

## Biological Sciences

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 \***Yuying Zhang**, Associate Professor

### \*Holds Dissertation Advisor Status

## Master of Science in Biology

To be admitted into the Master's degree program in Biology, a student must:

1. Hold a Bachelor's degree in a relevant discipline from an accredited college or university.
2. Have a 3.0 average or higher during the last two years of the undergraduate program and submission of Graduate Record Exam scores.
3. Two letters of recommendation of the student's academic potential.
4. Be accepted by a faculty sponsor.
5. Receive approval from the Departmental Graduate Committee.
6. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.5 overall on the IELTS is required.

### Degree Requirements

The Master of Science in Biology consists of a minimum 36 credits, including a thesis based upon the student's original research. A maximum of six credits of post baccalaureate course work may be transferred from other institutions, subject to the approval of the Graduate Committee.

### Required Courses

BSC 6457	Introduction to Biological Research	3
BSC 5931	Thesis Proposal Seminar	1
	Workshops and Laboratories <sup>1</sup>	4
BSC 6971	Master's Thesis <sup>2</sup>	6
	Electives <sup>3</sup>	22
	Quantitative Skills Requirement <sup>4</sup>	

<sup>1</sup> Following graduate committee approval, students may fulfill this requirement with any combination of graduate workshops, graduate laboratories, and graduate techniques courses (minimum of three separate courses).

<sup>2</sup> To be taken after qualifying exam is passed.

<sup>3</sup> These must include at least 16 credits of courses in the Department of Biological Sciences. No more than six credits can be transferred from another graduate program,

subject to the approval of the Graduate Committee. At least six credits must be at the 5000- or 6000-level (excluding thesis credits). Credits taken at the 4000-level beyond six, or at lower levels, will not count towards graduation.

<sup>4</sup> Two semesters of graduate courses in quantitative skills (e.g., statistics, mathematics, computer programming), or demonstrated equivalence of such, is required for the Master of Science in Biology.

### Graduation Requirements

A grade of 'C' or higher must be obtained in all courses with a cumulative average of 3.0 or higher in the 36 credits, and a thesis must be completed and accepted by the University.

#### Non-Thesis Track: Requirements

Doctoral candidates in the Biological Sciences Major who have filed the D-2 and D-3 forms that are accepted by the University Graduate School can receive a Master of Science in Biology en route to the PhD with "non-thesis track" appearing in the transcript.

#### Non-Thesis Track: Graduation Requirements:

A minimum GPA of 3.0 in all Graduate course work is required for the Master's degree.

### Doctor of Philosophy in Biology

To be admitted into the Ph.D. program in Biology, a student must:

1. Hold a Bachelor's degree in a relevant discipline from an accredited college or university
2. Have a 3.0 grade point average during the last two years of the undergraduate program or a Master's degree in a relevant discipline;
3. Submission of official Graduate Record Exam (GRE) scores.
4. Be sponsored by a Biology faculty member with Dissertation Advisor Status (see list of graduate faculty with DAS).
5. Arrange to have three letters of recommendation sent to the Biology Graduate Program Director evaluating the applicant's potential for graduate work.
6. Receive approval from the Department Graduate Committee.
7. International graduate students applicants whose native language in not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.5 overall on the IELTS is required.

### Degree Requirements

The Ph.D. in Biology is conferred on individuals in recognition of their demonstrated ability to master a specific field of knowledge and to conduct significant independent, original research. A minimum of 75 semester credits of graduate work beyond the baccalaureate are required, including a dissertation based upon the student's original research. A maximum of 36 credits may be transferred from a completed graduate program with the approval of the Advisory Committee.

### Required Courses

BSC 7961	Dissertation Proposal Seminar	1
BSC 7982	Dissertation Defense Seminar	1
BSC 5945	Supervised Teaching in Biology Workshops and Laboratories <sup>1</sup>	4
BSC 7980	Ph.D. Dissertation	15
	Electives <sup>2</sup>	8
	Quantitative Skills Requirements <sup>3</sup>	

### Recommended Course

BSC 6457	Introduction to Biological Research	3
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<sup>1</sup>Following graduate committee approval, students may fulfill this requirement with any combination of graduate workshops, graduate laboratories, and graduate courses (minimum of three separate courses)

<sup>2</sup>No more than 36 credits may be transferred from a completed graduate program, subject to the approval of the Graduate Committee.

<sup>3</sup>Two semesters of graduate courses in quantitative skills (e.g. statistics, mathematics, computer programming), or demonstrated equivalence of such, is required for the Ph.D. in Biology.

### Graduation Requirements

A grade of 'C' or higher must be obtained in all courses with a cumulative average of 3.0 or higher in the 75 credits; two semesters of quantitative skills courses must be completed, and a dissertation completed and accepted by the University.

### Combined MS in Forensic Science/PhD in Biology Pathway

The MSFS/PhD in Biology pathway combines the Master of Science in Forensic Science with a PhD in Biology. Student who pursue this degree will be enrolled in a continuous program; however, upon completion of all the requirements of the MSFS program (report option), students will be awarded a MSFS degree as they transition towards their PhD.

#### MSFS/PhD in Biology Pathway Requirements

For admission into the MSFS/PhD pathway, students must meet the admission criteria of a PhD student with the understanding that they will have an increased class load of 2-3 classes, e.g., Forensic Biology, Forensic Chemistry, and Forensic Analysis, when compared to the normal PhD applicant but will graduate with two degrees. The requirements will be as follows:

1. Hold a Bachelor's degree in a natural science from a relevant university.
2. Have a 3.0 GPA during the last two years of the undergraduate program and submission of official GRE scores.
3. Arrange to have three letters of recommendation sent to the Biology graduate program director evaluating the applicant's potential for graduate work.
4. Be sponsored by a Biology faculty member with Dissertation Advisor Status.
5. Receive approval from the Department Graduate program committee.
6. International graduate student applicants whose native language is not English are required to submit a score for Test of English as a Foreign Language (TOEFL) or for the International English Language

Testing System (IETLS). A score of 80 on the iBT TOEFL or 6.5 overall on the IETLS is required.

As these candidates will be dually enrolled in two graduate degree programs, candidates must complete minimum of 32 credit hours towards their MSFS degree with a grade of 'C' or higher and a cumulative GPA of 3.0. The MSFS report option must be completed and accepted by the University before full transition towards the PhD. Candidates must also complete a total of 75 credit hours toward the PhD with the allowance for credits transferred from the completed MSFS degree. The student will be able to earn both degrees in a similar time frame that it would take to obtain either degree if pursued consecutively.

Students will be required to select a Master's defense committee while pursuing the MSFS as well as a PhD dissertation committee. This committee may or may not be comprised of the same members as those selected for the Master's program. The Master's proposal should be presented after the second semester of admission and the PhD dissertation defense should be presented after the fourth semester after admission.

#### Required Courses

BSC 6457	Introduction to Biological Research	3
BSC 5931	Thesis Proposal Seminar	1
BSC 7961	Dissertation Proposal Seminar	1
BSC 5975	Thesis Defense Seminar	1
BSC 7982	Dissertation Defense Seminar	1
BSC 5406	Forensic Biology	3
CHS 5535	Forensic Analysis	3
CHS 5542	Forensic Chemistry	3
PCB 5665	Human Genetics	3
PCB 5685	Population Genetics	3

#### Elective Courses

PCB 6025	Molecular and Cellular Biology I	3
MCB 5116	Microbial Diversity	3
BSC 5459	Advanced Bioinformatics for Biologists	3
BOT 5852	Medical Botany	3
BOT 5727	Plant Genetics	3
PCB 5616	Applied Phylogenetics	3
STA 5207	Topics in Design of Experiments	3
STA 5507	Nonparametric Methods	3

#### Labs and Workshops

BSC 6925	Workshop: Non-Human DNA Profiling and Analysis	1
BSC 6926	Workshop in Biology: DNA Instrumentation	1
BSC 5935	Workshop in Biology: Advanced DNA Typing	1-2

#### Research

BSC 6971	Master's Thesis	6
BSC 7980	Ph.D. Dissertation	24

## Course Descriptions

### Definition of Prefixes

BCH-Biochemistry; BOT-Botany; BSC-Biological Sciences; MCB-Microbiology; OCB-Biological Oceanography; PCB-Process Biology (Cell/Molecular/Ecology/Genetics/Physiology); ZOO-Zoology

#### BCH 5040 Introduction to Biochemical Research (3).

Analysis of biochemical data and experimental design. Prerequisite: Graduate standing.

**BCH 5134C Workshop in Chromatography Techniques (1).** Workshop covers the theory and practice of chromatographic techniques to separate complex mixtures of biomolecules, including absorption, ion exchange, size exclusion and affinity chromatography. Prerequisite: Graduate status.

**BCH 5411C Techniques in Molecular Evolution Research (5).** Ribosomal genes from related organisms are amplified by polymerase chain reaction (PCR) and sequenced. Phylogenetic maps are made by computer from sequence data. Students may use material from their own research. Prerequisites: BCH 3033 and BCH 3033L, PCB 4524 and PCB 4524L or Graduate status.

**BCH 6130C Workshop in DNA Synthesis and Amplifications (1).** Workshop in the chemical synthesis of DNA and the amplification of specific genes by the polymerase chain reaction (PCR). Students may synthesize DNA oligonucleotides for use in their own research. Prerequisites: Graduate status and Permission of the instructor.

**BCH 6132C Workshop in Electrophoresis (1).** Workshop in the application of electrophoresis to biochemical and genetic experimentation. Students may use material from their own research in the laboratory section. Prerequisites: Graduate status and permission of the instructor.

**BCH 6133C Workshop in DNA Sequencing (1).** Workshop in the manual and automated sequencing of DNA. Students may sequence DNA from their own research. Prerequisites: Graduate status and permission of the instructor.

**BCH 6507C Workshop in Radiometry and Spectrophotometry (1).** Interaction of light with matter (absorption, fluorescence, light scattering) and emission (chemi- and bio-luminescence); analysis of spectra and enzyme kinetics. Prerequisites: PCB 3043 or permission of the Instructor.

**BOT 5186C Advanced Marine Botany (3-4).** Study of the taxonomy, biology, and ecology of seaweeds, seagrasses, and mangroves including a student research project. Prerequisites: BSC 2011 or equivalent.

**BOT 5159C Florida Plant Communities (3).** Two-week field trip to many diverse plant communities of the state. Ecological and environmental factors influencing plant distribution will be examined, contrasting vegetation among sites. Prerequisites: Ecology PCB 3043 or Permission of the instructor.

**BOT 5304C Workshop in Plant Morphology (2).** Techniques to analyze plant form and experience with the diversity plant morphology; field work using the collections at Fairchild Tropical Gardens. Prerequisites: 2 botany courses or permission of the instructor.

**BOT 5515 Biochemistry of Plant Natural Products (3).** Aspects of primary and secondary plant metabolism will be covered including bio-synthesis and degradation of natural products as well as their biological/pharmacological activity. Prerequisites: BCH 3033 or CHM 4304.

**BOT 5575 Photobiology (3). BOT 5575L Photobiology Lab (1).** The study of basic photochemical mechanisms as they occur in molecular biological processes such as photosynthesis, plant growth, animal vision, bioluminescence, and radiation damage. Prerequisite: Permission of the instructor.

**BOT 5602 The Functional Ecology of Tropical Plants (3). BOT 5602L The Functional Ecology of Tropical Plants Lab (1).** The relationship of climate and soils to the distribution and function of the major plant groups of the tropical regions. Prerequisites: Two courses in botany or permission of the instructor.

**BOT 5605 Plant Ecology (3) BOT 5605L Plant Ecology Laboratory (1).** In-depth study of plant ecology at three levels: individual, population, and community. Laboratory and field exercises will examine lecture topics. Prerequisites: PCB 3043 or permission of the instructor. Corequisite: Concurrent registration in lecture and lab courses.

**BOT 5615 Workshop: Seed Conservation (1).** Covers practical issues of seed conservation of tropical plants: longevity curves, seed germination protocols and seed conservation procedures. Prerequisites: Graduate students or permission of instructor.

**BOT 5647 Ecology of Marine Vascular Plants (3).** Biology and ecology of seagrasses and mangroves, with an emphasis on South Florida and Caribbean species. Physiological ecology, population and community ecology, and ecosystem processes. Prerequisite: Permission of the instructor.

**BOT 5648 Workshop on Aquatic Plants (1).** Biology and identification of aquatic plants. Prerequisites: Graduate status or permission of the instructor.

**BOT 5704 Botanical Terminology, Latin and Nomenclature (2).** Course is divided into 3 parts: 1) Botanical Latin and its use; 2) Plant description terminology, and current descriptive standards; and 3) Botanical nomenclature, the ICBN, Phycocode, and others. Prerequisites: BOT 5725C or BSC 5606, or approval of the Advisor.

**BOT 5725C Plant Systematics (3).** Theory and methods of classification of vascular plants using phylogenetic principles. Covers the integration of morphological and molecular characters. Prerequisites: Graduate students or permission of instructor.

**BOT 5727 Plant Genetics (3).** Topics related to higher plants, including polyploid inheritance, self-incompatibility, cytoplasmic inheritance, mutable alleles, complex loci, genome analysis, recombination and mutagenesis. Prerequisites: BSC 2010 and BSC 2011 and PCB 3063.

**BOT 5728 Plant Molecular Systematics (2).** DNA markers for phylogenetic analysis of vascular plants, including description of laboratory methods, computerized analytical techniques and evolutionary interpretation. Prerequisites: Graduate status or permission of instructor.

**BOT 5728L Plant Molecular Systematics Laboratory (2).** DNA markers for phylogenetic analysis of vascular plants, including description of laboratory methods, computerized analytical techniques and evolutionary interpretation. Prerequisites: Graduate status or permission of instructor.

**BOT 5816 Ethnobotany (3).** Review the use and management of plants by indigenous people. Discuss emerging theories in ethnobotany, examine the role of ethnobotany in conservation and resource utilization. Prerequisites: BOT 3810, BOT 3663, or ANT 3403, or permission of the instructor.

**BOT 5816L Ethnobotany Workshop (1).** Field methods in the study of plant use by traditional and modern societies. Examines botanical documentation, ethnological description and experimental design. Prerequisite: Permission of the instructor.

**BOT 5817 Field Ethnobotany (1-4).** A 4-week field course that introduces students to tropical vegetation and its use by traditional cultures. Topics include tropical botany, diversity, ecology, and the relationship between plants and people. Course may be repeated. Prerequisites: BOT 5816 and BOT 5816L or permission of instructor.

**BOT 5852 Medical Botany (3).** An examination of medicinal plants including the biology, chemistry, and pharmacology of botanical remedies, and their effects on human health. Prerequisites: BOT 3810 or BOT 5816 or permission of instructor.

**BOT 5924 Workshop in Tropical Plant Families (3).** An introduction to important spermatophyte families, including systematics, ecology, and conservation. Includes laboratory and field experience. Prerequisite: Permission of the instructor.

**BOT 5925 Workshop in the Biology of Southern Florida's Native Trees (3).** Distribution, floristic relationships, morphology, reproductive biology, taxonomy, and conservation of trees native to southern Florida. Prerequisites: BOT 3154, BOT 3663, or permission of the instructor.

**BOT 5928 Workshop on Grasses and Sedges of Southern Florida (1).** The systematics, ecology, and identification of South Florida grasses and sedges. Prerequisites: Graduate status or permission of the instructor.

**BOT 6275 Plant Breeding Systems (3).** Ecology, evolution, genetics and development of plant breeding systems. Prerequisite: Permission of the instructor.

**BOT 6585C Plant Structure and Function (4).** A quantitative assessment of plant architecture, morphology and anatomy in relationship to physiology, including the measurement of water relations, energy and gas exchange. Prerequisites: Permission of the instructor and graduate status.

**BOT 6724 Readings in Pollination Biology (1).** Current literature on pollination, including natural history, theory, experimental studies, and reviews. Prerequisites: Graduate status or permission of the instructor.

**BOT 6818 Readings in Ethnobotany (1).** An examination of 3 or 4 recent books in the ethnobotany or related disciplines, especially those dealing with theoretical issues. Prerequisites: BOT 5816, Graduate Standing, or permission of instructor.

**BOT 6901 Readings in Plant Mating Systems (1).** Current literature on theory, biology, and evolution of plant

mating systems. Prerequisites: Graduate standing or permission of the instructor.

**BOT 6920C Workshop in Field Techniques in Natural History of Insect/Plant Interactions (1).** A workshop in the techniques for collecting and preserving plants and insects for biological and taxonomic research.

**BOT 6921C Workshop in Field Techniques in Pollination Biology (1).** Techniques to do a thorough study of the pollination biology of any flowering plant; basic methods and simple instruments for field observations, measurements and manipulations. Prerequisite: Graduate status.

**BOT 6923 Workshop: Techniques in Plant Reproductive Biology (1).** Workshop in techniques for research on pollination and fertilization in plants. Histological and microscopic examination emphasized. Prerequisites: Graduate status and permission of the instructor.

**BOT 6926C Workshop in Plant Nutrient Analysis (1).** Field and laboratory methods used in the assessment of nutrient availability for primary producers. Prerequisite: Permission of the instructor.

**BOT 6928 Workshop on Plant Gas Exchange and Fluorescence (1).** Field and laboratory methods used for measurement of plant photosynthetic production and transportation. Prerequisite: Permission of the instructor.

**BOT 6935 Advanced Topics in Botany (3).** An intensive study of particular plant topics not otherwise offered in the curriculum. May be repeated for credit with different subject content. Prerequisite: Graduate status.

**BOT 6936 Readings in Plant/Animal Interactions (1).** Current literature on coevolution of plants and animals, theory, experimental studies, and reviews. Prerequisites: Graduate standing or permission of the instructor.

**BSC 5302 Ecosystems of the Past (3).** Analysis of local to global change in environments through time using faunal distributions, biodiversity, biogeography, physical and chemical properties of sediments, and stable isotopes.

**BSC 5405C Environmental Instrumentation (3).** Theory and techniques for measurement of environmental parameters of interest to field biologist. Prerequisite: Permission of the instructor.

**BSC 5406 Forensic Biology (3).** Forensic applications of molecular biology including PCR, STR techniques and other laboratory methods and data interpretation. Prerequisite: Graduate status.

**BSC 5446 Advanced Functional Genomics and Proteomics (3).** Analysis of Modern Strategies to understand fundamental biological aspects using advanced genomics and proteomic approaches. Prerequisites: PCB 3063 or equivalent.

**BSC 5459 Advanced Bioinformatics for Biologists (3).** Introduction to bioinformatic resources/methods for biology graduate students, accessing, searching, retrieving, and analyzing data, including an in-depth research project. Prerequisites: BSC 2010, BSC 2011, PCB 3063.

**BSC 5926 Graduate Bioresource Workshop (1).** This workshop is designed to introduce Biology graduate

students to the various resources available for graduate teaching and research. Prerequisite: Graduate status.

**BSC 5927 Workshop: R Programming for Biologists (2).** Statistical methods and biological/ecological applications using R programming language. Prerequisites: (Graduate standing in Biology) or (STA 3111 and STA 3112).

**BSC 5928 Workshop: Vertebrate Animal Research (1).** Reviews the ethical, legal and practical guidelines for conducting research with live vertebrate animals. Required for students capturing, handling or collecting vertebrate animals in the course of research or teaching. Prerequisites: Graduate status or permission of the instructor.

**BSC 5929 Workshop: Paleocology of South Florida (2).** Sampling, preparation, and identification of diatoms and foraminifera from a freshwater to marine transect, and application of ecology to interpreting past ecosystems.

**BSC 5931 Thesis Proposal Seminar (1).** Presentation of thesis proposal seminar. Permission of major professor required.

**BSC 5933 Current Topics in Tropical Biology (3).** An intensive study of particular tropical biology topics not otherwise offered in the curriculum. Prerequisite: Permission of the instructor.

**BSC 5935 Topics in Biology (1-3).** An intensive study of a particular topic or limited number of topics not otherwise offered in the curriculum. May be repeated for credit with different subject content. Prerequisites: Senior or graduate status.

**BSC 5936 Glaser Seminar: The Biology of Tomorrow (1).** A series of lectures by an invited, internationally recognized authority in biological topics of current and future concern.

**BSC 5945 Supervised Teaching in Biology (1-2).** Teaching in a biological discipline, under the supervision of departmental faculty. Prerequisite: Graduate status.

**BSC 5975 Thesis Defense Seminar (1).** Presentation of thesis defense seminar. Permission of major professor required. Prerequisite: Thesis proposal seminar.

**BSC 6314 Workshop: DNA Instrumentation and Analysis (1).** Introduction to instrumentation and analysis software used for DNA profiling. Permission of the instructor required. Prerequisite: Permission of the instructor.

**BSC 6415 Animal Cells in Culture (3).** Biology of animal cells cultured in semi-synthetic media: cell nutrition growth, cell cycle analysis, cellular transformation and differentiation, heterokaryons and somatic cell genetics. Prerequisite: Permission of the instructor.

**BSC 6456C Microcomputer Use in Biology (1).** Introduction to microcomputer operating environments, the utility of microcomputers in biology, and computer interfacing to biological instrumentation. Prerequisite: Permission of the instructor.

**BSC 6457 Introduction to Biological Research (3).** Analysis of existing biological data and experimental design. Prerequisite: Graduate status.

**BSC 6913 Student Research Lab (1-12).** Independent laboratory study in a project or projects of the student's choice. Registration by consultation with instructor. May be repeated for additional credit.

**BSC 6925C Workshop: Non-Human DNA Profiling and Analysis (1).** Current techniques in non-human DNA profiling using molecular markers. Prerequisite: Permission of the instructor.

**BSC 6926 Workshop in Biology (1-2).** A short intensive treatment of a specialized research topic or technique. Prerequisite: Permission of the instructor.

**BSC 6936 Topics in Biology (1-3).** An intensive study of a particular topic or limited number of topics not otherwise offered in the curriculum. May be repeated for credit with different subject content. Prerequisites: Senior or graduate status.

**BSC 6946 Graduate Biology Internship (1-12).** Non-thesis / non-dissertation internship in a laboratory or program outside FIU working under the supervision of a host scientist and an FIU faculty member. Prerequisite: Admission to candidacy.

**BSC 6950 Writing, Publishing, and Communicating Peer-Reviewed Papers in Biological Sciences (3).** This course trains early career scientists in the skills of mastering Biological Science writing, peer review, and publishing.

**BSC 6971 Master's Thesis (1-12).** Completion of thesis. Prerequisite: Permission of Major professor.

**BSC 7961 Dissertation Proposal Seminar (1).** Presentation of doctoral dissertation proposal seminar. Prerequisite: Permission of Major Professor required.

**BSC 7980 Ph.D. Dissertation (1-12).** Completion of dissertation. Prerequisites: Permission of Major Professor and Doctoral Candidacy.

**BSC 7982 Dissertation Defense Seminar (1).** Presentation of doctoral dissertation defense seminar. Permission of Major Professor required. Prerequisite: Dissertation Proposal Seminar.

**MCB 5116 Microbial Diversity (3).** **MCB 5116L Microbial Diversity Laboratory (1).** Analysis of metabolic and morphological diversity in bacteria in the context of bacterial systematics. Prerequisites: MCB 3020 and MCB 3020L and an additional course in microbiology or biochemistry. Corequisite: Concurrent registration of both lecture and lab courses.

**MCB 5205 Advanced Microbial Pathogenicity (3).** Overview of microbial pathogenicity, including interactions with hosts, evolution of pathogens, virulence factors, toxins, antibiotics, and case studies of specific pathogens. Prerequisites: MCB 3020 or permission of the instructor.

**MCB 5315C Workshop: Prokaryotic Cloning (2).** Description of molecular genetic methods for manipulation of prokaryotic DNA. Prerequisites: PCB 3063; BCH 3033 or CHM 4304; or permission of the instructor.

**MCB 5405 Biology of Photosynthetic Bacteria (3).** Study of the physiology and ecology of photosynthetic bacteria, including blue-green algae (cyanobacteria), purple and green bacteria, and halobacteria.

**MCB 5412 Advanced Microbial Physiology (3).** Overview of microbial metabolic diversity, including prokaryotic metabolic pathways, stress responses, cell signaling, and metabolic regulation. Prerequisite: Permission of the instructor.

**MCB 5453L Workshop: Prokaryotic Cell Signaling (1).** Covers chemical signals used by prokaryotes for cell-to-cell communications. Prerequisites: MCB 3020 or permission of instructor.

**MCB 5605 Microbial Ecology (3).** Principles and applications of microbial interactions with the environment. Current research areas are emphasized. Prerequisite: Graduate level standing.

**MCB 6445 Microbial Bioluminescence (3).** Molecular mechanisms, physiology, genetics and ecology of bioluminescence in microorganisms, particularly bacteria. Prerequisite: Permission of the instructor.

**MCB 6635 Marine Microbiology (3).** **MCB 6635L Marine Microbiology Lab (1).** Physiological-ecological study of the distribution and biology of marine bacteria; diseases of marine animals; bacterial role in oceanic mineral cycling. Prerequisites: MCB 3020 and MCB 3020L and BCH 3033 and BCH 3033L or MCB 4404 and MCB 4404L.

**MCB 6920 Luminescence Workshop (2).** Bioluminescence and chemiluminescent theory and methods applied to luminous bacteria and molecular biology. Prerequisite: Permission of the instructor.

**MCB 6935 Advanced Topics in Microbiology (3).** An intensive study of particular microbiological topics not otherwise offered in the curriculum. May be repeated for credit with different subject content. Prerequisite: Graduate status.

**OCB 5006 Advanced Biological Oceanography at Sea I (3).** An in-depth overview and critical discussion of current methods employed in biological oceanography including design of and working on research ships and planning of research cruises. Prerequisite: Permission of the instructor.

**OCB 5007C Advanced Biological Oceanography at Sea II (4).** A hands-on experience in research at sea involving cruise planning, participation in an offshore cruise on a research vessel, and subsequent sample analysis, data evaluation and research report. Prerequisites: OCB 5006 or permission of the instructor.

**OCB 5575L Workshop: Aquatic Flow Cytometry (1).** A practical introduction to theories and applications of flow cytometry in the analyses of aquatic microorganisms (bacteria, phytoplankton) and their physiology. Prerequisite: Permission of the instructor.

**OCB 5634 Marine Ecology (3).** **OCB 5634L Marine Ecology Lab (1).** Review processes determining species distribution and abundance in marine ecosystems. Energy flow and trophic relationships examined. Prerequisite: PCB 3043. Corequisite: Concurrent registration of lecture with lab course.

**OCB 5636 Advanced Marine Microbial Ecology (3).** Diversity, ecology and physiology of marine viruses, bacteria and protozoa, their role in marine food webs and the biogeochemical cycling of carbon and nutrients, and the significance of microbial food webs for marine

productivity. Prerequisites: BSC 2010, BSC 2011, OCB 3043, or graduate standing.

**OCB 5670L Techniques in Biological Oceanography (1).** A laboratory course designed to acquaint the student with biological sampling techniques at sea. Shipboard experience will be required as part of the course. Prerequisites: Previous course in marine biology and permission of the instructor.

**OCB 5715 Advanced Fisheries Science (3).** Theory and techniques of fisheries science comprising recruitment, growth, migration, population dynamics, modeling and measurement techniques. Prerequisite: Graduate standing.

**OCB 6716 Fisheries Population Dynamics (3).** Application of statistical techniques and the different classes of fisheries population dynamics models used in fish stock assessment. Prerequisites: OCB 4711 or OCB 5715.

**OCB 6927C Workshop in Scientific Diving (2).** Covers all aspects of conducting safe underwater research, including theoretical and practical aspects of diving, diving equipment, and scientific techniques. Requires original research. Prerequisites: Open water diving certification, permission of the instructor, FIU Diving Medical clearance, pass standardized swim test, at least 18 years old.

**PCB 5025L Molecular Biology Techniques Laboratory (3).** Covers DNA and RNA extraction, digestion, electrophoresis, Southern analysis, RFLP analysis, PCR amplification, cloning and automated sequencing. Prerequisites: Graduate status or permission of the instructor.

**PCB 5046 Advanced Plant Conservation Biology (3).** Survey of the causes and consequences of anthropogenic disturbances on plant diversity at different spatial scales, including critical evaluation of strategies to mitigate these impacts. Prerequisites: PCB 3043 or graduate status.

**PCB 5184 Workshop in Microtechnique (1).** Laboratory techniques required for preparation of tissues for light microscopy/histological study. Prerequisite: Graduate status.

**PCB 5215 Workshop in Histo—and Immunocyto—Chemistry (1).** Laboratory techniques for preparation of paraffin-embedded and frozen sections; selected procedures to demonstrate the fundamentals of histochemical and immunocytochemical labeling methods. Prerequisite: Graduate status or permission of the instructor.

**PCB 5235 Current Topics in Comparative Immunology (1).** A weekly seminar/discussion course consisting of research presentations by students, faculty and visiting scientists in the area of comparative immunology. It is recommended for students with a research interest in the comparative study of mammalian and nonmammalian species or using alternative animal models. Prerequisite: Permission of the instructor.

**PCB 5238 Marine Comparative Immunology Workshop (1).** A workshop at the Keys Marine Lab to present general and unique research methodologies associated with the immunology of marine animals. Prerequisite: Permission of the instructor.

**PCB 5239 Immunophysiology (3).** Physiological and endocrine regulation of the vertebrate immune system. Prerequisite: PCB 4233.

**PCB 5259 Topics in Developmental Biology (3).** Molecular and cellular mechanisms in the development of plants and animals. Prerequisite: Permission of the instructor.

**PCB 5307 Limnology (3).** **PCB 5307L Limnology Lab (1).** Chemical and physical properties of standing and flowing freshwater systems; ecophysiology and interactions of the fresh water flora and fauna in relation to abiotic factors; oligotrophic to eutrophic conditions.

**PCB 5327 Coastal Ecosystems and Modeling (3).** Basics of ecology for coastal and wetland ecosystems. The theory and mechanisms of simulation modeling. Hands-on creation and application of computer models in ecological research. Prerequisites: PCB 3043 and MAC 2311 or permission of the instructor.

**PCB 5328 Spatial and Landscape Ecology (3).** Ecological processes with spatial components, including neighborhood interactions, foraging, metapopulations, infectious diseases, invasive species, and habitat associations. Prerequisite: PCB 5423. Corequisites: PCB 5443; MAC 2311.

**PCB 5356L Tropical Ecology Field Lab (3).** Field course in Costa Rica with fieldwork in two or more diverse habitats (rainforest, and dry forest). Emphasis on diversity and interactions between species. Visits to selected sites of deforestation, conservation and restoration.

**PCB 5376 Animal Physiological Ecology (3).** **PCB 5376L Animal Physiological Ecology Laboratory (1).** Evolution-oriented approach to physiological adaptations of animals living in diverse environments. Considers the inter relationship between behavior, energetics, and integrative regulation of metabolism. Prerequisites: PCB 3043; BCH 3033 or CHM 4304.

**PCB 5405 Biochemical Ecology (3).** Principles of chemical communication between diverse organisms and the importance of a variety of allelochemicals in community structure. Prerequisite: Permission of the instructor.

**PCB 5407 Workshop: Microelectrodes in Microbial Ecology (1).** Use of microelectrodes to measure chemical micro-environments and biological processes in natural samples. Hands-on experience with O<sub>2</sub> and pH electrodes. Prerequisite: Permission of the instructor.

**PCB 5415 Advanced Behavioral Ecology (3).** In-depth investigation of the adaptive significance of behavior. Synthesis and discussion of literature and theory pertaining to the strategies and tactics organisms use to survive and reproduce. Prerequisites: Graduate status or permission of the instructor.

**PCB 5418C Advanced Marine Protected Areas (4).** Study of theory and methods for the design and management of Marine Protected Areas including a research project. Prerequisites: BSC 2010 and BSC 2011.

**PCB 5423 Advanced Ecology: Populations and Communities (3).** Advanced analysis of population and community ecology. Prerequisites: PCB 3043 or permission of the instructor or graduate status.

**PCB 5443 Advanced Ecology: Communities and Ecosystems (3).** Advanced analysis of ecological principles pertaining to communities, ecosystems, and landscapes, with special emphasis on the South Florida and Caribbean region. Prerequisites: PCB 3043 or permission of the instructor or graduate status. [A]

**PCB 5596 Workshop: In Situ Hybridization (1).** Analysis of gene expression by in situ hybridization techniques using whole mount and cryosectioned tissues. Prerequisites: Graduate status or permission of the instructor.

**PCB 5615 Molecular and Organismal Evolution (3).** The evolutionary relationships among nucleotides and proteins as well as the processes which yield these relationships. The possible molecular events leading to speciation. Prerequisite: PCB 3063.

**PCB 5616 Applied Phylogenetics (3).** Methods of phylogenetic analysis with a focus on pragmatic applications to ecological and evolutionary studies. Hands-on experience with current computer programs for phylogenetic analysis. Prerequisites: Graduate status or permission of the instructor.

**PCB 5665 Human Genetics (3).** **PCB 5665L Human Genetics Lab (2).** Principles and techniques in the analysis of humans and primates. Prerequisites: PCB 3063 and PCB 3063L, or permission of the instructor. Corequisite: Concurrent registration of lecture with lab course.

**PCB 5677 Evolution and Development (3).** The models and evidence for the interaction of development and evolution, using both plant and animal systems. Prerequisite: Permission of the instructor.

**PCB 5685 Population Genetics (3).** Advanced analysis of gene and genotype frequencies in theoretical populations and analysis of real data. Linkage equilibrium, drift, migration and selection are a few of the topics covered. Prerequisite: PCB 3063.

**PCB 5686 Population Biology (3).** **PCB 5686L Population Biology Lab (1).** Intrinsic properties of natural and theoretical populations and their dynamics and interactions, and responses to disturbance. Includes field problems and computer exercises. Prerequisites: PCB 3063 and PCB 4674, or permission of the instructor.

**PCB 5687 Evolutionary Ecology (3).** **PCB 5687L Evolutionary Ecology Lab (1).** Adaptations and interactions of plants and animals in natural and disturbed habitats. Prerequisite: PCB 3043.

**PCB 5725 Membrane Signal Transduction (3).** Hormones and neurotransmitters as extracellular messengers. Membrane receptors and mechanisms of signal transduction: membrane channels and enzymes, direct linkage and G-protein linkage. Second messengers. Prerequisites: BCH 3033 or CHM 4304.

**PCB 5786 Membrane Physiology (3).** Chemical and physical properties of the plasma membrane, its biosynthesis and functions in transport and signal transduction. Prerequisites: PHY 2048, PHY 2049, BCH 3033.

**PCB 5835 Neurophysiology (3).** **PCB 5835L Neurophysiology (1).** Comparative neurophysiology;

physicochemical mechanisms of resting and action potentials; synaptic transmission; neural coding and integration; sensory-motor function and neurophysiological basis of behavior. Prerequisites: BCH 3033 and MAC 2311.

**PCB 6025 Molecular and Cellular Biology I (3).** Protein structure, catalysis, kinetics, and molecular conformation, intermolecular forces; Prokaryotic recombination, transcription and translation, gene regulation and genome organization. Prerequisite: Graduate status.

**PCB 6027 Molecular and Cellular Biology II (3).** Eukaryotic recombination, transcription, translation, gene regulation and genome organization; Cellular components, cell structure, cell division, cell signaling, development, immunology and cancer. Prerequisite: Graduate status.

**PCB 6176C Biological Electron Microscopy (5).** Principles and techniques of transmission and scanning electron microscopy as applied to biological materials. Lecture-laboratory combination, enrollment limited. Prerequisite: Permission of the instructor.

**PCB 6236 Comparative Immunology (3).** An analysis of the immune systems and mechanisms of invertebrate and vertebrate animals. Prerequisite: Permission of the instructor.

**PCB 6237 Immunogenetics (3).** The impact of classical and molecular genetic analyses on our understanding of the immune response. Prerequisites: PCB 4233 and PCB 3063; or permission of the instructor.

**PCB 6318 Readings in Marine Ecosystems Ecology (1).** Analysis of current literature on theory, data and case studies of marine ecosystem ecology. Prerequisites: Graduate status or permission of the instructor.

**PCB 6417 Workshop: Modeling in Behavioral Ecology (1).** Workshop on modeling techniques used to investigate behavioral ecological questions. Development of models to generate testable predictions in behavioral ecology. Prerequisite: Permission of the instructor.

**PCB 6526 Advanced Molecular Biology (3).** Molecular genetics, controlling mechanisms, recombinant DNA, gene splicing and gene vector construction of viral, bacterial, plant and animal systems. Prerequisite: Permission of the instructor.

**PCB 6617 Advanced Phylogenetics (3).** Current issues and methods in phylogenetics for advanced students. Prerequisites: PCB 5616 or permission of the instructor.

**PCB 6618C Workshop: Parallel Bayesian Phylogenetics (1).** Workshop in the analysis of data to infer evolutionary relationships using Bayesian methods implemented in parallel on a computer cluster. Prerequisite: Permission of the instructor.

**PCB 6675 Evolutionary Biology and Ecology in the Antilles (3).** Introduction to the main ecological features of the Antilles and to the main evolutionary mechanisms behind the unique biodiversity of these islands. Prerequisite: Graduate status.

**PCB 6933 Trends in Neurobiology (2).** Critical analyses and discussions of selected research articles of current interests. Seminar format. Prerequisite: Permission of the instructor.

**PCB 6935 Advanced Topics in Genetics (3).** An intensive study of particular genetical topics not otherwise offered in the curriculum. May be repeated for credit with different subject content. Prerequisite: Graduate status.

**PCB 7235 Reproductive Immunology (3).** Molecular and cellular interactions in early development, ontogenetics, and mother and fetus. Prerequisite: Permission of the instructor.

**PCB 7689 Advanced Topics in Population and Evolutionary Genetics (3).** Comparison of the synthetic and mutational drift hypotheses; relationships between molecular and phenotypic evolutionary rates and the phenotypic effects of various forms of mutation. Prerequisite: Permission of the instructor.

**ZOO 5265 Biology of Crustaceans (3).** **ZOO 5265L Biology of Crustaceans Laboratory (1).** Morphology, physiology, systematics and evolution in crustaceans.

**ZOO 5371 Clinical Anatomy of the Trunk and Limbs (3).** **ZOO 5371L Clinical Anatomy of the Trunk and Limbs Lab (1).** A detailed analysis of the anatomical foundations of kinesiology and physical rehabilitation. Special emphasis will be placed on the functional anatomy of the trunk, pectoral and pelvic limbs with clinical correlations to the major disorders commonly treated by physical and occupational therapists. Prerequisites: ZOO 3731 or ZOO 4733. Corequisite: ZOO 5371L.

**ZOO 5376 Animal Design and Movement (4).** Basic biomechanical and behavioral theories of how animals feed and move. Prerequisites: BSC 2010, and BSC 2011, PHY 2053 and PHY 2054. [D]

**ZOO 5424 Herpetology (3).** **ZOO 5424L Herpetology Laboratory (1).** Biology of amphibians and reptiles from a systematic perspective. The three orders of living amphibians and the six living orders of reptiles are covered in detail. Prerequisites: BSC 2010 and BSC 2011, PCB 3043, or permission of the instructor. Corequisite: Concurrent registration of lecture with lab course.

**ZOO 5456 Ichthyology (3).** **ZOO 5456L Ichthyology Lab (1).** Systematics, structure, function, ecology, and evolution of fishes. Prerequisites: BSC 2010, BSC 2011 and PCB 3043. Corequisite: Concurrent registration of lecture with lab course.

**ZOO 5732 Advanced Anatomy Demonstration (1-4).** Dissection and demonstration of the human body with the emphasis on structure and function. May be repeated to a maximum of eight credits. Prerequisites: ZOO 3733 and ZOO 3733L, or permission of the instructor.

**ZOO 5745 Advanced Neuroanatomy (3).** In-depth knowledge of the embryonic development, structure, and function of the human nervous system with a great deal of clinical consideration. Prerequisites: ZOO 4743 or permission of the instructor.

**ZOO 5746 Comparative Neurobiology (4).** Structure and function of neural systems at many levels including biophysical and cellular mechanisms, molecular processes, neural circuits, development, and anatomy. Prerequisites: BSC 2010 and BSC 2011, CHM 1045 and CHM 1046 and PHY 2048; graduate standing or permission of the instructor.

**ZOO 5785 Advanced Neurobiology (3).** An in depth treatment of the nervous system covering molecular and cellular function, sensory and motor systems, and the neural basis of behavior. Prerequisite: Graduate standing.

**ZOO 5895 Zoo Conservation Biology (1).** Zoo Conservation Biology is a hands-on workshop that examines of the role of zoos in conservation science, conservation action, and conservation education. Prerequisite: Permission of Instructor

**ZOO 6423 Workshop on Reptile and Amphibian Sampling (1).** Biology and sampling methods for reptiles and amphibians. Prerequisite: Graduate status.

**ZOO 6782 Advanced Sensory Systems in Neurobiology (3).** A comparative overview of sensory systems for graduate students, covering environmental stimuli, physical transduction, neural processing, and behavioral responses. Prerequisite: ZOO 5785 or permission of the instructor.

**ZOO 6935 Advanced Topics in Zoology (3).** An intensive study of particular topics not otherwise offered in the curriculum. May be repeated for credit with different subject content. Prerequisite: Graduate status.