PROFESSIONAL SCIENCE MASTER’S IN APPLIED BIOTECHNOLOGY
(Name Change)

Name of Institution: Oregon State University
Name of Proposing College: Science
Name of Proposing Program: Molecular and Cellular Biology
Date of Proposal: 27 May 2011
Proposed Effective Term: Fall 2011

A. Title of the proposed instructional, research, or public service unit. For name changes, give both the current and proposed names. Describe the reason(s) for the proposed change.

Current name: MS in Molecular and Cellular Biology (non-thesis option in Applied Biotechnology)
Proposed name: Professional Science Master’s in Applied Biotechnology

This program has been offered as a non-thesis Professional Science Master’s (PSM) program since 2003. The PSM is a unique program that combines graduate-level education in Science, Technology, Engineering, or Mathematics (STEM) with training in business management, communication, research ethics, and other employer-relevant skills (http://psm.science.oregonstate.edu). Students complete an internship in lieu of thesis research, giving them practical experience in the workplace. There are now over 238 PSM programs offered by 110 institutions across the U.S. (http://sciencemasters.com/). There is a statewide PSM program development project underway involving multiple campuses in the OUS (http://oregonpsm.org). The Oregon University System (OUS) Provosts’ Council and State Board of Higher Education approved the “PSM” as a new degree option in Oregon (http://www.ous.edu/sites/default/files/about/polipro/files/ORPSMGuidelinesNov2010.pdf) on 24 February 2011. Changing the name of the degree will help us brand and promote these unique programs to employer groups, prospective students, and will recognize graduates who’ve completed this education, designed to provide depth of knowledge in STEM disciplines as well as breadth of training in management.

B. Location within the institution’s organizational structure. Include “before” and “after” organizational charts (show reporting lines all the way up to the Provost).

There will be no change in location within OSU’s organizational structure. This degree will offered as an option through the existing Molecular and Cellular Biology (MCB) Program, which is an interdisciplinary program residing in the College of Science and the Graduate School.

C. Objectives, functions (e.g., instruction, research, public service), and activities of the proposed unit.

1. Explain how the program’s current objectives, functions, and/or activities will be changed. Where applicable, address issues such as course offerings, program requirements, admission requirements, student learning outcomes and experiences, and advising structure and availability. How will the reorganized program be stronger than the existing program?
The existing degree options in the MCB Program will remain the same; however, a PSM in Applied Biotechnology will now be recognized as a separate degree instead of simply a non-thesis MS option within the program.

The objective of the PSM in Applied Biotechnology is to train students to be able to function effectively in industry, government, and medical environments. Biomedical and start-up companies need employees who can combine their scientific and technical knowledge with business management and communication skills. The PSM program can usually be completed in two years, based on full-time study and at least 54 credit hours. [http://psm.science.oregonstate.edu/program-curriculum-m-s-molecular-and-cellular-biology](http://psm.science.oregonstate.edu/program-curriculum-m-s-molecular-and-cellular-biology)

Comparison between the MCB non-thesis MS and PSM in Applied Biotechnology:

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<tr>
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<th>MS in Molecular &amp; Cellular Biology</th>
<th>PSM in Applied Biotechnology</th>
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<tbody>
<tr>
<td>Core courses (19 credits)</td>
<td>Core courses (19 credits)</td>
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<tr>
<td>Electives (22 credits)</td>
<td>Electives (11 credits)</td>
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<tr>
<td>Research projects (MCB 501; 4 credits)</td>
<td>Professional courses (18 credits)</td>
<td>Internship (MCB 510; 6-12 credits)</td>
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<td>Total: minimum 45 credits</td>
<td>Total: minimum 54 credits</td>
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Core lecture courses provide the conceptual framework necessary in the biotechnology sector. Microbial genetics, structure and function of eukaryotic cells, eukaryotic molecular genetics, and cell signaling and development are some of the topics that are covered, and an intensive laboratory experience (MCB 525) is a 2-week summer course that has attracted students from around the country for 8 years to learn molecular biology theory and practice. The core courses are the same for both programs:

**MCB 525. TECHNIQUES IN MOLECULAR AND CELLULAR BIOLOGY** (3). An intensive laboratory course introducing modern methods for the manipulation of cellular macromolecules. Recombinant DNA technology, protein chemistry, and in situ hybridization methods presented in a format that emphasizes experimental continuity. The course requires two weeks of intensive full-time involvement.

**MCB 554. GENOME ORGANIZATION, STRUCTURE AND MAINTENANCE** (4). How diverse organisms store their individual sets of genetic information (genomes). Evolution of genomes and gene families. Structures of DNA and chromatin. Biochemical and regulatory pathways that protect cellular genomes against environmental and endogenous damage and ensure transmission of faithful copies to progeny. Remodeling of genomes by recombination and transposition. CROSSLISTED as TOX 554. PREREQS: BI 311 (genetics or equivalent) and (BB 450 and BB 451 and BB 452) or (BB 490 and BB 491 and BB 492) or equivalent.

**MCB 556. Cell and Developmental Biology** (4). Examination of molecular and structural elements in eukaryotic cells and their relationship to function and development. Topics include nuclear organization, membranes, organelles, intracellular sorting, cell energetics, cell signaling, cell motility, cell division cycle, and developmental processes of selected model organisms. Critical reading and writing skills will be emphasized. PREREQS: BB 450 and BB 451 (biochemistry) or equivalent; BI 311 (genetics) or equivalent. Recommended: BI 460 (cell biology) or equivalent; MCB 554 and MCB 555.
MCB 555. GENOME EXPRESSION AND REGULATION (4). Prokaryotic and eukaryotic systems will be used to describe recent advances in understanding transcriptional and posttranscriptional control mechanisms. Topics include: microbial, yeast and mouse model systems; transcriptional control mechanisms; RNA processing, silencing and microRNAs; protein synthesis and posttranslational modification; microarray- and mass spectrometry-based expression genomics. PREREQS: BB 451 or equivalent.

MCB 668. BIOINFORMATICS AND GENOMICS (4). This course is divided into two 2-credit modules. First module teaches both the theory and practice of basic informatics techniques-including sequence alignment, sequence searching, and the evolution of protein families- and their applications at a genome-wide level (comparative genomics and functional genomics). Second module introduces the fundamental tools of bioinformatics (Linux, Perl) and bioinformatics algorithms necessary to process and analyze large datasets generated from high-throughput genomics experiments. The second module is structured in three sections: Programming Concepts (PC), Biological Applications (BA) and Biological Projects (BP). Programming Concepts lays the foundation for the later two sections. PC will teach students to work within a Linux operating system in a client/server environment. Students learn to create programs in Perl scripting language, which permeates modern bioinformatics applications. Relevant programming concepts are presented and code examples illustrated using biological data. BA builds on the PC foundation to provide "snapshots" of common bioinformatics methods. For example, formatting biological sequence data into standard file formats, parsing the output from common bioinformatics software, adding notations to biosequences, calculating common statistics associated with biosequences (i.e., reverse complementation of DNA sequence). BP uses the BA snapshots to develop more extensive projects. BP incorporates extensive coverage of theoretical and algorithmic concepts to explore a biological topic where dealing with the data in a computational and mathematical framework is essential. CROSSLISTED as MB 668.

Approved electives in an Area of Concentration give focus and identity to each student’s curriculum and allow for flexibility in response to changing employment demands. Current Areas of Concentration include: Bioinformatics, Biotechnology, Cell Biology, Developmental Biology, Genome Biology, Molecular Biology, Molecular Pathogenesis, Molecular Virology, Plant Molecular Biology and Structural Biology. Electives are chosen in consultation with the student’s major advisor.

The required professional courses are designed to be taken in sequence during the first academic year and include:

COMM 550. COMMUNICATION AND THE PRACTICE OF SCIENCE (3). [Pending approval #79896] Course develops a broad range of skills encompassing verbal, written, and visual media styles of communication. Topics include: working in teams and collaborative decision-making; interpersonal and organization communication; writing and making presentations to diverse audiences; negotiation and consensus building; and persuasion and influence in communication.

PHL 547. RESEARCH ETHICS (3). An examination of the interrelationship between ethical values and scientific practice. Topics include professionalism in science; scientific integrity, misconduct, and whistleblowing; the ethics of authorship; conflicts of interest between academic science and commercial science, and social responsibilities in science.
Guidelines relating to patent, trademark, copyright, and authorship issues are covered as well.

**PSM 513. PROFESSIONAL SKILLS** (3). Students work in teams with off-campus mentors to address a contemporary problem in a scientific field within the context of an existing business. This collaborative project will provide students with opportunities to integrate and apply their collective knowledge of business management, communication, and science to create innovative solutions. Project management, team skills, and leadership styles are also covered, and a final report and presentation are usually required. **PREREQS:** COMM 550 and PHL 547 and PSM 565 and PSM 566 and concurrent enrollment in PSM 567

**PSM 565. ACCOUNTING AND FINANCE FOR SCIENTISTS** (3). Students develop business management skills by learning principles of managerial and financial accounting and understanding profit and loss statements, cost analysis, and investment risks. Individuals utilize basic financial tools needed to develop business proposals and successful manage scientific projects in public and private work sectors.

**PSM 566. PROJECT MANAGEMENT AND MARKETING SCIENTIFIC TECHNOLOGIES** (3). Students gain an understanding of marketing principles and global markets with a focus on scientific technologies. Project management skills needed to effectively manage diversity, conflict and change in corporate, government and nonprofit environments as well as entrepreneurial ventures will be emphasized. **PREREQS:** PSM 565

**PSM 567. INNOVATION MANAGEMENT** (3). Students learn about different types of innovation, development and implementation of new technologies, and intellectual property. Student teams develop and present business plans as term projects. Structuring small business enterprises, project planning and management, and commercialization of new products and services prepare individuals for leadership roles in the innovation process. **PREREQS:** PSM 565 AND PSM 566

Students are required to complete a 3 to 6 month internship (6-12 credits) in lieu of thesis research, and most PSM in Applied Biotechnology students complete 6 month internships. Guidelines for development of an internship proposal, evaluation of performance, and final report requirements are available online and help ensure that the internship is a meaningful educational experience ([http://psm.science.oregonstate.edu/internships](http://psm.science.oregonstate.edu/internships)). Students have been hired by a variety of companies as interns, including Mitosciences, Bioanalytical Systems, Inc., Invitrogen, Siga Technologies, Inc., Genentech, Kashi Clinical Laboratories, and others. Opportunities are posted online ([http://oregonpsm.org/internships-and-jobs](http://oregonpsm.org/internships-and-jobs)), and the Oregon PSM Internship Coordinator facilitates placement of students.

Admission requirements are similar to those for other MCB graduate programs and include a minimum GPA of 3.0 on the last 90 quarter credit hours, completion of a 4-year undergraduate degree in math, science or engineering (equivalent to one academic year of physics, inorganic chemistry and organic chemistry, one biochemistry course, mathematics through integral calculus, and one or more biology courses), GRE scores of at least 1,100 combined verbal and analytical, TOEFL scores for international applicants (minimum of 550), a statement of interest, and three letters of recommendation ([http://psm.science.oregonstate.edu/admission-applied-biotechnology-program](http://psm.science.oregonstate.edu/admission-applied-biotechnology-program)).
Graduates from the PSM in Applied Biotechnology will be able to perform basic molecular biology procedures that are commonly used in the biotechnology industry and academic research laboratories. Graduates will have the theoretical training to plan experiments and interpret experimental results. They will also have a basic understanding of business principles, as well as project management and oral and written communication skills, to help them apply their science in a business context.

Students in this PSM program belong to two cohorts, which enhances their graduate experience: 1) classmates enrolled in the MCB graduate program, and 2) the PSM collective cohort comprised of students from other STEM disciplines (e.g., botany, physics, and environmental sciences). The PSM cohort engages in a variety of activities to help develop group cohesion and increase retention:

- A 5-day workshop the week prior to the start of fall term is held at an off-campus facility, and important topics not included elsewhere in the curriculum are covered. Some of these topics include project collaboration in the virtual environment, networking and dining etiquette, and interview and time management skills.
- All students complete the 18 credits of professional coursework together during the first academic year (two courses per term).
- Social events are regularly scheduled and include a fall gathering event at the beginning of fall term, a student mentorship program, an industry luncheon in early December, monthly seminars featuring off-campus speakers, 1st Friday happy hour gatherings, and an end-of-the-year barbecue picnic with industry representatives.

Students are initially advised by Dr. Ursula Becher, Director of Off-Campus Programs, Dr. Barbara Taylor, Director of the Molecular and Cellular Biology Program, and Dr. Kirstin Carroll, PSM Coordinator, and these individuals continue to provide general administrative support to each student enrolled in the program. Like other graduate students, a graduate committee consisting of a major professor and minimum of three members is required for each PSM student ([http://psm.science.oregonstate.edu/faculty](http://psm.science.oregonstate.edu/faculty)). These individuals provide advice regarding coursework and approve a Program of Study form, mentor students within their profession, facilitate laboratory rotations or research experiences, provide feedback on and final approval of an internship proposal, check on progress made during the internship, and grade the internship based on review of the student’s internship journal, the employer’s formal review ([http://psm.science.oregonstate.edu/internship_evaluation_form](http://psm.science.oregonstate.edu/internship_evaluation_form)), and the final report in lieu of student’s thesis. The internship supervisor provides on-the-job training based on learning outcomes described in the internship proposal.

2. Explain how outcomes in the newly organized program will be assessed.

Student learning is assessed by traditional measures (e.g., performance on written tests and in oral presentations), the internship evaluation, and students are required to undergo a final oral examination to receive their degree. An exit interview is conducted once a student has passed the oral examination to assess the PSM program and student’s perception of learning outcomes. All alumni from the program are tracked to assess post-graduation employment history ([http://psm.science.oregonstate.edu/alumni-profiles](http://psm.science.oregonstate.edu/alumni-profiles)). There are 14 alumni of the PSM in Applied Biotechnology, five students are currently enrolled, and another six will be joining the program this fall.

number of governors and state policymakers have come to recognize that higher education, including community colleges, four-year colleges, and research universities, cannot help drive economic growth in their states unless students’ academic success is linked to the needs of the marketplace.” The report emphasized the importance of encouraging employers’ input in higher education, and the PSM in Applied Biotechnology at OSU has attempted to do this starting with a joint industry-faculty workshop in June 2001. Approximately 43% of this program’s PSM graduates find employment in Oregon after graduation, and 57% remain in the Pacific Northwest, demonstrating how the program contributes to regional economic development.

D. Resources needed, if any: personnel, FTE academic, FTE classified, facilities and equipment.

No additional resources are needed.

E. Funding sources: state sources (institutional funds – state general fund, tuition and fees, indirect cost recoveries), federal funds, other funds as specified.

Funding sources will remain the same.

F. Relationship of the proposed unit to the institutional mission.

The PSM in Applied Biotechnology builds on existing faculty expertise in several departments and units across campus including Biochemistry and Biophysics, Microbiology, Zoology, Environmental and Molecular Toxicology, Pharmacy, Botany and Plant Pathology, and others. This program fits in OSU’s Signature Area of Distinction: Human Health and Wellness.

The biotechnology industry is a desirable avenue of economic development for the state of Oregon, but the development of this industry within the state has lagged largely due to a number of factors that are perceived as unfavorable by industry. Foremost among these is the lack of a qualified labor pool; a problem that is addressed directly by this program. Current OSU PSM Advisory Board members representing the biotechnology industry in Oregon include: John Audette, President and CEO of Mitosciences, Inc., Christ Beatty, President of Trillium FiberFuels, Inc., Barbara Bessey, Coordinator, Willamette Valley Bioscience Consortium, Dennis McNannay, Executive Director, Oregon Bioscience Association, and Takuji Tsukamoto, President of Chemica Technologies, Inc.

G. Long-range goals and plans for the unit (including a statement as to anticipated funding sources for any projected growth in funding needs).

n/a

H. Relationship of the proposed unit to programs at other institutions in the state.

n/a

I. If the program is professionally accredited, identify the accrediting body and discuss how the proposed change may affect accreditation.

n/a
Appendices:
- Transmittal sheet
- Budget table n/a
- Library evaluation n/a
- Liaison