Proposal for the establishment of a Doctoral Program in Biology in the Department of Biology at the Mayagüez Campus of the University of Puerto Rico.

Doctoral Program Committee

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I. INTRODUCTION

A. Program title and academic degree

The title of this program is:

The Doctoral Program of the Department of Biology of the University of Puerto Rico at Mayagüez.

This program will only include one academic degree and specialization:

Doctor of Philosophy of Science in Biology.

B. Brief description of the program

The Doctoral Program of the Department of Biology of the Mayagüez Campus of the University of Puerto Rico will confer the degree of Doctor of Philosophy of Science in Biology. This program will graduate students with a broad knowledge of the biological sciences, with excellent basic and applied research skills, and with the capacity to lead in academia, government, and industry. This program will offer a unique opportunity to develop and conduct research in a multidisciplinary environment as students can interact with scientists in biotechnology, marine sciences, engineering and agriculture. Moreover, it will be the only Doctoral Program in biology offered in the western part of Puerto Rico, and the third overall in Puerto Rico.

During the first ten years of the program we expect to graduate a minimum of five students, and at least double this rate in the following years.

C. Unusual modalities

This program does not include unusual modalities.

D. Expected date of initiating the program

The Doctoral Program of the Department of Biology of the University of Puerto Rico at Mayagüez will begin the first semester of the academic year 2011-2012.

E. Program duration and maximum time to complete the degree

Students who join this program with a Bachelor in Science degree are expected to complete the doctoral degree in four to five years, whereas those students who already have a Master in Science degree can complete the doctoral degree in at least three years. The current time limits for graduation, according to the University of Puerto Rico regulations (UPRM Academic Senate Certification # 09-09), are ten years for students entering the program with a Bachelor in Science degree and eight years for those students entering the program with a Master in Science degree.

II. PROFESSIONAL ACCREDITATION

This program does not require professional accreditation.

III. PROGRAM JUSTIFICATION

The Department of Biology at Mayagüez initiated its academic programs in 1946 with a B.S. in Biology, becoming the Department with the largest number of registered students at the Mayagüez Campus. In 1962, the Department established its M.S. program and during the past 12 years has graduated 157 students. These developments have been accompanied by a growing number of research and teaching projects and an enhanced interest of our graduates in an academic preparation leading to higher degrees. Therefore, the initiation of a Doctoral Program in Biology represents a logical development of our Department's academic programs and activities.

The establishment of our Doctoral Program will permit a significant increase in teaching and research collaborations, as well as new opportunities to compete for funding of more complex projects that are only feasible within the framework of a Ph.D. degree program. We anticipate that all participating professors will teach higher level graduate courses, will develop externally funded research, will publish regularly in peer-reviewed journals, and will supervise graduate student research projects.

During the past two decades the government of Puerto Rico has started several initiatives to transform our economy from manufacturing-based to knowledge-based capable of generating new products. More recently, biotechnology has been identified as one of the areas with the highest potential for development in Puerto Rico, and is strongly supported by our governmental leaders. The recently approved Law 214 of 2004, "Ley para Crear el Fideicomiso de Ciencia, Tecnología e Investigación de Puerto Rico" (Law for the creation of the Puerto Rico Science, Technology, and Research Trust) encourages this transformation.

Such developments pose some important challenges. First, Puerto Rican universities will have to adjust their degree and course offerings to cater to the new demands of preparing professionals who are experts in fields relevant to the new industrial programs. Second, any new products developed as a result of advances in modern technology, will require proper evaluation for their health and environmental safety by well-prepared professionals. Third, all other historical and current challenges of biological relevance will need to be confronted, such as urban sprawl and the continuously increasing human pressure over our natural resources. Our Doctoral Program will prepare professionals capable of understanding such problems and challenges, of clearly explaining them to society, and of contributing satisfactorily to their solution. Establishing the highest standards of scholarship in basic, as well as applied biological topics, will increase our society's preparedness, not only toward problems already identified, but also toward those that will appear on the horizon in years to come. Moreover, some of our graduates will be prepared to work out solutions to the aforementioned challenges in a multidisciplinary manner because of the skills obtained during their studies in this Doctoral Program.

Evidence for the demand and need of our Doctoral Program comes from several sources. Between 2001 and 2006 the M.S. program in Biology received an average of 97 applications per year. The results of a recent survey of our M.S. students completing their degrees between the

academic years 2004-05 and 2008-09 revealed that all of those responding to the survey (84 students) are either working (84%) or studying (16%), and among the latter 90% are on a Ph.D. program. Our Department has conducted two surveys among the active M.S. students, one in November of 2000 and another in February of 2006, concerning their interest in a possible Doctoral Program in our Department. In the most recent of these surveys (among 47 respondents) all students (100%) supported the creation of a Doctoral Program in this department (representing a 3% increase over the 2000 survey), and 88% of the 42 students who expressed interest in applying to any Doctoral Program after completing their M.S. degrees indicated that they would apply to the Doctoral Program of this Department if there was one already in existence (representing a 4% increase over 2000). These results stress the increased trust our students have in our capacity to provide them with a sound higher level education. Furthermore, some of our graduates start their doctoral degrees in the Departments of Marine Sciences or Chemistry situated on the Mayagüez campus because those are the only choices available to them in close proximity. Finally, our Doctoral Program is necessary because the only other Doctoral Program in biology within the University of Puerto Rico system, i.e. the one offered by the Rio Piedras campus, cannot fulfill the demand for doctoral degrees in biology in Puerto Rico, as it accepts annually an average of only 25% of the students applying each year.

IV. RELATIONSHIP BETWEEN THIS PROGRAM AND OTHER ACADEMIC PROGRAMS

A. Relationship with the Strategic Plan of the University of Puerto Rico and with the institutional plan of the Mayagüez Campus

The Doctoral Program in Biology will advance the Strategic Plan objectives of both the UPR system and those of UPRM. Through the design of core courses (see Appendix IV-1), the Program will promote literacy and ethics in the doctoral student. In addition to the interactions mediated through advanced courses, the program will foster research, creativity and a sense of social awareness. The program will also develop leadership skills through the implementation of innovative technologies and methodologies, allowing UPRM to enhance its research profile in national and international forums. Academic reciprocity will be facilitated with other international doctoral programs through exchanges, scientific collaborations and extending of formal invitation to external field experts for seminar and workshops in our campus. This internationalization will address one of the most critical aspects of the UPRM Strategic Plan.

B. Relationship of this program with other academic programs offered

1. Within the University of Puerto Rico at Mayagüez

The courses that complement the Doctoral Program in Biology will impact our current graduate offerings as well as other doctoral programs in our institution such as Marine Sciences, Chemistry, Civil Engineering, and Electrical Engineering. Similarly, they will complement the existing master programs in Biology, Crop Protection, General Engineering, Geology, and Food Science and Technology. Furthermore, our Doctoral Program will have a positive impact on two additional doctoral programs that our institution plans to offer, i.e., Biotechnology, and

Agronomy and Soils, by expanding the course offerings for their students and by allowing collaborations among these faculties. Some of our Biology faculty have and will have joint appointments with these departments and programs, allowing our students to share the corresponding resources and be exposed to additional points of views and learning philosophies.

2. With other units within the University of Puerto Rico

The Department of Biology at Río Piedras and the Medical Sciences Campus represent the only two units that offer a Doctoral Program in biology. The Río Piedras Campus offers specializations in: 1. Molecular, Cellular, Developmental Biology and Genetics, 2. Microbiology, 3. Environmental & Population Biology, and Systematics, and 4. Neurobiology. The Medical Sciences Campus offers specializations in: 1. Anatomy, 2. Physiology, 3. Microbiology, 4. Medical Zoology, and 5. Biology (mediated through an intercampus agreement with the Río Piedras Campus).

Although our Doctoral Program will offer similar areas of specialization, the topics that will be developed by our researchers will in many ways complement those offered by the Río Piedras and/or Medical Sciences Campuses. Moreover, an outstanding aspect of the UPRM Doctoral Program in Biology is the development of seven research areas that are unique in Puerto Rico: aerobiology, biology of extremophiles, bioremediation, genetic anthropology, microbiology of anaerobes, plant genetic improvement, biodiversity informatics, and protistology. The development of advanced courses in these specialized topics will be of interest not only to our graduate students but also to students from other institutions.

3. With other universities in Puerto Rico

Currently, there are two institutions, outside the UPR system, offering doctoral programs in biology or related fields. The Ponce School of Medicine (PSM) offers a Doctoral Program in Biomedical Sciences with specialization in anatomy, biochemistry, microbiology, pharmacology, and physiology; whereas the University of Turabo (UT) offers a Doctoral Program in Environmental Sciences with specialization in biology, chemistry, and environmental management.

The principal similarity among the PSM, UT and the proposed UPRM Doctoral Program is the degree title, i.e., Ph.D. in Biology. In contrast with the programs offered by PSM and UT, the UPRM Ph.D. program in Biology (a) requires a lower number of credits which is in line with a worldwide trend (Russo, 2004); (b) demands additional graduation requisites (see Table IV-1 and Chapter II); and (c) has a multidisciplinary approach stemming from our unique academic environment (i.e., a close association with Agronomy, Biotechnology, and Engineering).

Table IV-1. Comparison of the proposed Doctoral Program in Biology with the profiles of those currently offered in other institutions in Puerto Rico.

Program	**UPRM**	UT	PSM
Total Number of Credits	52	60	70
Core Courses	5	18	55
Specialization Courses	N/A	12	N/A
Elective Courses	29	12	3
Research	18	18	12
Comprehensive Examination	Oral & Proposal-Based Written Component	Oral & Written Essay Type	Written Essay Type
Additional Graduation Requisites	Teaching experience (two semesters); a minimum of one submitted manuscript; participation in at least one international scientific meeting	None	None
Focus	Multidisciplinary	Environmental, Conservation, and Management	Biomedical

V. CONCEPTUAL FRAMEWORK

A. Mission

The mission of the Ph.D. Program in Biology of the Mayagüez Campus of the University of Puerto Rico is to educate and train future scholars to excel and lead in academia, governmental or non-governmental agencies, or industry. We intend to accomplish this through pioneering and multidisciplinary research activities, particularly stemming from the unique academic diversity on our Campus, such as those interactions already developed with the Agriculture and Engineering Colleges, like existing research and teaching collaborations. Our students will have the opportunity to study a wide range of biological phenomena in a tropical Caribbean setting, which contains a variety of habitats, natural and anthropogenic disturbances, as well as extreme environments.

B. Goals

The Ph.D. Program in Biology will:

1. educate scholars to contribute to the advancement and understanding of a wide range of biological phenomena;
2. engage our students in pioneering and multidisciplinary research with other scientists on our campus and from other institutions;
3. prepare new generations of national and international researchers and educators, conscious of the ethical and societal relevance of their endeavors.

C. Specific objectives

Before completing their doctoral studies, the students of the Ph.D. Program in Biology will:

1. disseminate their contributions to the understanding of biological phenomena by:
    a. teaching of at least one basic lecture or laboratory course in biology for a minimum of two semesters;
    b. presenting their research results at a minimum of one scientific meeting;
    c. submission of at least one manuscript for publication in a peer-reviewed journal.
2. design and conduct a pioneering research project with the faculty of the Department of Biology or in collaboration with other faculties on campus or elsewhere,
3. effectively express the relevance of their research activities to funding agencies and the general public through regular coursework, seminars, and proposal grantsmanship.

D. Educational philosophy

The traditional American doctoral education approach expects doctoral candidates to make important and original contributions to academic research by coupling coursework with research under the supervision of an established scientist. Employers today seek more than such credentials. They expect the above plus good teaching skills, skills in collaborative work, problem solving, interpersonal skills, ethics, entrepreneurial initiative, and interdisciplinary experience (Campbell et al. 2005). Therefore, the participating faculty of the Department of Biology must provide the necessary conditions for our candidates to develop many of these skills.

E. Profile of the doctoral graduate

The graduates of the Doctoral Program in Biology will be professionals with extensive knowledge of a variety of biological sub-disciplines, and with specialized knowledge of the particular topic of their research. They will acquire the necessary scientific, technical, teaching, communication, management, and ethical skills to conduct and maintain successful research programs within academia, government or industry.

More specifically, graduates of the Doctoral Program in Biology will have:

1. Competence in effective writing and oral communication, obtained through reports and presentations required in many courses, the required two credits of the seminar core course, the required hours of teaching workshops, the required proposal writing core course, and the experience gained during the process of writing and defending their thesis proposals.
2. The ability to successfully compete for external funds, obtained through the required proposal writing core course and by writing their own thesis research proposal.
3. Competence in their selected area of specialization within biology, obtained through completing higher level courses and by completing a thesis research project.

4. The ability to work in teams and in interdisciplinary research, acquired in the course of the Program as they conduct their thesis research in a collaborative environment, share their research results with other scientists, and through potential experiences in other relevant research institutions.

VI. CURRICULUM COMPONENTS

A. Curriculum structure and distribution

The distribution of credits within this Doctoral Program will balance three major goals: topical literacy, research, and communication. Fifty six percent of the credits will be devoted to develop both literacy in research areas and technical expertise in their area of interest, whereas 34% of the credits will be research-oriented, and 10% will be devoted to foster effective oral and written communication skills in science.

1. Codification and composition of courses

Table VI-1. List of core and elective courses proposed for the doctoral program including course codification, contact hours, and description.

Codification	Title	Credits: Hour Credits	Description
Biol 8XXX	Doctoral Seminar in Biology	2: 2 Sem	Skills for an effective formal seminar will be presented and practiced. Doctoral students will organize and present various seminars about current topics in biology or about an aspect related to their research projects. Topics will be selected by agreement between the students and the professor in charge of the course.
Biol 8XXX	Writing Grant Proposals	3: 3 Sem	Training in writing effective grant proposals for submission to external funding agencies. This course will present several of the most common kinds of research proposals in the biological sciences, illustrate effective ways to plan a research project, and develop the necessary skills for writing an effective grant proposal.
Biol 5005	Elementary Plant Anatomy	3: 2 Conf, 1 Lab	The study of simple and complex tissues of the organs of vascular plants; the study of the characteristics of parenchyma, sclerenchyma and collenchyma cells, as well as the elements composing the xylem and phloem tissues.
Biol 5007	General Plant Morphology	3: 2 Conf, 3 Lab	The general principles of plant morphology, including evolutionary tendencies, phylogenetic lines and the life cycles of the principal groups of plants.
Biol 5009	Pteridology	3: 2 Conf, 3 Lab	Lectures and laboratories on the morpholgy, taxonomy and ecological distribution of the local ferns and their allies. Assigned readings and field trips.
Biol 5016	Plant Evolution	2: 2 Conf	Analysis of the geological, morphological, anatomical, physiological, and geographical evidence showing how the different plant phyla have evolved, with emphasis on the evolution of tracheophytes. Assigned reading reports.

Biol 5017	Tropical Bryology	3: 2 Conf, 3 Lab	The biology of the mosses, liverworts, and hornworts, emphasizing the structure, identification, reproduction, and ecology of the native species of Puerto Rico.
Biol 5018	Plant Physiology	4: 3 Conf, 3 Lab	Plant physiology: diffusion, transpiration, absorption and transport, mineral nutrition, metabolism, growth and development, hormones, effects of environmental factors.
Biol 5045	Scanning Electron Microscopy	3: 2 Conf, 3 Lab	Theoretical and practical aspects of the scanning electron microscope with emphasis on sample preparation for SEM, detection of the different types of signals emitted by the specimen, and image analysis
Biol 5055	Eukaryotic Molecular Genetics	3: 3 Conf	Recent discoveries related to: the eukaryotic genome, gene structure, recombination, DNA repair, transposable elements, chromatin, regulation of transcription and translation, catalytic RNA, mRNA processing, signal transduction, apoptosis, and to the genetics of development, the cell cycle, and cancer are emphasized.
Biol 5056	Eukaryotic Molecular Genetics Laboratory	2: 8 Lab	Practical experience where the research techniques used in eukaryotic molecular genetics are discussed. Steps are undertaken according to updated protocols for DNA preparation, polymerase chain reaction, restriction mapping, gene cloning, DNA sequencing, and construction of genomic and cDNA libraries.
Biol 5416	Herpetology	3	A study of the biology, classification and morphology of amphibians and reptiles, with emphasis on local species.
Biol 5417	Icthyology	3	A study of the biology, classification and morphology of fishes, with emphasis on local species. Field trips.
Biol 5585	Medical and Veterinary Entomology	3	This course offers the student interested in entomology, animal husbandry of veterinary science, an opportunity to become familiar with the recognition, characteristics, habits and control of insects, ticks, mites, and other arthropods that attack man and domestic animals.
Biol 5755	Virology	3	The Classification, Structure, Physiology and Biochemical Activities of Viruses.
Biol 5758	Bacterial Genetics	2: 2 Conf	DNA replication and expression in the prokaryotic cell; transfer of genetic information; the impact of genetic processes on the physiology and ecology of bacteria.
Biol 5759	Bacterial Genetics Lab	2: 8 Lab	Molecular techniques for the study of the genetics of bacteria and bacteriophages. Practical experiences in the processes of recombination, complementation, the control of genetic expression, and the transmission of genetic information among microorganisms.
Biol 5786	Pathologic Human Biology	3: 3 Conf	A systematic study of the dysfunctions of the cardiovascular, digestive, respiratory genitourinary and endocrine systems.
Biol 5765	Mycology	3: 2 Conf, 3 Lab	A study of the morphology, physiology, classification and relation of fungi to man. Emphasis is given to the isolation and identification of the different groups.
Biol 5815	Animal Behavior	3	A study of activities and responses of animals in meeting their life requirements. Field trips.
Biol 5955	Introduction to Research Methods in Ecology	3	Field and laboratory exercises serve to introduce the student to the basic methods used in ecological research. The student is trained in the use of computers for the analysis of ecological data.

Biol 5990	Field Biology Workshop	1-3: 2-4 Workshop	Intensive practical experience in selected areas of field biology, in or outside of Puerto Rico. A final written report will be required.
Biol 6015	Insect Morphology	4	A study of the general internal and external morphology of insects.
Biol 6155	Plant Ecology	4	The interrelations of plants and environment; climatic, edaphic, and biotic factors in their relation to origin, development, and structures of vegetation; introduction to ecological field work and the methods of ecological research. Practice is given in the recognition of associations, determination, and description of their structure, and relationships and measurements of environmental factors.
Biol 6199	Behavioral Ecology	3: 3 Conf	Recent developments in behavioral ecology. Evolutionary and ecological models applied to the behavioral problems of survival and reproduction integration of theory with field and laboratory evidences. Field trips required.
Biol 6356	Cytogenetics	3: 2 Conf, 3 Lab	A study of different aspects of the cell that affect inheritance.
Biol 6369	Population Genetics	3: 3 Conf	Genetic variation in natural populatons of both plants and animals in different communities covering selection, migration, mutations, mating systems, and the effect of population size on the maintenance of genetic variation.
Biol 6605	Environmental Pollution and Disturbance	3: 2 Conf, 3 Lab	An ecological consideration of pollution and disturbance of the environment; the effects of industrial, domestic and other pollutants of the ecosystem; the physical, chemical and biological parameters used in pollution control and abatement.
Biol 6607	Population Ecology	3	Study of populations for the analysis of the control and interaction among them. Topics such as mortality, fertility, population growth, competition and predator-prey interaction will be discussed.
Biol 6610	Limnology	3: 2 Conf, 3 Lab	A study of the physical, chemical and biological characteristics and interrelations of these factors in aquatic situations; community structure in still and running water; studies of local streams and ponds.
Biol 6617	Advanced Genetics	3	Discussion of selected topics in genetics.
Biol 6631	Cellular Biochemistry and Physiology	4	The interconversions of energy in living cells; photosynthesis and carbohydrate metabolism as energy sources; the utilization of metabolic energy for protein synthesis; solute and solvent movement; nerve and muscle phenomena. Emphasis on metabolic regulation and enzyme action.
Biol 6635	Medical Mycology	3	Study of the fungi pathogenic to man.
Biol 6637	Taxonomy and Morphology of Fungi	3	A thorough coverage of the phycomycetes, ascomycetes, deuteromycetes and basidiomycetes from a taxonomical and morphological approach, with emphasis on saprophytes, zoo pathogens and phytopathogens.
Biol 6642	Advanced Mycology	3	A study of fungi, with emphasis on current literature and methods of research.
Biol 6650	Bacterial Diversity	3	The diversity of prokaryotic organisms in relation to ecophysiological and evolutionary perspectives, emphasizing their isolation, identification, and application.

Biol 6688	Scientific Photography for Biologists	2	Photographic techniques in biological research. A presentation and a portfolio of the student's work is required.
Biol 6689	Biological Research Methods	2	Methods and theory of investigation in the biological field, including a study of the biological literature and of sources of information from major institutions active in this field. The student is required to write a research proposal in his area of interest.
Biol 6690	Graduate Seminar	1	Discussion of recent literature in biology and related fields. Students will discuss principal topics in their special fields.
Biol 6705	Advanced Food Microbiology	3: 2 Conf, 1 Lab	Microbiology of food commodities. The nature and function of beneficial and harmful microorganisms. Foodborne diseases. Effects of food processing and storage on microorganisms.
Biol 6990	Research	6	Research for a thesis.
Biol 6991	Special Studies in Biology	3	Supervised research in some special topics of biology other than a thesis problems, but designed to provide experience and training in scientific investigation.
Biol 6992	Special Studies in Biology	3	Supervised research in some special topics of biology other than a thesis problem, but designed to provide experience and training in scientific investigation.
Biol 6993	Special Topics in Biology I	3	Selected topics in biology, botany, microbiology, and zoology.
Biol 6994	Special Topics in Biology II	3	Selected topics in biology, botany, microbiology, and zoology.
Biol 6997	Selected Topics in Biology: Laboratory	3	Laboratory practice of selected topics in biology, botany, microbiology, or zoology.
Bota 6006	Physiology of Bacteria	3: 2 Conf, 3 Lab	The physiology of bacteria and the biochemistry of microbial processes.
Bota 6007	Phytogeography	3: 3 Conf	A study of the geographical distribution of plants, with special emphasis on the ecological and historical factors affecting their distribution.
Zool 5005	Invertebrates of Puerto Rico	3: 2 Conf, 3 Lab	Taxonomy and ecology of the most common invertebrates of Puerto Rico, especially Arthropoda (exclusive of insects and marine forms) and Mollusca.
Zool 6019	Advanced Parasitology	4: 3 Conf, 3 Lab	Lectures, conferences, reading and laboratory work dealing with practical problems of classification, morphology and host relations of animal parasites.
Zool 6025	Systematic Zoology	3: 3 Conf	The naming and classification of animals, rules and basis of nomenclature, quantitative methods of analysis, and methods for presentation of systematic findings.
Zool 6039	Animal Ecology	3: 2 Conf, 3 Lab	A study of the principles of ecology as applied to animals.
Zool 6056	Zoogeography	3: 3 Conf	A study of the geographical distribution of animals, with special emphasis on factors affecting this distribution. Assigned readings and reports.
Zool 6058	Insect Taxonomy	3: 1 Conf, 4 Lab	The classification of the hexapoda. Construction of keys, preparation of description, nomenclatural problems, faunistic and monographic studies, catalogs and bibliographies.
Chem 5071	General biochemistry I	3: 3 Conf	Chemical characterization of proteins, carbohydrates, lipids, and nucleic acids; principles of enzymology and bioenergetics; biological membranes and transport; recombinant DNA techniques; biological oxidations.

Chem 5072	General biochemistry II	3: 3 Conf	Biosynthesis and biodegradation of carbohydrates, lipids, amino acids, and nucleic acids; integration and regulation of animal metabolism; chemistry of genetic expression and regulation.
Chem 6815	Plant biochemistry	3: 3 Conf	Chemistry of plant constituents. Chemical processes occurring during the growth and development of plants; biochemistry of photosynthesis.
Chem 6915	Enzymes	3: 3 Conf	Fundamental principles of enzymatic reactions, including topics such as: mechanisms, kinetics, inhibitors, and activators.
Geol 6107	Geology and Tectonics of the Caribbean	3: 3 Conf	The geologic and tectonic evolution of the Caribbean plate and adjacent areas.
Cmob 5016	Phycology	3: 2 Conf 3 Lab	Fundamental study of algae in general, with reference to the main groups: Chlorophyta, Xantophyta, Cianophyta, Phaeophyta, Rhodophyta. Study of biology, life histories, morphogenesis, ecology, evolution, taxonomy, and commercial or industrial uses of algae, and their importance in the bio-economics of the sea and other bodies of water.
Cmob 6018	Marine Ecology	4: 3 Conf 3 Lab	Structure and function of marine ecosystems; flux of energy and materials in biogeochemical cycles.
Cmob 6075	Freshwater Invertebrates	3: 1 Conf 4 Lab	Identification of freshwater invertebrates, their role in the environment, and their importance in aquaculture and pollution studies.
Cmob 6077	Zooplankton Ecology	3: 2 Conf 3 Lab	Aspects of zooplankton ecology in relation to oceanographic processes in estuarine, neritic, and oceanic ecosystems. Includes experiences in sampling techniques and experimental design.
Cmob 6618	Biological Oceanography	3: 2 Conf 3 Lab	Marine life and its relationship to geological, physical and chemical aspects of the ocean; basic techniques fundamental to marine research. Demonstrations and field trips.
Cmob 6635	Research Methods in Marine Sciences	3: 3 Conf	Techniques of data collection, analysis, and interpretation with emphasis on research problems relevant to the marine ecosystems of Puerto Rico.
Cmob 6645	Marine Plankton Biology	2: 1 Conf 3 Lab	Study of the marine plankton with emphasis on systematics, morphology, life histories, physiology, feeding, and reproduction. Importance of plankton on the economy of the sea, particularly in their role as primary and secondary producers.
Cmob 6655	Molecular Marine Biology	4: 2 Conf 6 Lab	Theory, practice, and applications of molecular marine biology.
Cmob 8635	Marine Microbiology	3: 2 Conf 3 Lab	A study of the biology of marine microalgae, bacteria and protzoa, with emphasis on the techniques of pure cultures and the physiology and ecology of marine organisms, both autotrophic and heterotrophic.
Cmob 8636	Marine Parasitology	4: 2 Conf 6 Lab	Parasitology of marine organisms with emphasis on local fauna; collecting methods, preparation for the study and identification of parasites.

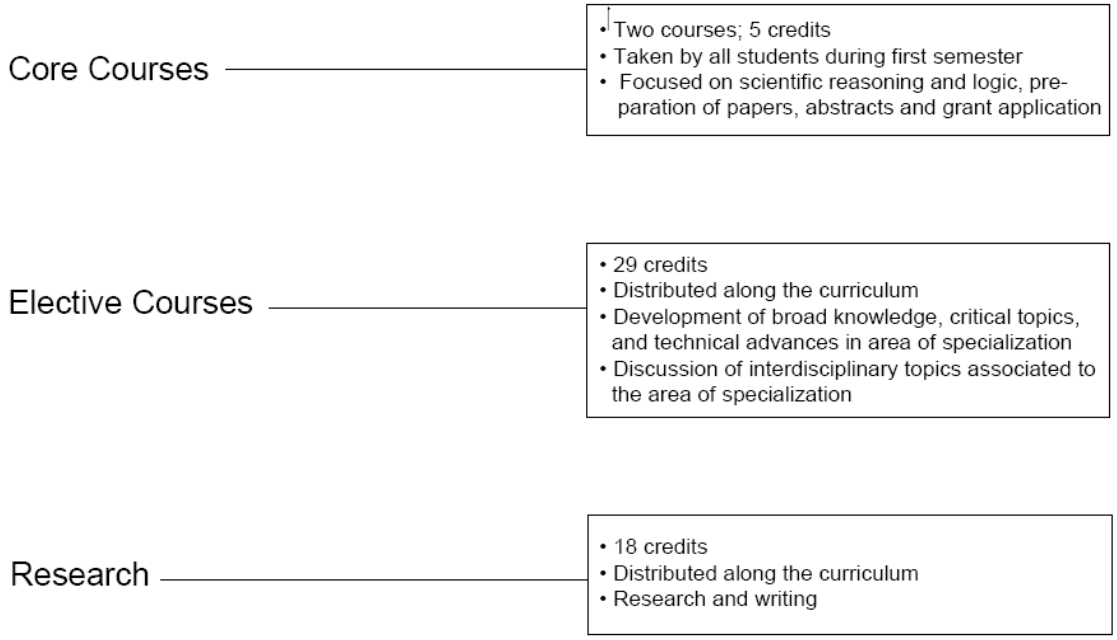
Cmob 8645	Marine Physiology	3: 3 Conf	The physiological processes at the cellular and organismal levels directly concerned with the adaptation of the organism to the physical and chemical environment of the ocean; the more specialized physiological processes encountered in the study of the growth and behavior of marine organisms.
Cmob 8646	Marine Physiology Laboratory	1 or 2: 3 or 6 Lab	Laboratory research projects on a specific physiological process of marine organisms in response to marine environment
Cmob 8658	Advanced Marine Parasitology	3: 1 Conf 6 Lab	Study of advanced topics on the parasites of marine animals. A research project will be required.
Cmob 8665	Morphology of Marine Invertebrates	3: 2 Conf 3 Lab	Form, structure and function of representative marine invertebrates.
Cmob 8676	Systematics of Marine Invertebrates	4: 3 Conf 4 Lab	Taxonomy, phylogeny and distribution of marine invertebrates with special attention to local forms.
Cmob 8678	Marine Popuelation Biology	3: 3 Conf	Principles of population biology and their application to the organization of marine communities.
Cmob 8679	Marine Botany	3: 2 Conf 3 Lab	A study of the flora of the sea, with emphasis on the morphology, ecology and taxonomy of algae.
Cmob 8685	The Rhodophyta of Puerto Rico	3: 2 Conf 3 Lab	A study of the life cycles, reproduction, taxonomy and ecology of the macroscopic red algae of Puerto Rico.
Cmob 8686	Ichthyology	3: 2 Conf 3 Lab	A study of the morphology, physiology and ecology of fishes, with emphasis on marine forms.
Cmob 8695	The Phaeophyta	3: 2 Conf 3 Lab	Life cycles, biology, morphology, ecology, taxonomy and evolution of the brown algae.
Cmob 8696	The Chlorophyta	3: 2 Conf 3 Lab	Life cycles, biology, morphology, ecology, taxonomy, and evolution of the benthic marine green algae.
Cmob 8708	Coral Reef Biology	3: 3 Conf 3 Lab	Evolution, characteristics, and distribution of coral reefs
Esma 6660	Biostatistical Analysis	3: 3 Conf	Descriptive and inferential statistical techniques, design of experiments, construction of biomathematical models, bio-essays and probit analysis.
Agro 5005	Biometrics	3: 2 Conf, 3 Lab	Basic concepts of statistical reasoning applied to problems in agricultural, biological and environmental sciences. Data gathering, graphical description and numerical summarization. Concepts of probability and sampling. Estimation and hypothesis testing, analysis of variance, linear regression and correlation. Students describe and analyze real data sets and use statistical computing programs.
Agro 5006	Genesis, Morphology and Classification of Soils	3: 3 Conf	Historical development of concepts of soil and systems of soil classification; principles and nomenclature of "Soil Taxonomy"; environmental factors and processes of soil formation; and field study of soil profiles.
Agro 5007	Soil Physics	3: 2 Conf 3 Lab	Physical properties of soils, and factors affecting them; soil consistency, structure, water, air, temperature, tillage; evaluation and influence in determination of soil productivity.
Agro 5008	Soils of Puerto Rico	3: 2 Conf 3 Lab	Study of the genesis and distribution of the soils of Puerto Rico, based on environmental conditions; classification of soils using the "Soil Taxonomy" system; evaluation of the morphological, chemical, physical, and mineralogical properties of soils with respect to agricultural and not agricultural uses.

Agro 5010	Management of Natural Forests	3: 3 Conf	The study of the composition and structure of the different forest systems of the tropics; wet forest, deciduous forest, conifer forest and mangrove from the stand point of multiple use and sustainability.
Agro 5015	Conservation, Management, and Development of Natural Resources	3: 3 Conf	Study of concepts, methods and techniques in the conservation, management and development of natural resources, and their effects on environmental quality. Contemporary problems in the management and allocation of issues and natural resources will be discussed.
Agro 5501	Agricultural Biotechnology	3: 3 Conf	Biological concepts for biotechnology: enzymes, nucleic acids, genetic transfer mechanisms, operons, plasmids, vectors, cloning, DNA sequencing, monoclonal antibodies, clonal production and hybridization.
Agro 6005	Use of Statistical Computer Packages in Biometry	2: 2 Conf	Use of statistical computer packages in the analysis of experimental data.
Agro 6600	Advanced Biometrics	3: 2 Conf, 3 Lab	Advanced study of analysis of variance, covariance and multiple regression, design and analysis of experiments applied to research problems in agricultural, biological and environmental sciences. Students design experiments, analyze data and use statistical computing programs.
Agro 6604	Soil-Plant Relationships	3: 3 Conf	Study of the processes that affect root growth and development, methods of study of such processes, availability of nutrients and factors that affect their movement and absorption; growth as a function of dry matter accumulation, root proliferation and nutrient uptake.
Agro 6607	Soil Chemistry	3: 2 Conf 3 Lab	Chemical composition and properties of soils, chemical processes of weathering, soil solution reaction, chemical properties of clays, and ionic exchanges in soils.
Agro 6624	Soil Mineralogy	3: 2 Conf 3 Lab	Identification of the constituent minerals of soils, and their relation to soil classification and agricultural practices.
Cfit 5006	Phytoremediation	3: 3 Conf	Advanced undergraduate course where the principles used in Phytoremediation will be discussed. These include the use of vascular plants for the phytoextraction, rhyzofiltration, phytostabilization and phytovolatilization of organic contaminants from the soils and water resources. Phytoremediation offers a permanent solution for removing the contaminants from the environment.
Cfit 6644	Environmental Physiology	3: 3 Conf	Environmental aspects of phytophysiology, including energy, nutrition cycles, pollution, and other.
Cfit 6645	Advances in Biological Nitrogen Fixation	3: 2 Conf, 1 Sem	Mechanism by which atmospheric nitrogen is incorporated into plant proteins and modern techniques utilized for its study, organisms capable of fixing nitrogen in a free-living state or in symbiosis with plants, methodology to take advantage of this process in agriculture.
Inpe 6609	Advanced Dairy Bacteriology	3: 2 Conf 3 Lab	The microbiology of milk and milk products. thermodynamics and their relationship with animals.
Proc 5005	Phytopathogenic Fungi	3: 2 Conf 3 Lab	Examination of the most interesting groups of fungi from the phytopathogenic point of view: their taxonomy, nomenclature, morphology, genetics, host-parasite relationship, physiology, and ecology. Distinctive characteristic of specific pathogens.

Proc 5006	Insects of Tropical Crops	3: 2 Conf 3 Lab	Major insects affecting tropical crops, their biology and taxonomy; identification of damages in the field as well as in the laboratory; appropriate measures of control.
Proc 6608	Advanced Tropical Phytopathology	4: 4 Conf	Study and analysis of the etiology, pathology, epiphytology, and control of major plant diseases of the most important economic tropical crops.
Proc 6624	Morphology and Taxonomy of Phytoparasitic Nematodes	3: 2 Conf 3 Lab	Morphology, anatomy, and taxonomy of phytoparasitic nematodes; rules and problems of nomenclature.
Proc 6645	Biological Control: Concepts and Theories	3: 2 Conf 3 Lab	Ecological theories that study the use of beneficial organisms for the population density regulation of organisms noxious to crops of economic importance. Other topics to be studied are: the structure of the agroecosystem community, predator-prey ecological relations, types and components of predation, post-introduction programs and aspects of integration, perspectives and development of biological control strategies, with emphasis on insect control.
Proc 6650	Phytovirology	3: 2 Conf 3 Lab	Fundamental concepts of plant viruses including transmission, vector identification, their effects on insect vectors, host range, classification, serology, and physical properties and methods of control. Research methods are emphasized in the laboratory.
Inel 6007	Introduction to Remote Sensing	3: 3 Conf	History, principles, and applications of remote sensing. Electromagnetic radiation; aerial photography; image interpretation; land observation satellite systems; image resolution; preprocessing and classification of images; geographic information systems.
Inel 6069	Active Remote Sensing	3: 3 Conf	Discussion of the theory underlying radar and lidar techniques. Topics include: wave propagation and polarization, cross section of targets, matched filters, ambiguity function, coded radar signals, signal processing and interpretation of radar and lidar returns, and their applications.
Intd 5001	Multidisciplinary Archaeology I	3: 2 Conf 2 Lab	Introduction to archaeological research in Puerto Rico and the Caribbean from a multidisciplinary perspective. Includes the study of archaeological sites and regions using approaches and techniques provided by diverse disciplines of the natural sciences and engineering. Organized in modules of Introduction to Archaeological Theory; Survey and Remote Sensing; Excavation and Geoarchaeology.
Intd 5002	Multidisciplinary Archaeology II	3: 2 Conf 2 Lab	Introduction to the systematic description of archaeological data, their recording procedures, analysis, and methodical synthesis of the data produced. Includes the analysis of material remains using approaches and techniques provided by diverse disciplines of the natural sciences and engineering. Organized in modules of Archaeometry, Analysis or Archaeological Materials, and Synthesis of Archaeological Data.

2. Curricular scheme

The curricular sequence is characterized by balance (i.e., a limited number of core courses with ample time for research) and high flexibility, with a high number and diversity of electives offered.



B. Curricular sequence

1. Year one

During the first year, students will devote their attention to intensive scientific writing and grant application procedures. This strategy will facilitate one of the objectives within the UPRM Strategic Plan, and will contribute early on towards a successful doctoral candidacy by stimulating efficient communication, authorship in refereed publications and proficiency in obtaining research funds. The flexibility of our curricular sequence allows an adequate course sequence even with courses that have pre-requisites. Doctoral students will have a maximum course load of nine credits per semester for the first year, and an average of six credits per semester for the following years (research credits are included). During the first year, doctoral students will assemble their graduate committees and select their research topics.

Year One

First Semester	**Credits**	**Second Semester**	**Credits**
Elective Course	3	Elective Course	3
Elective Course	3	Elective Course	3
Elective Course	3	Elective Course	3
Totals	9		9
		Year Four Total	**18**

2. Subsequent years

Students will focus on elective courses and on their research topic. Also during the second year, students will defend their doctoral thesis research proposal. In their last year, students will fulfill the requirement of the two-credit Seminar core course by providing a seminar to the Department. During their final year, students will be awarded with the Ph. D. degree after successful defense of their thesis.

Year Two

First Semester	**Credits**	**Second Semester**	**Credits**
Writing Grant Proposals	3	Elective Course	3
Elective Course	3	Research	3
Research	3	Elective Course	2
Biology Seminar Series	0	Biology Seminar Series	0
Totals	9		8
		Year Four Total	**17**

Year Three

First Semester	**Credits**	**Second Semester**	**Credits**
Elective Course	3	Research	6
Research	3		
Biology Seminar Series	0	Biology Seminar Series	0
Totals	6		6
		Year Four Total	**12**

Year Four

First Semester	**Credits**	**Second Semester**	**Credits**
Research	3	Doctoral Seminar in Biology	1
Doctoral Seminar in Biology	1		
Totals	4		1
		Year Four Total	**5**

C. Curricular coherence and effectiveness

The curricular sequence of the Doctoral Program in Biology is coherent with the vision and mission of the University of Puerto Rico at Mayagüez:

Vision

To become a leading institution of higher learning in Puerto Rico and throughout the entire American hemisphere while responding to the needs of a modern society within dynamic and diverse surroundings while searching unceasingly for truth, knowledge, justice, and peace.

Mission

1. To form educated, cultivated citizens capable of critical thinking and professionally prepared in the fields of agricultural sciences, engineering, natural sciences, humanities, arts, and business administration capable of contributing to the educational, cultural, social, technological and economic development of Puerto Rico and of the international community within a democratic and collaborative framework.

2. To promote research and creative endeavors to meet the needs of our local and international society while preserving, transmitting, and advancing knowledge.

3. To provide excellent service that will contribute to the sustainable and balanced development of our society.

4. To share knowledge so that it becomes accessible to all.

Each UPRM mission statement is matched with relevant skills, courses, activities, and goals of the proposed Doctoral Program (Table VI-2).

Table VI-2. Coherence between the UPRM doctoral curricular sequence and the mission of the institution regarding graduate student profile.

Skill	Course Example	Course Activity	Doctoral Program Goal
Written and Oral Communication Skills (Mission 3 & 4)	Seminar, Grant Proposal Writing, Elective Courses, Proposal Defense	Class presentations and reports at the graduate level courses; proposal and dissertation defense; presentations at technical meetings; and publications in peer-reviewed journals.	Upon completion of their degree, students will use oral and written communication skills effectively.
Analysis of Literature (Mission 1 & 4)	Seminar, Most Elective courses	Class presentations and reports; doctoral qualifying examination, and dissertation defense.	Students will be able to critically analyze content and discipline knowledge as well as identify key questions in their research areas.
Problem Solving (Mission 1 & 2)	Seminar, All Elective Courses, Grant Proposal Writing, Proposal Defense	Professional exchanges with other research laboratories; peer interactions in scientific meetings; and potentially short-term internships in other institutions.	Students will be able to solve an original research problem in biology and will develop management skills and team work.
Ethical Awareness in Research (Mission 1, 2, 3 &4)	Elective Courses, Internships	Discussion of ethical guidelines (i.e., NSF Manual of Scientific Misconduct), ranging from conflict of interest to plagiarism and falsification.	Upon completion of their degree, the students will be able to identify and manage ethical misconduct in research.

D. Pedagogical methodologies

There are various educational methodologies used in Biology to foster a comprehensive learner-based doctoral student. These methodologies range from traditional lecturer-centered approach (i.e., conference and seminars) to the individual-based approach (i.e., reflection journal, course portfolio, cooperative learning, journal clubs, laboratory meetings, distance learning [e.g. facilitated through UPRM's WebCT Internet portal], internships and independent research).

Our department has the infrastructure (technologically equipped classrooms, fully equipped research laboratories), the logistics (faculty specialized in assessment and education), and the computer structure (nine servers, and various statistical software packages, among others) that will enhance these multiple teaching methodologies. Moreover, UPRM has developed four institutional offices that bring methodological and pedagogical support to faculty and graduate students. These are:

1. Centro de enriquecimiento profesional (CEP: Center for Professional Development) http://www.uprm.edu/cep/

2. División de educación contínua y estudios profesionales (DECEP: Division of Continued Education and Professional Studies) http://educon.uprm.edu/

3. Instituto para el desarrollo de la enseñanza y el aprendizaje en línea (IDEAL: Institute for the development of On-line Learning and Education) http://www.uprm.edu/ideal/index.htm

4. Oficina de mejoramiento contínuo y avalúo del RUM (OMCA: Office for Assessment and Continued Improvement) http://www.uprm.edu/omca

F. Assessment plan

The learning outcomes of our doctoral program will be assessed using various tools (Table VI-3). Immediate indicators include the number of doctoral candidates, the number of dissertations, the number of grants approved per graduate student, and the number of refereed publications. Doctoral students must write an appealing proposal and defend it before an evaluating committee who will assess the proposal idea for clarity, correctness, and importance of the potential results. The same methodology will be applied for evaluating the dissertation. It is expected that students will publish at least one paper based on their dissertation research. Data will be kept on the number of students who submit a paper for publication before graduation.

Additional tools will be applied and developed following current institutionalized models of assessment (http://www.uprm.edu/omca).

Table VI-3. Assessment of Student Learning Plan.

Written and Oral Communication Skills	• Presentations and reports in graduate level courses • Proposal and dissertation defense • Presentations at technical meetings • Publications in peer-reviewed journals
Analysis of Literature	• Presentations and reports in graduate level courses • Course examination, student seminar, essay questions, group discussions • Presentations and reports in graduate level courses • Publications in peer-reviewed journals • Doctoral qualifying examination • Dissertation defense
Problem Solving	• Proposal writing • Doctoral qualifying examination • Dissertation defense
Ethical Awareness in Research	• Proposal writing • Doctoral qualifying examination • Dissertation defense

Additional assessment tools are included in Appendix VI-1 to portray checking points along the program to guarantee the success of the doctoral students of this program.

VII. ADMISSION, REGISTRATION, AND GRADUATION

A. Requirements for admission[1]

1. Satisfy the admission requirements of the Graduate School of UPRM.
2. Have a Bachelor in Science or equivalent. The Departmental Graduate Studies Committee can assign undergraduate courses to be taken to remove any deficiencies.
3. Have a minimum cumulative GPA of 3.0 (out of 4.0)
4. Have a minimum GPA of 3.0 (out of 4.0) in Biology

[1] Conditioned to laboratory space and advisor availability.

5. Submit scores for Graduate Record Examination (GRE) general. In addition, foreign applicants should submit Test of English as a Foreign Language (TOEFL) scores, or provide an equivalent testimony of their proficiency in English.

B. Enrollment projection

Enrollment projection, including new enrollments, transfers and, re-admissions is estimated based on the following:

1. **Comparison between the Río Piedras/Medical Sciences Intercampus Biology Ph.D. program of the University of Puerto Rico, the Environmental Science (Biology) Ph.D. program of the University of Turabo, and the Marine Sciences Ph.D. program of the University of Puerto Rico at Mayagüez.**

    a. The Rio Piedras/Medical Sciences Intercampus Ph.D. program in Biology of the University of Puerto Rico, established in 1980, attracts an average of 40 applications annually and accepts 25% of them. More than 40 faculty members participate in this program which graduates on average 8 doctoral students annually.
    b. The University of Turabo Ph.D. program in Environmental Science (Biology), established in 2005, has attracted 45 students so far. At the time of writing this proposal no Ph.D. degree has been awarded by this program.
    c. The University of Puerto Rico at Mayagüez Ph.D. program in Marine Sciences, established in 1972, attracts an average of 15 applications annually and accepts 20-35% of them. Twenty three faculty members participate in this program which graduates 2-3 doctoral students annually. This Ph.D. program has a clear focus in the marine sciences while the proposed Ph.D. program in Biology will focus on non-marine ecosystems and phenomena within the biological scienes.
2. **Application and graduation rates of the Biology Masters program of the University of Puerto Rico at Mayagüez over the past 10 years.**
    a. The Biology Department at UPRM receives on average 74 applications annually, with an acceptance rate of 39%.
    b. The Biology Department at UPRM graduates on average 13 Master students annually.
3. **Survey conducted in 2006 among the Masters students in Biology at the University of Puerto Rico at Mayagüez regarding the establishment of a Ph.D. program in Biology.**
    a. One hundred per-cent of the 47 students responding are in favor of the establishment of Ph.D. program in Biology at the University of Puerto Rico at Mayagüez.
    b. Eighty-eight per-cent of the 42 students who would pursue a Ph.D. degree upon the completion of their Masters degree would apply to the Ph.D. program in Biology at the University of Puerto Rico at Mayagüez, while the other 12% would apply elsewhere.

4. **Report by the National Science Foundation "US Doctorates in the 20th Century" by Thurgood et al. (2006)**
    a. 69.7% of the Ph.D. graduates in Biology are employed in academia.
    b. 14.2% of the Ph.D. graduates in Biology are employed in government agencies.
5. **Analysis of our current resources**
    a. Physical facilities are detailed in Chapter X. The Ph.D. program poses no extra burden on the existing facilities.
    b. During the past two years an average of 12.5 Biology Master students have been supported through external funds.
    c. New Ph.D. students will be gradually replacing Master students and thus the Biology Department graduate student numbers will not change significantly.
6. **Recruitment plan**

The recruitment plan will consist of a series of activities including but not limited to newspaper advertisements, website postings of professional societies and forums, and participation in national and international scientific meetings. These activities will allow the divulgation of the graduate program to prospective students. [The students (B.S. or M.S.) from the population at UPRM, the larger UPR system, and other higher education institutions within Puerto Rico and throughout the world will be exposed to our program through these efforts.] These efforts should satisfy the projected application demand (25 applications per year) to start the Ph.D. program with an average of 5 students per year.

In summary, all the above data analyses indicate that our projected enrollment should consist of an average of five Ph.D. students accepted into the program per year.

C. Requirements for the degree

1. Total credit hours

The students in the Ph.D. program will take and pass a minimum of 52 credits as follows:

a. 5 credits in core courses (Seminar: 2 credits; Proposal Writing: 3 credits)
b. 29 credits in elective courses;
c. 18 credits in doctoral dissertation research.

2. Minimum GPA

The minimum GPA for graduation as established by the Graduate School will be 3.0 in all courses included in the student's program.

3. Total credits accepted as transfer

The Departmental Graduate Committee will evaluate all transfer of credits requested by the student; we will accept a maximum of 14 externally obtained credits.

4. Residency

Ph.D. students will study at UPRM for at least four semesters if they have a B.S. degree and for at least two semesters if they have a M.S degree.

5. Language requirement

There is no language requirement other than Spanish and English as imposed by the Graduate School.

6. Teaching requirement

Every Ph.D. student has to complete two teaching requirements:

1. To complete 6 hours of training in teaching methods either through workshops (e.g., CEP) or through university level courses.
2. To teach one or more courses at least during two semesters.

The certificates from the workshops and courses will serve as evidence for the first requisite. Those candidates that have previously fulfilled these requirements will submit their file to their Graduate Committee and it will be evaluated. Any credits obtained as part of this requirement will not count toward the minimum of 52 credits mentioned in item C. 1. above.

7. Preliminary examination (comprehensive exam)

The student will take a comprehensive exam which includes a written and an oral component. The written component will consist in a research proposal. The oral component will consist in an examination that will cover important concepts within the student's discipline and furthermore integrate information from courses completed by the student at the time of the exam. Both components of the exam will be administered and graded by the Graduate Committee; with a passing or failed grade. Either one of the components of the exam can be repeated in case the student failed; however, the comprehensive exam has to be approved by the Graduate Committee no later than the 12^{th} week of the 6^{th} semester of the student's program.

8. Proposal and dissertation

All doctoral students will conduct an original research project, which will contribute significant new findings to science. The student will describe the project in the above mentioned proposal supervised by his/her Graduate Committee, and will defend the proposal in front of such Committee no later than the 2^{nd} semester of the 3^{rd} year. The student will defend the doctoral dissertation during an oral presentation and exam according to the requirements of the Graduate School.

9. Departmental seminar

Ph.D. students will present a departmental seminar based on their research results as part of the requirements for graduation. The presentation will take place immediately after the student has applied for dissertation defense to the Graduate School and before the last day of classes of the current semester. All Ph.D. students are required to attend all departmental seminars.

10. Peer reviewed publication

The Ph.D. candidates will submit at least one article for publication to a peer-reviewed journal. In order to apply for dissertation defense, the student will present proof of article submission to the Biology Graduate Student Coordinator.

11. Time limit for graduation

Students are expected to graduate in 4 or 5 years. While students admitted with a B.S. into the Ph.D. program will have a maximum of 10 years to graduate, students admitted with a M.S. into the Ph.D. program will have up to 8 years to graduate. In both cases the time is counted from

the moment the student enrolls for the first time in the program, even if the student takes a leave of absence or suspends his/her studies for any reason.

VIII. FACULTY

A. Faculty profile

The Department of Biology presently has a faculty of 42 full-time professors, 37 with doctoral degrees. Thirty-one members of this faculty, all full-time and with doctoral degrees, have expressed their support and willingness to participate in the Doctoral Program (Table VIII-1). This group of professors includes graduates from several renowned institutions, mostly from the United States.

The participating professors have average academic loads (in credit-hours per semester) of 6.2, 2.3, 3.1, and 2.2 corresponding to teaching, research release, student research, and other duties (e.g., administrative), respectively; these professors hold an average of 1.7 course preparations per semester (Table VIII-1). There will be no significant increase in academic loads for these professors after approval of this doctoral program because the program's three core courses proposed will be taught in alternating years and the teaching responsibilities for these core courses will be shared by several professors. Moreover, the need for teaching other graduate courses is not expected to increase significantly because we do not expect an increase of graduate students but rather a gradual substitution of M.Sc. candidates by Ph.D. candidates.

Nineteen of the Biology Department's faculty held external funding from agencies like NSF, NOAA, DOE in the 2006-2007 academic year. A total of $2,129,525 in external funds were granted to these professors during the academic year 2006-2007. There has been an increasing trend of external funds requested, as well as external funds obtained, in this Department since the 2001-2002 academic year (Figure VIII-1), evidencing the commitment of the faculty to quality research and academic productivity.

Likewise, the participating professors published 108 articles in peer-reviewed journals over the 2001-2007 period; an average of 3.5 articles per professor during that period. The number of peer-reviewed publications has increased over the past 5 years (Figure VIII-2).

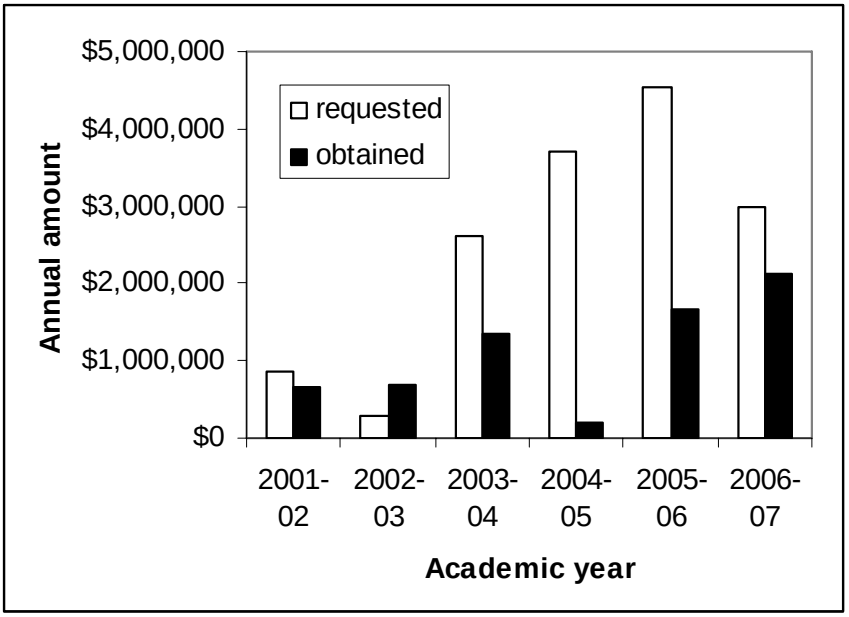


Figure VIII-1. Amounts of funds requested and obtained from external sources by professors of the Department of Biology over the past 6 academic years.

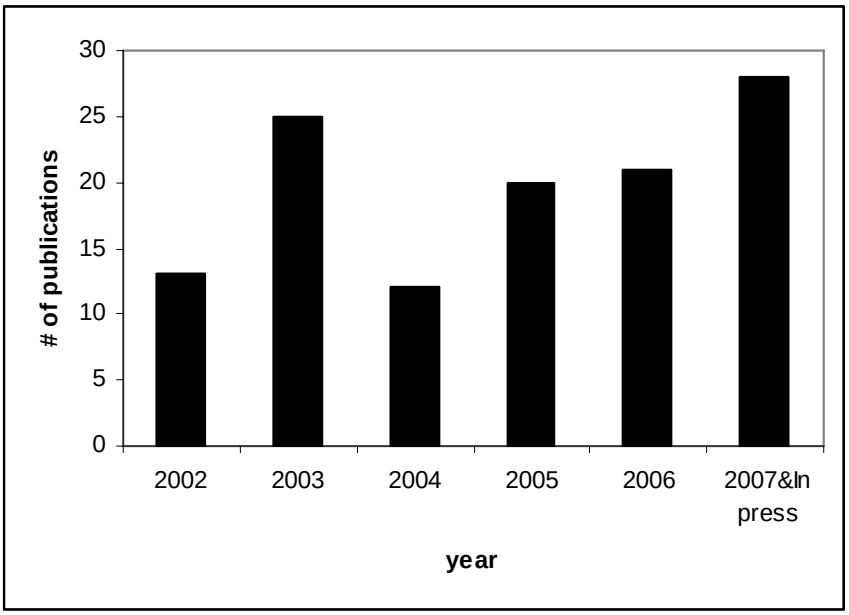


Figure VIII-2. Number of peer-reviewed publications by professors of the Department of Biology over the past 6 years.

Table VIII-1 Supporting faculty profiles. Rank: Assis. = Assistant Professor, Assoc. = Associate Professor, Prof. = Full Professor. Academic load values: teaching credits, research release credits, credits for student research, credits for other duties, and (# of teaching preparations/semester), respectively. External support: programs or agencies providing external support during years 2006 and 2007.

Name	Rank	Institution; year Ph.D. obtained	Specialty area	Post-doctoral experience	Average academic load during past 5 semesters	# peer-reviewed publications; 2002-2007 (while at UPRM)	External support (2006-2007)	Graduate courses to teach in PhD program
Carlos Acevedo	Assis.	Vanderbilt University, School of Medicine; 2006	Immunology	No	4.0, 5.25, 1.25, 1.5 (1)	2 (1)	None	Biol 6991, 6992
Dimaris Acosta	Assoc.	University of Guelph, Canada; 2003	Protistology	No	8.8, 1.2, 2.4, 0 (2.4)	8 (5)	RUI05, RUI06	Biol 5955, 6991, 6992, Writing Grant Proposals, Doc. Seminar
Jaime Acosta	Assoc.	Virginia Polytechnic Institute; 1995	Entomology	No	9.4, 0, 4.8, 1.2 (3)	0	None	Biol 5585, 6991, 6992
Mónica Alfaro	Assoc.	UPR-Mayagüez, Marine Sciences; 2003	Marine ecology	No	9.4, 0, 2.8, 3.4 (2.8)	1 (1)	None	Biol 6991, 6992, Zool 6056
Fernando Bird	Assoc.	University of Kansas; 1994	Herpetology	No	10.8, 0, 5.2, 0.2 (2.8)	2 (2)	None	Biol 5416, 5990, 6369, 6991, 6992, Zool 6025
Sonia Borges	Prof.	Universidad Complutense de Madrid; 1988	Invertebrate zoology	No	10, 0, 3.2, 0 (2.2)	9 (9)	None	Biol 6689, 6690, 6991, 6992, Zool 5005
Lucy Bunkley	Prof.	Auburn University; 1984	Parasitology	No	2.2, 0, 3.4, 6.4 (1)	15 (15)	SFRF	Biol 5417, 6991, 6992, Zool 6019
Rosa Buxeda	Prof.	Rutgers University; 1993	Microbiology	No	0.6, 0, 0, 11.4.0 (0.2)	2 (2)	Amgen, Lily, NSF, Abbott	Biol 6991, 6992
Matías J. Cafaro	Assis.	University of Kansas, 2003	Mycology	Yes	5.7, 4.2, 3.6, 0 (1.8)	9 (6)	NSF	Biol 5765, 6642, 6991, 6992, Writing Grant Proposals, Doc. Seminar

Name	Rank	Institution; year Ph.D. obtained	Specialty area	Post-doctoral experience	Average academic load during past 5 semesters	# peer-reviewed publications; 2002-2007 (while at UPRM)	External support (2006-2007)	Graduate courses to teach in PhD program
Franklin Carrero	Assis.	University of Illinois at Urbana; 2005	Cellular biology	No	4.4, 6.0, 1.8, 0.2 (1.4)	2	None	Biol 6631, 6991, 6992
Mildred Chaparro	Prof.	Texas A&M University; 1985	Microbiology	No	0.4, 0, 0, 12.0 (0.2)	0	NOAA	Biol 6705, 6991, 6992
Jesús D. Chinea	Assoc.	Cornell University; 1992	Ecology	No	7.6, 3.6, 1.2, 0 (1.8)	5 (5)	NSF, FWS, USDA	Biol 6155, 6991, 6992, 6993, 6994, 6997, Writing Grant Proposals, Doc. Seminar
Carlos A. Delannoy	Prof.	University of Colorado; 1984	Ornithology	No	9.6, 0, 3.8, 0 (2.2)	2 (2)	FWS	Biol 6991, 6992
Nanette Diffoot	Prof.	Virginia Polytechnic Institute and State University 1992	Virology	No	1.6, 1.2, 3.6, 7 (0.8)	1 (1)	Howard Hughes	BIOl 5755, 6991,6992
Nico M. Franz	Assis.	Cornell University; 2005	Systematic entomology	Yes	5.2, 5.4, 2.0, 0 (1.8)	12 (5)	NSF	Biol 6015, 6690, 6991, 6992, Zool 6058
Duane A. Kolterman	Prof.	University of Wisconsin; 1982	Botany	No	9.6, 0, 1.6, 5.2 (1.8)	2	FWS, USDA	Biol 5018, 6991, 6992, 6993, 6994
David Logue	Assis.	Colorado State University; 2004	Zoology	Yes	Hired in 2009	15 (0)		Biol 5815, 6607, 6199, 6991, 6992
Sandra L. Maldonado	Assoc.	Cornell University; 2001	Mycology	No	3.8, 5.4, 5.2, 0 (1.4)	5 (5)	Sea Grant, NSF, RUI	Biol 5765, 6637, 6991, 6992
Juan C. Martínez Cruzado	Prof.	Harvard University; 1988	Molecular and evolutionary genetics	Yes	8.0, 0.4, 5.0, 0 (2)	3 (3)	Atlantea, DSPR, NSF	Biol 5397, 6991, 6992
Arturo Massol	Prof.	Michigan State University; 1994	Microbial ecology	No	4.2, 2.4, 5.2, 0.2 (1.6)	7 (7)	DSPR, SG, DOE, NOAA	Biol 6605, 6991, 6992
Rafael Montalvo	Assoc.	University of Nebraska; 2003	Microbiology	No	7.1, 3.6, 4.8, 1.4 (2)	3 (3)	None	Biol 6606, 6650, 6991, 6992

Name	Rank	Institution; year Ph.D. obtained	Specialty area	Post-doctoral experience	Average academic load during past 5 semesters	# peer-reviewed publications; 2002-2007 (while at UPRM)	External support (2006-2007)	Graduate courses to teach in PhD program
Luis Ríos Hernandez	Assis.	University of Oklahoma, Norman; 2003	Anaerobic microbiology	Yes	5.5, 6.0, 2.0, 0 (1.25)	2 (1)	None	Biol 6991, 6992
Carlos Ríos Velázquez	Prof.	University of Wisconsin; 2000	Microbiology	Yes	3.5, 3.8, 5.2, 5.2 (1)	2 (2)	NSF	Biol 5758,5759
Carlos Rodríguez Minguela	Assis.	Michigan State University; 2005	Microbial ecology	No	7.6, 3.6, 1.6, 0 (1.4)	0	RARN, NOAA	Biol 6991, 6992
Alejandro Ruíz	Prof.	University of Oklahoma; 1981	Clinical microbiology	No	9.6, 0, 4.2, 1.8 (3.2)	0	None	Biol 6635
Carlos J. Santos	Assoc.	University of Wisconsin-Madison; 2001	Limnology	No	9.1, 1.2, 4.8, 1.6 (2)	2 (2)	NSF, EPA, FWS	Biol 6610, Zool 5005
Inés Sastre de Jesús	Prof.	City University of New York; 1987	Botany	Yes	6.9, 1.25, 2.6, 1.5 (1.8)	1 (1)	NSF	Biol 5016, 5017, 6689
Dimuth Siritunga	Assoc.	The Ohio State University; 2002	Molecular biology	Yes	5.2, 4.2, 5.6, 0.2 (1.8)	8 (7)	NSF, Gates, Rockefeller	Biol 5018, Writing Grant Proposals, Doc. Seminar
Jarrod Thaxton	Assis.	Louissiana State University; 2003	Plant biology	Yes	6.0, 6.0, 0, 1.0, (1)	4 (0)	DOD	Biol 6991, 6992, Restoration Ecol.
John M. Uscian	Prof.	University of Nebraska; 1994	Cellular physiology	No	8, 0.6, 2.8, 1.8 (2.4)	0	NOAA	Biol 6631, 6991, 6992
María Vargas	Prof.	Arizona State University; 1997	Mycology	No	5.2, 0, 4.4, 6 (1.4)	0	None	Biol 6642, 6991, 6992
Anthony V. Washington	Assis.	Southern Methodist University of Dallas; 1998	Molecular Genetics	Yes	Hired in 2009	6 (0)		Biol 6991, 6992

IX. PROGRAM ADMINISTRATION

Our Doctoral Program will be administered by campus-wide and departmental administrative units.

The Office of Graduate Studies at the University of Puerto Rico Mayagüez Campus is the unit responsible for implementing the rules governing graduate studies. This unit receives the admission applications, sends the applications that fulfill the admission requirements to the corresponding academic department, and notifies applicants about the final decision made by the Dean of Arts and Sciences. This office is also responsible for certifying whether the candidate has approved the required courses, has an approved thesis proposal, has completed a thesis with the appropriate format, and mails the thesis to University Microfilms International (UMI).

At the Department level, administration of the program will involve interactions between departmental-wide units (the Coordinator for Graduate Studies, the Departmental Graduate Studies Committee) and a student-focused committee (the Student Graduate Committee). The responsibilities of each of these components are detailed in Certification 97-21 (Regulations that govern Graduate Studies at UPRM). The Coordinator for Graduate Studies of the Department of Biology, currently the Associate Director for Graduate Studies of this department, presides the Graduate Studies Committee. One of the departmental administrative assistants will help the Coordinator for Graduate Studies in following up our doctoral candidates' progress and in obtaining the data for evaluation and assessment.

X. TEACHING, RESEARCH AND SERVICE RESOURCES

The Department of Biology has hired new faculty members into tenure track positions who are engaged in research as part of their appointments. In order to facilitate this process, the College of Arts and Sciences grants one year of reduced teaching load to allow the new professors sufficient time to set up their laboratories, apply for external funds, and initiate their research. Additional release time is granted when external awards are obtained. Furthermore, the College of Arts and Sciences, as well as the Center for Research and Development (CID), provide competitive small seed money grants to initiate research. Research facilities are available with modern equipment devoted to research, as well as classroom and teaching laboratory space that can be a useful resource in support of research. External funds acquired by faculty for research programs greatly increased in recent years, as evidence e.g. in a 722% increase for the Biology Department in 2005-2006 (as stated in the CID annual report). The external funds have permitted upgrading of research facilities and equipment; e.g. a new sequencing instrument has been acquired through NSF Award # 0503541. The new research programs will benefit the Department by increasing student diversity, and by stimulating interactions and collaboration within the university and outside. Professors and graduate students actively involved in cutting-edge research will upgrade and enhance the content of the respective courses they teach. In the calendar year 2007, the graduate students in the Department received 48 research assistantships totaling $159,259 in the areas of mycology, microbiology, plant molecular biology, entomology and ecology supported through public and private external research funds (e.g. USDA Forest Service, NSF, NOAA, Amgen Corporation, Gates Foundation, CIIC).

The Department maintains, among other facilities, fully equipped teaching laboratories for mycology, microbiology, immunology, virology, cell biology, zoology and botany. These laboratories are run by full-time, uniquely dedicated technical personnel. The Department also has vehicles for fieldwork and access to a recently upgraded field station in the Toro Negro State Forest. It also houses the Microscopy Center, where several microscope services are offered.

The Biology building has up-to-date internet connections (INTERNET 2) that allow faculty and students to readily access electronic journals through the General Library and other internet sources. Our current research resources support teaching in the graduate programs at high level courses, which will include the Ph.D. program in the future. The Biology building is equipped with modern communication services, which include video conference (Polycom 4000MP) capabilities available for virtual classes and seminars broadcasted to distant locations. These facilities allow the faculty to develop new teaching methods incorporating new technologies to traditional learning approaches. The Department employs a permanent IT technician, who helps administer and maintain our IT resources, which include 7 Dell PowerEdge 750/2850 servers providing support for the departmental webpage, an active directory, a Windows Update Server, DNS, DHCP, Firewall and several online databases such as BioServices (faculty information), BRAHMS (herbarium collections), SPECIFY 6 (invertebrate collections).

The General Library at UPRM has all essential resources to support the Ph. D. program in Biology. The library has over 755 journals in biology and is constantly expanding its holdings by acquiring online journals and database services. The increase in the number of electronic resources, the main preference of researchers, exceeds the increase in the number of traditional bounded sources. The General Library continuously updates its holdings by acquiring resources recommended by faculty. Many important journals are exclusively published online and almost all of the prestigious scientific journals have parallel publications in both media, printed and electronic. From the perspective of the Biology Department, a committee exists that gathers, on an annual basis, the suggestions of the faculty about new resource needs (books, journals, databases, etc.). The information is sent to the General Library, where the requests are processed according to the funds available.

XI. FACILITIES, LABORATORIES AND TEACHING EQUIPMENT

During the summer of 2005, the Department of Biology moved to the New Biology Building, a new structure with a surface area of 190,000 square feet. The building has 11 teaching classrooms (561 seats), 15 teaching laboratories, and 11 research laboratories, all of them equipped with digital projectors and computers with an OC3/Internet2 connection. In addition, there are 40 faculty offices, a faculty lounge, two computer centers, and an auditorium prepared for video-conferencing. Each computer center is equipped with 32 computers each (all connected to the Internet). Appropriate software and printers are available for teaching and as a resource for the biology community. It is important to note that the new classrooms and laboratories are much bigger than in the former biology building. Furthermore, graduate students have individual cubicles in a room specially designed for them including access to computers with Internet, where the graduate students can attend to their obligatory office hours. The building also has two biology student association offices (βββ, Premedical, AEB). All classrooms and offices are prepared for handicap access.

The Department of Biology has auxiliary facilities and equipments housed in the same building. The herbarium (MAPR), holding more than 25,000 specimens, is located on the ground floor. Also on the ground floor is the Microscopy Center, which includes a scanning electron microscope, a confocal laser microscope; as well as conventional light, Nomarski (optical interference), fluorescence and phase contrast microscopes, and microphotographic equipment. The Department has invested significantly in new and modern equipment for its research laboratories; among these are modern and sophisticated growth chambers, freezers of various temperature ranges, thermocyclers for PCR, microscopes and stereoscopes, centrifuges, electrophoresis equipment and others. A separate Entomology Laboratory (3,200 square feet), located near the Nursing School, is presently being renovated and is slotted to house the various Departmental collections of invertebrate animals. The purchase of a new small utility vehicle (SUV) and a van has increased the size of the Departmental fleet, which now has two passenger vans, a pick up truck and two SUVs. At the moment of writing (summer 2007), the blueprints of the new annex green house and animal care facility have been approved.

The Department has its own Biological Field Station located in Bosque Estatal de Toro Negro in the Central Mountain Region, which can accommodate 16 people on a surface area of 1,937 square feet. Faculty members conduct research and train students in the ecological and biodiversity aspects of the Reserve. This facility serves as a primary natural laboratory for the Department. In addition, another area just east of the Biology building, composed of approximately 7 acres of secondary growth forest, is used to develop experiments and teach courses in botany, zoology, mycology, microbiology and ecology. The Department has requested this area be granted the status of University Urban Forest and be protected from further development. The Ph.D. program in Biology will be developed in the new Biology Building; hence it will not have any impact on other existing facilities on campus. On the contrary, by moving to its new location the Department has freed space in the former building which can be used by other university dependencies.

XII. STUDENT SERVICES

The Mayagüez Campus of the University of Puerto Rico offers several student services, including opportunities to obtain teaching, research or service assistantships.

Doctoral students who enter the program with a Bachelors degree will be allowed to receive a maximum of five years of graduate assistantships, while those entering the program with a Masters degree can receive graduate assistantships for three years. However, these limits can be extended for two and three years in special cases for students entering the program with either a masters or bachelors degree, respectively (Note: only one of those years of extension can be paid through institutional funds). As of the year 2007, stipends for doctoral students fluctuate from approximately $917 for students entering with a Bachelors degree to approximately $1,057 for those entering with a Masters degree. Graduate assistants will work under the supervision of at least one faculty member.

All doctoral students will receive teaching assistantships in order to fulfill their teaching requirement. Students receiving teaching assistantships from institutional funds have their registration fee waived; other fees and medical plan costs are not waived.

Doctoral students working for researchers that have externally funded projects may receive assistantships. We expect an increase in the number of research assistantships granted after the

Doctoral Program has been approved due to the larger number of externally funded programs to which our faculty will be able to apply. The registration fee and other fees are not waived for externally funded assistantships.

A third type of assistantship is the service assistantship. Students receiving this type of assistantship will work in duties at the level of knowledge and training of the student but not the kind of duty typically done by the non-academic personnel of the Biology Department.

In addition to the above, doctoral students can also apply for scholarships. United States citizens or permanent residents can apply, through the Dean of Student Affairs, for a $2,000 scholarship for travel to national and international conferences to present their research findings. The Graduate Students Office maintains a list of various programs that provide different scholarships.

Students receiving assistantships through institutional or externally funded programs are not considered faculty members of the Biology Department.

In addition to the above, students at our campus benefit from various services including a Sports Department offering sport and fitness services and facilities, extensive assistance on degree-related issues by the Office of Graduate Studies, an Office for Services to Students with Disabilities, emergency and other medical assistance at the on-campus Medical Services Center, and a Placement Office that helps students secure employment after graduation.

XIII. STUDENT CATALOG AND OUTREACH

The Ph.D. Program in Biology started at the University of Puerto Rico-Mayagüez on August of 2011. The Department website: http://biology.uprm.edu/, offers additional information on the program and about the research facilities and interests of its faculty.

Admission requirements:

1. A Bachelor of Science or equivalent with a minimum cumulative grade point average of 3.0 (out of 4.0) and a minimum grade point average of 3.0 in Biology.
2. Submit scores for Graduate Record Examination (GRE) general and for Test of English as a Foreign Language (TOEFL), or provide an equivalent testimony of proficiency in English.

Program requirements:

Graduate courses: A minimum of 52 credits, of which no more than 9 can be at the 5000 level and no less than 43 at the 6000 level or higher. Among the previous 43 credits, 18 credits will be doctoral dissertation research. The minimum grade point average required for graduation will be 3.0.

Teaching requirement: Every Ph.D. student will complete at least 6 hours of training in teaching methods either through workshops or through university level courses. Also, teaching one or more courses at least during two semesters is required of every student.

Thesis research: The student will conduct an original research project, which will contribute significant new findings to science. The student will describe this project in a written proposal, and will defend the proposal in front of his/her Graduate Committee no later than the 2nd semester of the 3rd year.

Preliminary examination: The student will take a comprehensive exam which includes a written and an oral component. Both components will be administered and graded by the Graduate Committee. These components have to be passed no later than the 12th week of the 6th semester of the student's program.

Departmental seminar: Ph.D. students will present a departmental seminar based on their research results immediately after the student applies for dissertation defense and before the last day of classes of the current semester. All Ph.D. students are required to attend all departmental seminars.

Publications: Ph.D. candidates will submit at least one article for publication to a peer-reviewed journal. In order to apply for dissertation defense, the student has to present proof of article submission to the Biology Graduate Student Coordinator.

XIV. BUDGET

A. Expenses

The requested funds (Table XIV-1) are for:

1. New research faculty – The Strategic Hiring Plan of the Department of Biology includes the creation of three new faculty positions. We therefore request the creation of these three new tenure-track Assistant Professor positions, who will focus on research and teaching of specialized courses in the areas of Metabolomics/Bioinformatics, Microbiology, and Conservation Biology (Appendix XIV-1). Funds are requested for the corresponding salaries and fringe benefits, and for start up funds ($100,000 each).
2. A Core Laboratory Facility – The entire faculty has expressed the need to establish a Core Laboratory Facility for housing, using and maintaining several major pieces of equipment with open accessibility to research faculty and students. The faculty members responsible for three established contiguous laboratories have agreed to allow the reconfiguring of their laboratory spaces to accommodate such facility. Funds are requested for the reconfiguration of laboratory space ($250,000), one laboratory technician, and several major pieces of equipment (e.g., a large autoclave, molecular biology equipment, gel documentation system, incubators, nanopure water system, freezers (-20˚C), ice maker (crush), GC, HPLC, spectrophotometer).
3. Addition of biology-related on-line library resources.
4. Invited Speakers Program – At least two speakers of high qualifications in a biological discipline will be invited during a one year period to make a seminar presentation and

interact with faculty and students. Funds are requested for a modest stipend, and to cover their travel costs.

5. A new all-road vehicle – The Department of Biology currently owns two all-road vehicles; one of them is more than ten years old and is likely to be decommissioned soon. We will need at least two of these vehicles in adequate condition for use by research faculty and doctoral students.
6. Teaching and research software – Funds are requested to upgrade existing software used in teaching high level courses and for annual support (i.e., geographical information systems, remote sensing, multivariate analyses), as well as for purchasing some new statistical software packages (i.e., statistical packages, phylogenetic analysis software).

Table XIV-1. Five-year budget.

CATEGORIES	Year				
Recurring costs	1	2	3	4	5
Additional faculty (3)	$236,012	$245,453	$255,271	$265,482	$276,101
Laboratory technician (1)	$24,520	$24,765	$25,019	$25,284	$25,559
Library resources	$10,000	$10,400	$10,816	$11,249	$11,699
Educational software maintenance fees	$1,285	$1,336	$1,390	$1,445	$1,503
Invited speakers	$3,000	$3,120	$3,245	$3,375	$3,510
Equipment annual maintenance fees	$71,890	$74,966	$77,964	$81,082	$84,826
Non-recurring funds					
Reconfiguration of laboratory space (Core Facility)	$250,000				
New equipment for Core Facility	$90,237				
New vehicle	$35,000				
New teaching and research software	$3,457				
Start up funds for new faculty	$300,000				
Annual totals	$1,025,401	$360,040	$373,705	$387,917	$403,198
5-year grand total					$2,400,261

B. Income sources

It is highly likely that the establishment of this Doctoral program will stimulate submission of new proposals for external funds, particularly those of a collaborative nature. However, it is difficult to estimate how much additional income from such sources will be obtained.

XV. ASSESSMENT PLAN AND PROGRAM EVALUATION

An Assessment Committee will be established with three members: the Graduate Program Coordinator as president, and two other faculty members of the Department of Biology participating in the Doctoral Program. Individual assessments will be conducted annually and a cumulative assessment will be conducted at the end of the fifth year after approval of the program. The criteria to be considered include:

1. Percent of students retained in the program;
2. Students' academic progress;

3. Amount of external funds obtained by faculty;
4. Attendance to and number of presentations by faculty or students at professional meetings;
5. Number of manuscripts submitted by faculty or students and accepted for publication;
6. Job offerings or post-doctoral positions obtained by doctoral graduates; and
7. Employers' satisfaction with doctoral graduates of this program.

Information on the above criteria will be obtained by several tools. A portfolio will be assembled by the student, and held by the Graduate Student Coordinator, with information on the student's progress. Questionnaires will be completed annually by the students and the participating faculty. Also, some of the above information will be obtained from the quarterly reports completed by the faculty and gathered by the Department on issues regarding faculty academic and research productivity.

XVI. DEVELOPMENT PLAN

The faculty of the Doctoral program will arrange for several activities to improve the conditions to make this program successful. Some of these activities will be conducted early on; regardless of any evaluation results, to advance immediately with regards to several aspects of the program (e.g., increase proposal submission and external funding, increase number of peer-reviewed publications). Other activities will be conducted regularly as assessment data are gathered to secure adequate results in fulfilling our objectives (e.g., student recruitment, retention, and timely graduation).

Objective	Activity	Frequency	Resources	Outcome
Recruitment of students	Announcements a. Websites b. Newspapers c. CD promotion	Every semester	Biology faculty and staff	Continuous increase in the number of students applying to and admitted to the program each year during the first 5 years of the program
External funds	Seminars on how to write grant proposal and develop research collaborations	Annually	UPRM, NSF, NIH, EPA, PR government, Sea Grant, Industry	Increment in the amount of external funds received and collaborative research projects

Objective	Activity	Frequency	Resources	Outcome
Completion of Doctoral degree	a. Graduate committee b. Yearly report c. Oral and written exam d. Dissertation defense	Fourth and Fifth year	UPRM, Faculty	80% of the students entering with a M.S. will graduate in 4 years while 80% of those with a B.S. will graduate in 5 years
Publications	Submit publications to peer reviewed journals	5th year	Faculty	Double the number of peer-reviewed publications per faculty member from the 5-year average rate prior to the approval of the program
Job-offering or post doctoral positions	Request questionare from graduated student	One year after graduating	Student	All graduating students with a job or post doctoral offering within one year of graduating
Employment satisfaction	Request questionare from employer	One year after employment	Employer	All employers reporting good satisfaction

XVII. ADDITIONAL INFORMATION

XVIII. REFERENCES

Campbell, S.P., A.K. Fuller and D.A.G. Patrick. 2005. Looking beyond research in doctoral education. Frontiers of Ecology and Environment 3: 153-160.

Russo, E. 2004. Special report: Fast track PhD's. Nature 431: 382-383.

Thurgood, L., M.J. Golladay and S.T. Hill. 2006. U.S. Doctorates in the 20th Century. National Science Foundation, Division of Science Resources Statistics, NSF 06-319.

XIX. APPENDICES

Appendix IV-1. Descriptions of core courses.

Appendix VI-1. Additional assessment tools.

Appendix XIV-1. Strategic Hiring Plan of the Department of Biology.