration of cells into tissues
- Immune system components and functions
- Molecular basis of cancer

SLO 2 - Graduates of the MCB program will be able to describe the structures and various cellular functions associated with the macromolecules found in cells:
- DNA
- RNA
- Protein
Nucleotides
- Amino Acids
- Lipids
- Fatty acids
- Carbohydrates
- Chromosomes

SLO 3 - Graduates of the MCB program will be able to explain the techniques and logic of methods employed in molecular biology research:
- Purification and analysis of DNA
- Purification and analysis of RNA
- Purification and analysis of proteins
- Purification of cells and organelles
- Growth of microorganisms
- Tissue culture
- DNA synthesis, cloning, and sequencing
- Bioinformatics
- Gene expression analysis
- Genetic selections
- Gene replacement
- Mutagenesis
- Fluorescence microscopy
- Protein sequencing
- Proteomics
- Metabolomics
- X-ray crystallography
- Flow cytometry

SLO 4 - Graduates of the MCB program will be able to explain the molecular basis of human diseases and research on prospective treatments:
- Huntington’s disease
- Alzheimer’s disease
- Muscular dystrophy
- Several forms of cancer
- Cystic fibrosis
- Creutzfeldt-Jakob disease

ii. Skills outcomes.
SLO 5 - Graduates of the MCB program will have experience in and be able to perform techniques employed in molecular biology research:
- Purification and analysis of DNA
- Purification and analysis of RNA
- Purification and analysis of proteins
- Purification of cells and organelles
- Growth of microorganisms
- Tissue culture
- DNA synthesis, cloning, and sequencing
- Bioinformatics
- Gene expression analysis
- Genetic selections
- Gene replacement
- Mutagenesis
- Fluorescence microscopy

**SLO 6** - Graduates of the MCB program will be able to critically evaluate scientific studies:
- Understand and critically analyze primary literature in the field
- Employ the logic of experimental design to design simple experiments
- Solve quantitative problems in molecular biology
- Communicate the logic and findings of scientific research in both written and oral formats

**iii. Values outcomes.**

**SLO 7** - Graduates of the MCB program will be able to evaluate the ethical implications of research methods and outcomes:
- Employing different philosophical theories (utilitarian, deontological, casuistic) to case studies
- Identifying groups that may be impacted by experimental protocols or research outcomes
- Evaluating the responsibilities of different groups (individuals, the scientific community, corporations, governments, etc.) in the conduct and regulation of scientific research

2. Appropriateness of Program for College, University and State

2A. **Uniqueness of an MCB degree at UH.** Molecular and cellular biology are the driving forces behind the majority of biological research studies today and form the basis of the medical, biotechnology and nanotechnology industries. Currently, there is no undergraduate degree in molecular and cellular biology offered at the University of Hawai‘i. The proposed program will be a cohesive presentation of our understanding of life at the molecular level, focusing on eukaryotic life forms and human health and disease. No other undergraduate program has such a mandate. Some existing programs may appear to have significant overlap with the proposed program, but closer examination shows that they are quite distinct. For instance, a degree in Microbiology has a cell and molecular biology focus by virtue of the unicellular nature of most microorganisms and the emphasis on molecular studies concerning viruses and the immune system, but their is a heavy emphasis on the molecular biology of bacteria, which are prokaryotes and constitute the majority of microbiological studies. Degrees in Botany and Zoology focus at the organismal and systematic levels on plants and animals (excluding humans), respectively. A BS degree in Bioengineering (BE) is offered by the College of Tropical Agriculture and Human Resources (CTAHR). However, as the name implies, this degree is focused heavily on the application of engineering to biological systems. Inherent differences between the BE program and the proposed MCB program are highlighted by the fact that the two programs share no upper-level degree requirements. In addition, the chair of the
department of Molecular Biosciences and Bioengineering, which administers the BE degree, supports creation of the proposed MCB BS degree (please see letters of support in Appendix section 8A). A degree in Biology is described as offering “broad training in the biological sciences” and includes significant coursework in ecology, evolution and organismal biology. The number of courses required to satisfy the breadth offered by the program precludes the in depth specialized training in Molecular Cell Biology offered by the proposed program. Concentration in Cell and Molecular Biology is offered in the Biology program, but rather than being a well-defined course of study, concentration is defined by compiling 15 credits from a list of 29 qualifying courses that involve molecular and/or cell biology to some extent. Please note that the director of the Biology program also supports the formation of the proposed MCB program.

Examination of the upper division requirements for degrees in Molecular Cell Biology, Bioengineering, Biology, Botany, Microbiology, and Zoology highlights the uniqueness of the proposed MCB program. The proposed MCB degree is alone in requiring a rigorous, well-defined set of courses central to molecular cell biology. It is the only degree that requires the following courses: Cellular Biology (BIOL 406), Cellular Biology Laboratory (406L), and a capstone course that integrates molecular biology theory with practices in the research and medical fields (Biology of Cancer, MCB 472). The proposal for the capstone course, MCB 472 has been approved by the Natural Sciences Curriculum Committee and review by the Arts and Sciences PCC should precede that for this proposal.

Comparison of proposed MCB upper-level core requirements with those of the most closely related existing degrees at UH Manoa (data from 2007-2008 Catalog).

The MCB program shares the following number of its 9 upper-level core courses with core courses for existing degrees in the life sciences:

- Bioengineering – 0
- Biology – 3
- Botany – 2
- Microbiology – 2
- Zoology – 3

Proposed MCB BS degree:
1. MICR 314, Research Ethics
2. BIOL 375 Concepts of Genetics
3. BIOL 375L, Concepts of Genetics Lab
4. MBBE/BIOL 402 or BIOC 441, Biochemistry
5. MBBE/BIOL 406, Cellular Biology
6. BIOL 406L, Laboratory in Cellular Biology
7. BIOL 407, Molecular Biology
8. MICR 461, Immunology
9. MCB 472, Biology of Cancer (Capstone course)

Bioengineering BS degree:
1. BE 350 Dynamic Systems Modeling
2. BE 350L Dynamic Systems Modeling Laboratory
3. BE 373 Transport Phenomena
4. BE 481 Senior Engineering Design I
5. BE 482 Senior Engineering Design
6. ME 311 Thermodynamics

Biology BS degree with concentration in Cell and Molecular Biology:
1. BIOL375, Concepts of Genetics
2. BIOL 375L Concepts of Genetics Lab
3. MBBE/BIOL402 or BIOC441, Biochemistry
4. For concentration in CMB - 15 credit hours from the following list of 29 approved courses:
   BIOL 390 Communicating in the Biological Sciences
   BIOL 401 Biotechnology
   BIOL 406 Cellular Biology
   BIOL 406L Cellular Biology Lab
   BIOL 407 Molecular Biology
   BOT 410/410L Plant Anatomy/Lab
   BOT 470/470L Principles of Plant Physiology/Lab
   ICS 475 Bioinformatics: Introduction
   MICR 351/351L Biology of Microorganisms/Lab
   MICR 361 Introductory Bioinformatics
   MICR 431 Microbial Physiology
   MICR 461 Immunology
   MICR 463/463L Microbiology of Pathogens/Lab
   MICR 475 Bacterial Genetics
   MICR 490/490L Animal Virology/Lab
   PHYL 301/301L Human Anatomy and Physiology/Lab
   PHYL 302/302L Human Anatomy and Physiology/Lab
   ZOOL 416 Histology
   ZOOL 420 Developmental Biology
   ZOOL 430/430L Animal Physiology/Lab
   ZOOL 432 Comparative Physiology

Botany BS degree:
1. BOT 470 Plant Physiology
2. BOT 470L Principles of Plant Physiology Lab
3. BOT 462 Plant Evolution
3. BIOL 375 Concepts of Genetics
3. BIOL 375L Concepts of Genetics Lab

Microbiology BS degree:
1. MICR 351 Biology of Microorganisms
2. MICR 351L Biology of Microorganisms Lab
3. MICR 431 Microbial Physiology
4. MICR 461 Immunology
5. MICR 475 Bacterial Genetics
6. MBBE/BIOL 402 or BIOC 441, Biochemistry

Zoology BS degree:
1. BIOL 375 Concepts of Genetics
2. BIOL 375L Concepts of Genetics Lab
3. MBBE/BIOL 402 or BIOC 441, Biochemistry
4. ZOOL 320/475 Vertebrate Zoology/Biology of Invertebrates
5. ZOOL 320L/475L Vertebrate Zoology/Biology of Invertebrates Lab
6. ZOOL 490 Seminar in Zoology
7. ZOOL 499 Directed Reading or Research

2B. Appropriateness of administering the MCB program in the Microbiology Department.
Administration of the MCB degree from the Department of Microbiology is both appropriate and has several advantages. Rather than create an “orphan” program run by committee, the MCB program will have the resource backing and concentration of responsibility for its administration in a department whose faculty conduct research in molecular and cell biology. Existing faculty research programs all have components that will complement and be complemented by an instructional program in the molecular biology of prokaryotes and eukaryotes. Such programs include those focused on the human immune system (Patek), animal-bacteria pathogenic interactions (Hoang and Douglas), animal-virus interactions (Li), yeast and fungi (Robert and Donachie), bioinformatics of eukaryotic genomes (Alam), and developmental biology (Callahan). All members of the department have research programs incorporating studies at the molecular level, making the department unique within the College of Natural Sciences. In addition, studies in the department are not limited to bacteria. Almost all of these research programs incorporate the molecular biology of eukaryotic organisms, which is to be the focus of the MCB degree.

2C. Student demand. There is tremendous pent-up demand for a MCB undergraduate degree program as evidenced by student enrollment in upper-level courses in the biological sciences. Currently, it is the Department of Microbiology that is partially fulfilling this demand. In the ’06-’07 school year, the Department of Microbiology, with 64 majors, taught the equivalent of 92% of the upper-division SSH taught by the Biology program, which, in the 06-07 school year, had 560 majors (Please see Appendix section A). Furthermore, one Biology course with a molecular focus, Concepts of Genetics (BIOL 375) accounted for 28% of all upper division student semester hours in the Biology Program. In the Microbiology Department we would like to think that it is our superior teaching that attracts students from other departments to take our courses as electives, but the reality is that Microbiology courses are molecular in nature, and the perceived value of molecular and cell biology courses is high among undergraduates. While BIOL 375 is a required course for the 560 Biology majors, non-Microbiology majors are electing to take Microbiology courses. As examples MICR 351 (Biology of Microorganisms), 461 (Immunology), 431 (Bacterial Physiology) and 475 (Bacterial Genetics) historically have all had substantially more non-majors than Microbiology majors enrolled. In the fall 2006 semester 76% of students in these courses were non-majors, and 45% were Biology majors taking these courses as electives.

1 In 2008 Microbiology has 83 undergraduate majors
It could be argued that the Department of Microbiology is already teaching the upper division cell and molecular courses to undergraduates in the life sciences at UH. However, with the exception of the immunology course, the Microbiology instructional program focuses on the study of prokaryotic and lower eukaryotic organisms. What is lacking is a degree program focused on the molecular and cellular biology of higher eukaryotic organisms. The establishment of an undergraduate MCB degree with the resource backing of the Department of Microbiology will remedy this deficiency at UH.

In order to directly assess the level of interest in an MCB degree amongst students, the following email message was sent to current Biology and Microbiology Majors in February of 2008:

Dear Life Science Student,
We are currently considering the introduction of an undergraduate B.S. degree in Molecular Cell Biology. The program would focus on molecular and cellular aspects of mammalian biology with an emphasis on humans and human health. We are surveying life science's students to determine the level of interest in such a degree program.
I ask that you take a minute to answer by simply replying to this message with your answer to the one question below.

1. If a BS in Molecular Cell Biology were available when I started my undergraduate studies, that would now be my major. (1=definitely yes, 2=likely, 3=maybe, 4=not likely, 5= no, that would not be my major)

   ANSWER:

Of 198 respondents, students answered as follows:

Definitely 51 = 26%
Likely 56 = 28%
Maybe 60 = 30%
Not likely 18 = 9%
Definitely not 13 = 7%

Clearly there is a high level of interest among current students, and interest in future years would be expected to remain high or increase given the recent and predicted future strong growth of fields that employ molecular cell biology training. Extrapolating the numbers above to the total number of Biology and Microbiology majors indicates that over 170 would have definitely chosen the MCB major and an additional 180 would likely have made it their major.

2D. Community Need. Occupations in the fields of medicine, pharmacology, pathology, genetic testing and counseling, biotechnology, nanotechnology, teaching, and basic research are some of the highest paying in the state of Hawai‘i. In a 2005 report released by the Hawai‘i State Department of Labor & Industrial Relations Research & Statistics Office (a copy of which can be found at http://www.hiwi.org/), wages in jobs categorized as R&D in physical, engineering, and life sciences ranked third in a list of 24 and were twice the state average, with
medical scientists averaging the highest in the life sciences. Hospitals, diagnostic labs, the medical school and biotechnology companies, among others, require employees with knowledge and degrees in the molecular cell biology of mammalian systems. These jobs not only pay well, but they also require large support structures that employ additional people in good paying positions. Expansion in R&D, diagnostic, and health related sectors of the economy fits well with the state’s commitment to attract clean, high-technology industries to Hawai‘i. The MCB program will create a pool of people qualified to fulfill the personnel demands of health and biotechnology related positions currently in Hawai‘i and allow the state to attract new businesses.

3. Organization of the program

The BS degree in MCB will be a part of the Department of Microbiology and will undergo periodic review by Microbiology faculty and a MCB curriculum committee to be comprised of Microbiology faculty, and other faculty teaching courses included in the program and conducting research in the area of molecular cell biology. This committee will include a minimum of one faculty member from the each of the life science departments in the college of Natural Sciences: Botany, Microbiology and Zoology (soon to be Biology).

3A. Advising and counseling. Advising of students generally consists of two types of activities: counseling on career-related choices and administrative facilitation. Upon declaring MCB as their major, all students will be assigned a faculty member who will serve as their advisor. Students will be permitted to change advisors for reasons of personal preference as they wish. With enrollment under 100 students, faculty will be the primary source of both types of counseling, a situation mirrored in the current Program in Microbiology. Once enrollment exceeds 100 students, each student will still have a faculty member to consult with on career-related choices, and a student support staff person will be requested to lessen the burden of more administrative advising.

3B. Program course requirements. To earn a BS degree in Molecular Cell Biology, all candidates will be required to complete the college program requirements for the BS degree, which includes fulfilling the Arts and Sciences breadth/depth option and meeting the minimum 104 Arts and Sciences credit requirement. In addition to the UHM General Education requirements, course requirements for the BS degree in MCB can be divided into three categories: basic science, MCB core, and MCB elective courses, details of which are listed below. Basic science courses are intended to prepare students for upper-level coursework. MCB core courses form the foundation of the degree. And, MCB elective courses allow students to tailor their degree to suit their needs and interests. Please note that all courses currently exist with the exception of the Capstone course, MCB 472, Biology of Cancer, which has been approved by the Natural Sciences Curriculum Committee and should precede this proposal for review by the Arts and Sciences PCC. Grades of C or better will be required for credit towards the degree. No program admission requirements are anticipated. The number of program credits is intended to allow students to graduate with a competitive BS degree in MCB in four years.

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The MCB core courses were chosen for the following reasons. Genetics and Biochemistry traditionally serve as basis of any program in molecular cell biology. They describe the basic concepts of molecular interactions required for understanding how the constituents of a cell carry out basic cellular functions. Cellular Biology and Molecular Biology form the heart of the program, integrating the basic concepts of biochemistry and genetics with organelle and sub-cellular functions to describe a living cell. In addition to focusing the program on human health and disease processes, Immunology and the Biology of Cancer challenge students to apply their basic knowledge of molecular cell biology in more specialized fields, two of the most heavily researched fields in all of biology and healthcare. Finally, Research Ethics equips students with the tools necessary to identify and evaluate the ethics of research in molecular cell biology and its potential outcomes for research subjects, researchers, and society. Elective courses allow students to apply their basic knowledge of molecular cell biology in more specialized fields of their choice.

Basic science course requirements

1. BIOL172-172L, Introduction to Biology II  
   Credits: 4
2. BIOL275-275L, Cell and Molecular Biology  
   Credits: 4
3. Either CHEM161-161L & CHEM162-162L, General Chemistry I & II  
   or CHEM181A-181L, Honors General Chemistry  
   Credits: 5 - 8
4. CHEM272-272L & CHEM273, Organic Chemistry I & II  
   Credits: 8
5. Either MATH215 & MATH216, Applied Calculus I & II  
   or MATH241 & MATH242, Calculus I & II  
   Credits: 7 - 8
6. Either PHYS151-151L & PHYS152-152L, College Physics I & II  
   or PHYS170-170L & PHYS272-272L, General Physics I & II  
   Credits: 8 – 9

Subtotal  
   Credits: 36 - 41

MCB core course requirements

1. BIOL375-375L, Concepts of Genetics  
   Credits: 3 + 1
2. MBBE/BIOL402 or BIOC441, Biochemistry  
   Credits: 4
3. MBBE/BIOL406-406L, Cellular Biology  
   Credits: 3 + 2
4. BIOL407, Molecular Biology  
   Credits: 3
5. MICR461, Immunology  
   Credits: 3
6. MCB472, Biology of Cancer (Capstone course)  
   Credits: 3
7. MICR314, Research Ethics  
   Credits: 1

Subtotal  
   Credits: 23

MCB elective courses (minimum 10 credits, to include 1 laboratory class)

BIOL/BOT/ZOOL/MICR499, Directed Research  
   Credits: 1 - 3
ICS475, Introduction to Bioinformatics Sequences and Genomes Analysis  
   Credits: 3
MATH304, Mathematical Modeling I – Deterministic Models  
   Credits: 4
MATH305, Mathematical Modeling II – Probabilistic Models  
   Credits: 4
MICR499, Directed Research  
   Credits: 1 - 3
MICR431-431L, Microbial Physiology  
   Credits: 3 + 1
MICR461L, Immunology                    2  
MICR470, Microbial Pathogenesis            3  
MICR475-475L, Bacterial Genetics          3 + 1  
MICR490-490L, Animal Virology             3 + 2  
MBBE405, Microbial Biotechnology          3  
PHYL301-301L, Human Anatomy and Physiology        4 + 1  
ZOOL420-420L, Developmental Biology         3 + 2  
ZOOL442, Introduction to Neuroscience        3  
Select graduate-level courses by permission  
Total                          69 - 74  

**3C. Curriculum map.** The following curriculum map illustrates how MCB required courses promote each of the program student learning outcomes described earlier.

SLO 1 - Graduates of the MCB program will be able to explain and discuss how processes are integrated at the molecular level to create a functional eukaryotic cell.
SLO 2 - Graduates of the MCB program will be able to describe the structures and various cellular functions associated with the macromolecules found in cells.
SLO 3 - Graduates of the MCB program will be able to explain the techniques and logic of methods employed in molecular biology research.
SLO 4 - Graduates of the MCB program will be able to explain the molecular basis of human diseases and research on prospective treatments.
SLO 5 - Graduates of the MCB program will have experience in and be able to perform techniques employed in molecular biology research:
SLO 6 - Graduates of the MCB program will be able to critically evaluate scientific studies.
SLO 7 - Graduates of the MCB program will be able to evaluate the ethical implications of research methods and outcomes.

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<th>Student learning outcome #</th>
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<td>BIOL275/L</td>
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<td>BIOL375/L</td>
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<td>MBBE402</td>
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<td>MICR461</td>
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<td>MBBE406/L</td>
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<td>BIOL407</td>
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<td>MCB472</td>
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I = introduced; E = emphasized; M = mastered at senior level
3D. Sample schedule. The sample schedule below for the B. S. in MCB illustrates how a student may complete the degree program in 4 years at Manoa.

YEAR 1 FALL SEMESTER
F BIOL171-171L (4) (Core)
F/S CHEM161-161L (4) or F 181A-181L (5)
F/S MATH215 or 241 (4) (Core)
Core &/or Lang (4-5)

YEAR 1 SPRING SEMESTER
S BIOL172-172L (4)
F/S CHEM162-162L or 272-272L (5)
F/S MATH216 (3) or 242 (4)
Core &/or Lang (4-5)

YEAR 2 FALL SEMESTER
F/S CHEM272-272L or 273-273L (4)
F/S PHYS151-151L or 170-170L (5) (Core)
Core &/or Lang (7)

YEAR 2 SPRING SEMESTER
F/S CHEM 273-273L (4) or other
F/S PHYS152-152L or 272-272L (4)
S BIOL275-275L (4)
Core &/or Lang (4)

YEAR 3 FALL SEMESTER
F BIOL375-375L (4)
F MICR461 (3)
F BIOL407 (3)
Core &/or Lang (6)

YEAR 3 SPRING SEMESTER
F/S BIOL402 (4)
S MICR314 (1)
S BIOL406-406L (5)
Core &/or Lang (6)

YEAR 4 FALL SEMESTER
Major Elective (3)
Major Elective (3)
Core &/or Lang (10)

YEAR 4 SPRING SEMESTER
S MCB472 (Capstone) (3)
Major Elective w/lab (4)
Core &/or Lang (9)

The sample schedule above assumes 16 credits per semester. In addition to the major requirements, students must satisfy 43 credits of Core and Language requirements. 10 of the 43 credits are satisfied by prerequisites for major courses (indicated by “Core” above), leaving 33 credits to be satisfied. The schedule above allows for 50 credits of Core or Language credits, indicating that in about 5 of the 8 semesters students could elect to enroll for only 12 or 13 credits and still fulfill graduation requirements. Practically, this could translate into a student taking 4 courses per semester in each of their Freshman and Sophomore semesters and 5 courses in 3 of 4 semesters in their Junior and Senior semesters.

3E. Catalog entry. The following is the proposed entry for the University of Hawai‘i at Mānoa 2009-2010 Catalog.

Degrees offered: BS in molecular cell biology.

The academic program Molecular cell biology (MCB) is the study of cells, cellular systems and their interactions at the molecular level. Since the discovery of DNA as the genetic material, molecular biology and its application to the study of the smallest unit of life, the cell, has had profound impacts on science, healthcare, technology, and philosophy. The primary objective of the program in Molecular Cell Biology is to prepare students for careers in fields that require
advanced knowledge of molecular biology. Such fields include medicine, pharmacology, pathology, genetic testing and counseling, biotechnology, nanotechnology, teaching, and basic biological research. The course of study focuses on the molecular biology of eukaryotic organisms, with an emphasis on understanding human health and disease. Graduates of the program will be able to

i. explain and discuss how processes are integrated at the molecular level to create a functional eukaryotic cell;

ii. describe the structures and various cellular functions associated with the macromolecules found in cells;

iii. explain the techniques and logic of methods employed in molecular biology research;

iv. explain the molecular basis of human diseases and research on prospective treatments;

v. perform techniques employed in molecular biology research;

vi. critically evaluate scientific studies; and

vii. evaluate the ethical implications of research methods and outcomes.

Advising  Prospective majors are strongly encouraged to talk to an advisor as soon as possible to design and acceptable program of study. Students should contact the main office of the Department of Microbiology at (808) 956-8553 for information on advising services.

BS in Molecular Cell Biology

Requirements (C grade minimum)

- BIOL172-172L
- BIOL275-275L
- MICR314
- BIOL375-375L
- MBBE/BIOL402 or BIOC441
- MBBE/BIOL406-406L
- BIOL407
- MICR461
- MCB472
- 10 credit hours of approved major electives to include one laboratory course.

Related Requirements (C grade minimum)

Students are encouraged to complete these courses before entering their junior year.

- CHEM161-161L and CHEM162-162L or CHEM181A-181L
- CHEM272-272L and CHEM273
- MATH215 and MATH216 or MATH241 and MATH242
- PHYS151-151L and PHYS152-152L or PHYS170-170L & PHYS272-272L

4. Enrollment

As mentioned in section 2C, in a recent survey of current Biology and Microbiology majors 26% of respondents indicated that they would have definitely majored in MCB and 29% would have likely chosen the MCB major if it had been available when they started their undergraduate studies. Accordingly, we expect enrollment in the undergraduate MCB degree program to be robust from the start and continue to climb each successive year after its introduction for several years. Conservative estimates for majors by year are: 1st year – 25; 2nd
year – 50; 3rd year – 100; 4th year – 150; 5th year - 200. Estimates are based on our survey of UH Biology and Microbiology students and the proportion of students in the life sciences at other universities enrolled in undergraduate molecular and cellular biology programs. For instance, at UC Davis, a UH peer institution, 1650 of 4765 students (35%) with declared majors in the College of Biological Sciences are majoring in Biochemistry and Molecular Biology, Cell Biology or Genetics. At the University of Washington, a UH benchmark institution, 407 of 1128 (36%) life science majors are enrolled in the Molecular, Cellular and Development program (please see Appendix section B for details). 36% of the non-Marine Biology life science majors in the College of Natural Sciences at UH represents 274 majors. MCB majors will consist primarily of students that would have otherwise been Microbiology or Biology majors and students that were attracted to UH because it offers the MCB Program.

5. Resources for implementation and first cycle operation

This particular program is unique in that no new courses, other than the capstone, are being proposed at the outset. This is possible because all of the core courses and essentially all of the elective courses are taught at least once per year.

We expect an increase in enrollment in two core courses, BIOL406 and BIOL407. The instructor for BIOL407 (H. De Couet) is enthusiastic about the change. G. Presting has been the instructor for BIOL406 for many years and, although he too is enthusiastic about the new program, it is not clear whether he will be available in the future. If Presting cannot teach the course, we expect the College of Natural Sciences to supply funds for an instructor. In the event that no funds are available, current faculty have also agreed to teach this course, if necessary (to that end, P. Patek will probably be the primary instructor for BIOL406 in spring 2009). BIOL375, Genetics, is also taught every fall. It is required of all Biology majors and has enrollment of about 160. Thus, this course must be taught at least once per year. Since most of the students in the MCB program will come from those that otherwise would be Biology and Microbiology majors, a significant increase in enrollment in BIOL375 is not expected.

Many of the lecture courses in the MCB program are accompanied by laboratory courses. State-of-the-art laboratory courses need state-of-the-art laboratory instrumentation; this can be very expensive. If the degree program is approved, we will apply for a NSF Course, Curriculum, and Laboratory Improvement (CCLI) grant. These pay up to $150,000. No matching funds are required. Initiation of new programs is an opportune time for requesting funding of this sort from NSF. Securing this funding will give us the opportunity to start this program with high-end equipment that matches what students might see in a research laboratory and provide the best training possible for students that wish to continue their molecular cell biology training or want to enter the workforce in a modern laboratory. However, while NSF funding would facilitate creation of a world-class MCB laboratory training program, the existing laboratory courses are quite satisfactory and attaining such a grant is not necessary for the success of the MCB program.

No new library, physical, or faculty resources are required for implementation of the program in its first cycles of operation. Although no new faculty are required, it would be advisable to eventually hire a full time faculty to teach Genetics (BIOL375) and Cell Biology (BIOL406). These courses have been taught by faculty outside of the College of Natural Sciences, and in the past there has been some difficulty finding an instructor for the Genetics course.
6. Efficiency

If the program is successful we would hope that new courses will be added. However, because of budgetary constraints at UH, the proposed program consists of largely existing courses. The one course that does not currently exist, the Capstone course, will be team taught by existing faculty. We suspect that the major impact of the program initially will be increased enrollment in the required core courses, thus improving their educational efficiency and cost per student semester hour. Cost per major is expected to remain the same as a Biology major or rise slightly due to increased enrollment in the Cell Biology Lab course (BIOL406L) because lab courses tend to be more expensive than lecture courses.

7. Demonstration of effectiveness

Assessment of the program will be measured by the MCB Curriculum Committee in three broad categories: student learning, student satisfaction, and faculty effectiveness. Student learning will be assessed in the following ways:

Performance in the proposed capstone course  The capstone course will integrate much of the basic knowledge that the students should have learned during their previous undergraduate years. At the end of the semester, the faculty teaching the capstone course will report to the MCB steering committee the academic strengths and weakness of the students and suggest areas where improved or additional instruction is needed.

Similarly, at the end of the semester, the students will be asked to not only evaluate the capstone course, but will evaluate the entire degree program (see below). They will be able to make comments on individual courses and, in the framework of the capstone course as an integrated look at molecular cell biology, provide their thoughts on whether the degree program has provided them the basis to understand the complex molecular and cellular interactions that are involved in cancer development. They will be asked to suggest areas where improved or additional instruction is needed. They will also be queried about their future plans.

Research activity conducted by students with faculty mentors Although not required, students will be encouraged to conduct research in molecular cell biology and receive credit toward the degree by signing-up for Directed Research (e.g., MICR499, BIOL499, MBBE499). It is generally believed that hands-on experience in a research laboratory provides students with a feel for research and biology that cannot be achieved in lecture courses and teaching laboratories. We will make a concerted effort to place as many students as possible in research environments and will consider this a success if significant numbers of students are signing up for Directed Research.

Placement of students after graduation in industry, graduate and medical schools and post-graduation satisfaction surveys One year, three years and five years post-graduation, former students will be contacted to request information on whether they are working in the field or continuing their education in the life or health sciences. For those that are continuing work or education in the life sciences, we will request information on whether their undergraduate training has provided them with the foundation to succeed in their chosen field.
Feedback from employers and schools  With the permission of the students who have answered the post-graduation survey, we will contact their employer/school and ask how our graduates compare to their other employees/students.

Student satisfaction with the program will be assessed in the following ways:

Anonymous exit survey and interview  These surveys and interviews will be done in conjunction with the capstone course (see above).

Program enrollment trends  It is expected that the enrollment in the degree program will significantly reflect the quality of the program. If, after several years, the percentage of life sciences students with the MCB major is below what is seen at other institutions then we will need to determine why there is such a trend.

Individual faculty effectiveness will be assessed in the following ways:

Responses to CAFE and course-specific evaluations  All upper-level required courses will use the university CAFE forms as well as course-specific evaluations to be completed by students at the end of a course. Because most of the courses are not MCB courses, individual instructors (most will be on the MCB steering committee) will be solicited to share evaluations with the program steering committee for assessment purposes.

Student performance in different areas of the capstone course  Because the capstone course integrates many of the concepts and skills acquired in other courses, it is an opportune time to assess the success of those courses.
8. Appendix

8A. Student semester hours for 2006-7.

<table>
<thead>
<tr>
<th></th>
<th>lower division SSH</th>
<th>upper division SSH</th>
<th>Total SSH</th>
<th>number of majors*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>7743</td>
<td>2120</td>
<td>9863</td>
<td>529 (594)‡</td>
</tr>
<tr>
<td>Botany</td>
<td>749</td>
<td>944</td>
<td>1657</td>
<td>30 (37)</td>
</tr>
<tr>
<td>Microbiology</td>
<td>1389</td>
<td>1947</td>
<td>3369</td>
<td>64 (71)</td>
</tr>
<tr>
<td>Zoology</td>
<td>764</td>
<td>927</td>
<td>1691</td>
<td>87 (77)</td>
</tr>
</tbody>
</table>

Fall '06 data from Star Correspondent on 9/28/2006
Spring '07 data from Star Correspondent on 1/12/07
All 399 and 499 data is excluded (the number are small)
‡ number of majors in fall 2007; from Star Correspondent
*From Star Correspondent 2/6/07
Fall '06 data from Star Correspondent on 9/28/2006
Spring '07 data from Star Correspondent on 1/12/07
All 399 and 499 data is excluded (the numbers are small)

Undergraduate SSH relative to Microbiology

<table>
<thead>
<tr>
<th></th>
<th>lower division SSH</th>
<th>upper division SSH</th>
<th>Total SSH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>5.6</td>
<td>1.1</td>
<td>2.9</td>
</tr>
<tr>
<td>Botany</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Microbiology</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Zoology</td>
<td>0.6</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

8B. Molecular Cell Biology enrollment at UH benchmark and peer institutions

i. University of Washington Department of Biology (UH Benchmark)

Molecular, Cellular, & Development: 407
Physiology: 295
General Biology BS/BA: 277 (267 BS/10 BA)
Ecology & Evolution: 67
Environment & Conservation: 46
Plant Biology: 21
Old Zoology, Botany, and Cellular Biology Majors: 15
Most current total # of life science students: 1,128

Total Molecular, Cellular, & Development/total enrolled at U of Washington - 407/1128=36%
ii. UC Davis College of Biological Sciences (UH peer)

<table>
<thead>
<tr>
<th>Enrollment by Declared Majors (Fall Quarter 2006)</th>
<th>Number</th>
<th>% of declared</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Biochemistry and Molecular Biology</td>
<td>1,090</td>
<td>22.9%</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>1,914</td>
<td>40.2%</td>
</tr>
<tr>
<td>*Cell Biology</td>
<td>111</td>
<td>2.3%</td>
</tr>
<tr>
<td>Evolution, Ecology, and Biodiversity</td>
<td>69</td>
<td>1.4%</td>
</tr>
<tr>
<td>Exercise Biology</td>
<td>444</td>
<td>9.3%</td>
</tr>
<tr>
<td>*Genetics</td>
<td>449</td>
<td>9.4%</td>
</tr>
<tr>
<td>Microbiology</td>
<td>168</td>
<td>3.5%</td>
</tr>
<tr>
<td>Neurobiology, Physiology, and Behavior</td>
<td>492</td>
<td>10.3%</td>
</tr>
<tr>
<td>Plant Biology</td>
<td>27</td>
<td>0.6%</td>
</tr>
<tr>
<td>Total Enrollment</td>
<td>4,764</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Molecular Cell Biology (MCB) students at UC Davis:
Biochem and molecular Biol...1090
Cell Biology.................................. 111
Genetics......................................449
Total MCB/Total enrolled.....1650/4764=35%
To whom it may concern,

We in the Department of Molecular Biosciences and Bioengineer (MBBE) support the formation of a Molecular Cell Biology (MCB) undergraduate major program. Its curriculum is strong and will be taught by good professors.

The curriculum will not interfere with our undergraduate Plant and Environmental Biotechnology major or any other of our teaching activities. The MCB program should feel free to use any of the MBBE courses they want their students to use. We have been invited to continue to use two of their courses, MICR 351/351L and MICR 461, as highly recommended electives students with certain interests in our program. They are very good courses, in our opinion.

Respectfully submitted,

[Signature]

Professor and Chair
MEMORANDUM

TO: Paul Patek, Chair
Department of Microbiology

FROM: Martha E. Crosby, Chair
Department of Information and Computer Sciences (ICS)

SUBJECT: BS degree in Molecular Cell Biology (MCB)

Members of the department of Information and Computer Sciences enthusiastically support the proposal to offer a BS degree in Molecular Cell Biology (MCB) in the department of Microbiology.

The ICS Department recently hired Dr. Guylaine Poisson, a Computer Scientist with expertise in both bioinformatics and biology, with the goal of strengthening collaborations between ICS and life science departments in the College of Natural Sciences, such as Microbiology. The ICS department would be happy to include the ICS Bioinformatics courses (ICS475 and ICS 476), taught by Dr. Poisson, as a related electives for the proposed MCB degree. Do not hesitate to contact me if I can provide further support for the MCB BS degree.
From: Heinz G. de Couet [mailto:couet@hawaii.edu]  Sent: Thursday, February 14, 2008 3:33 PM  To: 'Paul Patek’  Subject: undergraduate program in cell- and molecular biology

Paul,

Thank you for inviting my comments on the proposed degree in cell- and molecular biology. I will forward a similar commentary to the Biology program.

I am in strong support of the proposed program and I think it is timely.

I believe that this specialized degree would attract a significant number of new students, and also channel existing Biology students with an interest in a professional career in cell-and molecular biology, biomedical research, and health-related technical professions towards this degree. This is consonant with national priorities and federal initiatives to boost the number of students entering research-related professions. I therefore see the proposal in the best interest of the students.

To some extent, I do agree with criticism that the program as proposed does not offer more than the present Biology degree. I believe your proposal would be strengthened by adding a capstone course or integrating experience to distinguish itself from the Biology BS, such as a mentored research project or a problem-oriented laboratory course. On the other hand, I feel strongly that an educational “product” with a distinguishing name and description alone will be attractive to potential students. We learned a while ago that simply advising a student to take marine-oriented courses to become a “Marine Biologist” simply wasn’t the same as offering a specialized degree with an appropriate label.

I am excited about the prospect of seeing increasing enrollments in my own courses (BIOL 407, Molecular Biology, and the associated lab course BIOL 406L). I hope that the central role you propose to give my courses in this new degree would somehow lead to better dedicated technical and TA support. For example, a suitably qualified preparator could support an entire suite of instructional offerings that are centered around molecular techniques. I would also hope that a larger group of interested students may lead some of us to develop additional upper-division courses that embrace the quantitative aspects of modern biology, such as genomics or systems biology.

If such a degree were to be offered, Gernot Presting and I would probably propose to merge cell biology (BIOL406) and molecular biology (BIOL407) into an integrated two-semester course that would no longer pretend to maintain the outdated separation between structure, function, and the underlying genetics and biochemistry. Since both courses are listed as required by the proposed degree program, we would probably call them Cell-and Molecular Biology I and II. I am also working towards an upper division course on “The Biology of Cancer” that
would list at least Cell Biology as a prerequisite. An increased student population could make this course a success and it may act as an attractant for motivated pre-medical students to enroll in this degree program.

I wish you good luck with this venture and you may count on my support all the way.

Gert

Heinz Gert de Couet, Ph.D.
Dept. of Zoology
University of Hawai‘i at Mānoa
2538 McCarthy Mall
HONOLULU HI 96822
USA
phone (808) 956 9686
Fax     (808) 956 9812
http://www.hawaii.edu/zooology/faculty/decouet.htm
http://www.crch.org/ProfileDeCouet.htm
From: Gernot Presting <gernot@hawaii.edu>
Date: February 26, 2008 11:20:16 AM HST
To: Sean Michael Callahan <scallaha@hawaii.edu>
Cc: Paul Patek <patek@hawaii.edu>
Subject: MCB

Dear Sean and Paul,

I am writing to express my support for an undergraduate degree expressly in Molecular and Cellular Biology. The steady enrollment of roughly 30 undergraduates each year in the Cell Biology Course (BIOL406) during the four years that I have taught it, demonstrates that there is interest among the students to pursue this challenging and exciting discipline. The MCB degree will allow the building of a community of students with these shared interests.

I am delighted to hear that you already have received the support of the MBBE department via Harry Ako. Please let me know how I can help in this effort.

Gernot.

==================================
Gernot Presting
Assistant Professor
Molecular Biosciences and Bioengineering
University of Hawaii

To learn more about our research, please see:

www.genomics.hawaii.edu
www.plantcentromeres.org
www.genomics.hawaii.edu/Rhodophyta
February 26, 2008

Sean Callahan  
Associate Professor  
University of Hawaii  
Department of Microbiology  
207 Snyder Hall, 2538 McCarthy Mall  
Honolulu, HI 96822  
Tel: 808 956-8015  
Fax: 808 956-5339  
scallaha@hawaii.edu

Dear Sean,

It is exciting to note that you are proposing a new "Molecular Cell Biology" undergraduate degree program to the Natural Sciences Curriculum Committee, UHMC. We are all aware that molecular cell biology is the foundation of many scientific disciplines. This program has the potential to open new avenues to University of Hawaii's undergraduate students.

I enthusiastically support your endeavor and look forward to working with you in this Molecular Cell Biology degree program and I would be happy to enlist my biochemistry course, MBBE402, as an integral part of it.

Best Wishes

Sincerely,

Pratibha V. Nerurkar, Ph.D.  
Associate Professor
Paul, subsequent to reviewing your revised proposal and several discussions about it with colleagues, with this e-mail I am endorsing the proposal to offer a new B.S. in Molecular Cell Biology.

Some considerations:

1. The new program may increase enrollment in BIOL 171, 171L, 275 and 275L with concomitant increases in recurring costs for faculty, TAs, TIs, and lab supplies. This might similarly impact introductory CHEM courses.

2. Upper division courses might be transferred from Biology to the department of the principal faculty member teaching the course. This would apply to the present BIOL 375/L, 406/L, and 407. Cross-listing between the most relevant departments may also be desirable.

Good luck as you carry this process forward.

Sherwood Maynard, Director
aloha paul,

thank you for providing the background to understand your proposal for a molecular cell biology bs degree. after having just returned from this year's nsf graduate fellowship research proposal panel meeting (i have been on the genetics and evolutionary biology panel for the last 2 years, and before that, was on the cell and molecular biology panel for 5 years), i can say that the most competitive undergraduates coming into graduate school on a national level have the kind of undergraduate training this sort of major is poised to deliver. the most highly rated proposals, among the 342 my panel read and scored, gave special emphasis at an advanced level to both the bench technology and the conceptual innovations in bioinformatics. and, to be truly nsf competitive, there also had to be an explicit understanding of the broader impacts that an ethics course prepares students to address.

you have my support, good luck, becky