DEPARTMENT OF BIOLOGY

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Faculty

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Dr. M. Begonia, Professor
Dr. C. Buckley, Assistant Professor
Dr. J. Cameron, Professor
Dr. H.C. Cho, Assistant Professor
Dr. H. Cohly, Assistant Professor
Dr. E. Cruz-Rivera, Assistant Professor
Dr. S. Ekunwe, Associate Professor
Dr. I. Farah, Associate Professor
Dr. B. Graham-Evans, Assistant Professor
Dr. M. Hardy, Professor
Dr. C. Howard, Associate Professor
Dr. H. Hwang, Professor
Dr. R. Isokpehi, Assistant Professor
Dr. E. Izevbigie, Associate Professor
Dr. R. Kafoury, Associate Professor
Dr. A. Mohamed, Dean Emeritus
Dr. K. Ndebele, Assistant Professor
Dr. D. Sobolev, Assistant Professor
Dr. J. Stevens, Associate Professor
Dr. D. Sutton, Assistant Professor
Dr. P. Tchounwou, Presidential Distinguished Professor
Dr. B. Wilson, Associate Professor

Degree Programs

The Department of Biology offers graduate study leading toward the following advanced degrees:

1. Master of Science in Biology (M.S.),
2. Master of Science in Environmental Science (M.S.), and
3. Master of Science in Teaching (M.S.T.).

The M.S. is research-oriented; the M.S.T. is generally a course-oriented degree. All are designed to satisfy academic requirements for those students intending eventually to seek degree(s) beyond master's or specialist's level.

Programs Objectives

1. To provide academic and practical training of high quality at the master's degree level,
2. To contribute to the pool of biologists qualified to undertake doctoral degree programs, and to obtain employment in industry, government and academic institutions, and
3. To offer a program that will enable environmental science majors to obtain the necessary classroom, laboratory and field experiences required for entering areas in and related to environmental science directly upon graduation.

Admissions Requirements

All applicants seeking admission to the Master of Science program in Biology must meet the following minimum admission requirements:

1. Applicants must meet all the requirements as set forth by the Graduate School (refer to the Division of Graduate Studies' Graduate Admission section, JSU Graduate Catalog),
2. An undergraduate degree in biology or related field. For Environmental Science M.S. program applicants, at least 16 credit hours of biology courses are required,
3. A minimum undergraduate grade point average (GPA) of 3.00 or higher as evidenced by an official transcript,
4. Three letters of recommendation (sent directly to the department), at least 2 from academic professors who can assess the applicant's: a) academic qualifications; b) written and oral communication skills; c) capacity for critical and analytical thinking; and d) overall potential for graduate studies,
5. A Satisfactory Graduate Record Examination (GRE) composite (verbal plus quantitative) score is required.. The GRE score must be sent directly to the department,
6. A Satisfactory Test of English as Foreign Language (TOEFL) required for international applicants
7. A career goal essay (maximum of 800 - 1200 words),
8. Incomplete and late applications (received after the deadlines: March 1 for Fall semester; March 15 for Summer; and October 15 for Spring semester) will not be evaluated.

Transfer of Credits

Course for which transfer credits are sought must have been completed with a grade of "B" or better. Approval is required by the Chair of the Department.

Time Limit

No student will be granted an MS degree unless all requirements are completed within a period of eight (8) consecutive calendar years from the time of admission to the program.

Residence

Students are required to spend one academic year in resident study on the campus. One academic year may include two adjacent regular semesters or one regular semester and one adjacent summer session. To satisfy the continuous residence requirement, the student must complete a minimum of eighteen (18) hours for the required period.

Master of Science in Biology

Courses available for the M.S. degree in Biology provide appropriate preparation for:

1. Biological, marine and environmental sciences,
2. Advanced professional degrees elsewhere in zoology, plant science, marine science, environmental biology, environmental health, toxicology, meteorology, physiology, microbiology, biochemistry, anatomy and other associated areas,
3. Research careers in industry, government and academic institutions, and
4. Professional degrees in medicine, dentistry, veterinary medicine, pharmacy and related health fields.

Degree Requirements

A student seeking the M.S. in Biology degree will be required to complete a minimum of thirty (30) semester hours with a "B" or better average and submit an acceptable thesis. Six (6) of the required credits must be in "Thesis Research". A student will follow a testing schedule consisting of written graduate comprehensive examination and the thesis defense.

Required Courses

Course	Title	Semester Hours
BIO 511	Biostatistics	3
BIO 515	Molecular Biology, *or*	
BIO 540	Cell Biology, *or*	4
CHEM 531	Biochemistry	
BIO 589	Graduate Seminar	1
BIO 599	Thesis Research	6
	Total Hours	14

Elective and Concentration Courses

A student in consultation with his/her advisor and guidance committee must select a minimum of sixteen (16) semester hours from departmental course offerings to complete degree requirements with emphasis in one of the following areas.

Molecular Biology	Developmental Biology
Genetics	Microbiology
Plant Science	Anatomy and Physiology
Environmental Science	Marine Biology
Invertebrate Zoology	

Master of Science in Teaching

The M.S. in Teaching degree provides: (1) M.S.T. at Jackson State University, (2) Advanced certification for teacher education in the biological sciences, (3) Careers in educational administration, and (4) Advanced degrees in science education and related fields.

Degree Requirements

A student seeking the M.S.T. degree may select from one of three programs options, i .e.

1. Thirty (30) semester hours plus an acceptable thesis. Six (6) of the required credits must be in BIO 599-Thesis Research,
2. Thirty-three (33) semester hours plus an acceptable research project. Three of the required credits must be in BIO 587-Independent Study, and
3. Thirty-six (36) semester hours.

Required Courses

Course	Title	Semester Hours
EDFL 511	History and Philosophy of Education	3
PSY 566	Advanced Educational Psychology	3
EDFL 568	Curriculum Methods	3
EDFL 515	Methods of Educational Psychology	3
EDFL 514	Elementary Statistics	3
	Total hours	15
BIO 509	General Genetics	4
BIO 515	Molecular Biology	4
BIO 523	Ecology	4
BIO 589	Graduate Seminar	1
	Total hours	13

*Any student who does not have a Class "A" teaching certificate must also complete the following course requirements for certification.

PSY 305	Adolescent Psychology	3
BIO 401	Biology in Secondary Schools	4
	or	
BIO 505	Biology for Teachers	
EDO 591	Practicum & Student Teaching	9
	Total Hours	16

Elective and Concentration Courses

A student selecting program options No. 2 or 3 in consultation with his/her advisor and guidance committee must select sufficient electives from departmental courses to complete degree requirements with emphasis in one of the following areas.

Molecular Biology	Developmental Biology
Plant Science	Anatomy and Physiology
Genetics	Microbiology
Environmental Science	Marine Biology
Invertebrate Zoology	

Total Required Hours Brought Forward (All Options)		21
Option1:		
BIO 599	Thesis Research	6
	Elective in biology, environment or general sciences	3
	Total Hours	30
Option 2:		
BIO 587	Independent Study	2
	Electives in biology, environment or general sciences	10
	Total Hours	33

Option 3:

Electives in biology, environment or general sciences	15
Total Hours	36

Master of Science in Environmental Science

The M.S. in Environmental Science program provides an education that allows for greater opportunities in employment and further education in the diverse field of environmental science, particularly as the need relates to minorities and women. It also provids a cadre of trained individuals committed to using their environmental literacy toward the betterment of the environment and mankind.

Degree Requirements

A student seeking the M.S. in Environmental Science degree will be required to complete a minimum of thirty (30) semester hours, with a B or higher average and submit an acceptable thesis. Six of the required credit hours must be in Thesis Research. A student will follow a testing schedule consisting of written graduate comprehensive and the thesis defense. It is the student's responsibility to fill out and return all forms at the appropriate times during the student's tenure in the department.

Required Courses

Course	Title	Hours
BIO 506	Human Environments and Natural Systems	4
BIO 511	Biostatistics	3
BIO 523	Ecology	4
BIO 589	Graduate Seminar	1
BIO 599	Thesis Research	6
	Total Hours	18

Elective Courses

A student in consultation with her/his advisor and graduate committee must select a minimum of twelve (12) semester hours from those areas and departments offering appropriate instruction.

BIO 514	Methods in Environmental Analysis	4
BIO 515	Molecular Biology	4
BIO 516	Marine Botany	4
BIO 512	Natural Resources and Conservation	4
BIO 531	Invertebrate Zoology	4
BIO 533	Biology of Water Pollution	4
BIO 534	Ichthyology	4
BIO 540	Cell Biology	4
BIO 546	Selected Topics in Marine/Env Sc	1
BIO 547	Introduction to Oceanography	4
BIO 553	Tropical Marine Ecology	4
BIO 580	Limnology	4
BIO 602	Special Problems in Env Science	1-4
BIO 610	Environmental Microbiology	4
BIO 615	Principles of Bioremediation	3
CHEM 515	Environmental Chemistry	4
ITHM 520 -531	Industrial/Technical Hazardous Materials Management courses	3-6

Course Descriptions

BIO 501 Environmental Science (3 Hours). An introductory course for non-major graduate students dealing with the science of the environment and man's relationships through political, social, economic, and ethical processes.

BIO 506 Human Environments and Natural Systems (3 Hours). Emphasis placed on fundamental problems that confront man from day to day. Topics among others for discussion are ecology, population, energy, food, transportation and land pollution.

BIOL 506 Human Environments and Natural Systems Lab. (1 Hour) Selected laboratory exercises, visiting lectures and field trips are designed to provide a broad view of applications and concepts in environmental science.

BIO 507 Biology for Elementary Teachers. (3 Hours) Prerequisites: None. The application of biological procedures and techniques at the elementary school level with emphasis on selected topics in biology.

BIOL 507 Biology for Elementary Teachers Laboratory. (1 hour) Prerequisite: Bio 101. Laboratory designed to expand and illustrate subject-matter areas stressed in Bio 507.

BIO 508 Fundamentals of Electron Microscopy. (4 hours) Prerequisites: Senior, graduate level, and consent of instructor. To introduce the students to the techniques of electron microscopy so that they may be able to initiate their own biological investigations. Emphasis will be placed on laboratory work.

BIO 509 General Genetics. (4 Hours) Prerequisite; Bio 318. A study of the principal concepts of heredity to include the application of classical and modem genetics.

BIO 511 Biostatistics. (3 Hours) This course is designed for students in biological sciences with no advanced training in mathematics. Basic concepts in statistical methods and experimental techniques and their general applicability in biology will be stressed.

BIO 512 Natural Resources and Conservation (3 hours) A study of our natural resources with emphasis on their origin, properties, use and misuse and good conservation practices.

BIOL 512 Natural Resources and Conservation Lab. (1 hour) Students are involved in the collection of data concerning the use and the analysis of conservation practices for both domestic and public waste, water, and energy resources.

BIO 513 Advanced Human Nutrition. (3 hours) Prerequisites: Bio 233 or 218 and CHEM 241. Review of nutrient sources, requirements and deficiency diseases of man. Emphasis on nutritional metabolism under normal and pathological conditions, and current research.

BIO 514 Methods of Environmental Analysis. (3 Hours) Theory, methods and techniques for identifying and qualifying environmental contaminants. Sampling methods are discussed and some coverage is provided on methods for separation and concentration.

BIO 515 Molecular Biology. (3 Hours) Study of the structure, synthesis, isolation and interactions of macromolecules of biological interest.

BIOL 515 Molecular Biology Laboratory. (1 Hour) Prerequisite: Must be taken concurrently with Bio 515. Laboratory techniques used to purify proteins, DNA, and RNA and the methods used to analyze these macromolecules.

***BIO 516 Marine Botany.** (3 Hours) Prerequisites: Bio 119, Biol 119, Bio 416; open to qualified undergraduates. Survey of seaweeds (marine algae), marine phytoplankton and maritime vascular plants, treating structure, reproduction, life histories, distribution and ecology. Lecture and laboratory to be taken during same semester.

***BIOL 516 Marine Botany Laboratory.** (1 Hour) Prerequisite: Must be taken with lectures in Bio 516. Collection, preservation and preparation and microscopic examination with purpose of emphasizing identification of seaweeds.

BIO 520 Biological Photography. (3 Hours) Prerequisite: Consent of instructor. The course is designed to equip students with the knowledge and expertise to produce high quality prints and slides. Emphasis is placed on laboratory work (darkroom).

BIOL 520 Biological Photography Laboratory. (1 Hour) Laboratory activities give the student experience in exposing and developing black and white films and making prints with various print papers. Must be taken concurrently with Bio 520.

BIO 521 Plant Morphology. (3 Hours) Prerequisite: Bio 119. Study of anatomical, reproductive, ontogenetic and phylogenetic aspects of vascular and non-vascular plants.

BIOL 521 Plant Morphology Laboratory. (1 Hour) Selection of exercises involving the structures, developments and relationships of nonvascular and vascular plants.

BIO 522 Plant Taxonomy. (3 Hours) Prerequisite: Bio 119. Classification and nomenclature of flowering plants; introductory method of collection; laboratory and field studies of representative plant families.

BIOL 522 Plant Taxonomy Laboratory. (1 Hour) Prerequisites: Botany 118, 119. Exercises on collection, . classification and nomenclature of flowering plants.

BIO 523 Ecology. (3 Hours) Prerequisite: Senior standing or consent of instructor. A study of the tropic relationships and energy transfer in ecosystems.

BIOL 523 Ecology Lab. (1 Hour) This lab course is designed to be, and should be, taken concurrently with the Ecology lecture course (BIO 523). The ecology laboratory sessions are structured to reinforce topics discussed in lecture and provide a treatment of technical topics not covered in the lecture. Methods common to the laboratory and field will be taught. Students will 1) gain a deeper, understanding of the main concepts of ecology and ecological processes and 2) develop critical and analytical thinking skills along with reasoning and logical thinking skills, and apply them to ecological -concepts.

BIO 524 Plant Physiology. (3 Hours) Prerequisite: Bio 119. Principal physiological processes of plants including water relation, synthesis, and use of foods and growth phenomena are discussed.

BIOL 524 Plant Physiology Laboratory. (1 Hour) Laboratory exercises will be continued to verify the principles of Plant Physiology.

***BIO 525 Introduction to ' Marine Geology. (1 Hour)** Prerequisites: Bio 408, 408A, or permission of instructor; open to advanced undergraduates. Introductory geology from the marine viewpoint; morphology and origin of ocean basins, plate tectonics, marine sedimentation, coastal features and marine georesources. Lecture and laboratory to be taken during same semester.

***BIOL 525 Introduction to Marine Geology Laboratory.** (1 Hour) Prerequisite: Must be taken with lectures in Bio 525. Field and laboratory exercises in recognition of geological features and specimens, study of techniques, core samples, mapping and marine topographic profiles.

BIO 526 Mycology. (3 Hours) Prerequisite: Bio 119. A survey of the principal fungal classes. Morphology and cytology of fungi and their relation to industry and agriculture.

BIO 528 Evolution. (3 Hours) Prerequisite: Bio 409 or the equivalent. A study of the processes of organic change. Historical developments of the major concepts and mechanisms. (S)

BIO 529 Plant Anatomy. (3 Hours) An introduction to cell division, development, and maturation of the structures of the vascular plants.

BIOL 529 Plant Anatomy Laboratory. (1 Hour) Selection of exercises involving cell division, development and maturation of the structures of vascular plants.

BIO 530 Advanced Microbiology. (3 Hours) Prerequisites: Bio 313; CHEM 242. Special techniques for culturing microorganisms. Includes a survey of some of the important microbes in medicine, industry and public health.

BIOL 530 Advanced Microbiology Laboratory. (1 Hour) Teaches the student special methods in isolating, culturing, and identifying certain microorganisms of medical and industrial importance. Must be taken concurrently with Bio 530.

BIO 531 Invertebrate Zoology. (3 Hours) Prerequisites: Bio 114, CHEM 142. Intended for students who wish to obtain a comprehensive knowledge of the invertebrates.

BIOL 531 Invertebrate Zoology Laboratory. (1 Hour) Prerequisite: Must be taken concurrently With Bio 531 . A taxonomy consideration of the invertebrate fauna. Students are also introduced to empirical observation in such areas as ecology, physiology and behavior.

BIO 532 **Advanced Parasitology.** (3 Hours) Prerequisites: Bio 331; CHEM 142, 242. The physiology of specific parasite and host-parasite

relationships will be studied in great detail. Clinical specimens will be studied.

BIOL 532 Advanced Parasitology Laboratory. (1 Hour) Prerequisite: Bio 331 and/or consent of the instructor, The course will emphasize the experimental approach to Parasitology. Important parasites of man and other animals will be studied from clinical specimens. Must be taken with Bio 532.

BIO 533 The Biology of Water Pollution (3 hours) Biological approaches to water pollution problems is discussed. The effect of pollution on life in aquatic environments is emphasized.

BIOL 533 The Biology of Water Pollution Lab. (1 hour) Selected laboratory exercises, instrument use, and field trips are designed to further enhance the student's awareness in water pollution effects, analysis and problem solving.

BIO 534 Ichthyology. (3 Hours) Prerequisites: Bio 115, Biol 115; open to advanced undergraduates. Biology and classification of marine and freshwater fish; emphasis on identification and collecting. Lecture and laboratory to be taken during same semester.

BIOL 534 Ichthyology Laboratory. (1 Hour) Prerequisites: Bio 115, Biol 115. Must be taken with lecture in Bio 534. Field collecting, sorting, preserving, classification of marine fish; emphasis on identification.

***BIO 539 Marine Microbiology.** (3 Hours) Prerequisites: Bio 313, Biol 313, 416, Biol 416. Open to advanced undergraduates. A survey of the most important marine microorganisms; emphasis on bacteria, sampling techniques, enumeration of indicator organisms, isolation of pathogenic organisms from seafood. Lecture and laboratory to be taken during same semester.

***BIOL 539 Marine Microbiology Laboratory.** (1 Hour) Prerequisites: 313, 416. Must be taken with lectures in Bio 539. Techniques in sampling, isolation, culture and enumeration of pathogenic and nonpathogenic marine microorganisms.

BIO 540 Cell Biology. (3 Hours) Prerequisites: Bio 111, 119 or 121, 313, and CHEM 241. Study of cell anatomy as revealed by electron microscopy. Emphasis on bioenergetics, cell metabolism and current cell research.

BIOL 540 Cell Biology Laboratory. (1 Hour) Prerequisites: Bio 112,119, 313. Must be taken concurrently with Bio 540. Laboratory activities which develop techniques for isolation of cellular organelles and quantitative analyses of biomolecules.

BIO 544 **Arthropod Disease.** (3 Hours) Prerequisites: Bio 115, 427. Emphasis is given to the control and prevention of insect and other arthropod borne diseases, the physiology, taxonomy, life-cycles and ecology of important vectors.

BIOL 544 Arthropod Disease Laboratory. (1 Hour) Study the external structure and make outline sketches to indicate the characteristics used in classification of representative forms and unknown specimens of organisms important to medicine and veterinary science.

BIO 546 Selected Topics in Marine and Environmental Studies. (1-2 Hours) Prerequisites: None; open to advanced undergraduates or others on consent of instructor. Lectures on a broad range of marine and environmental topics of general interest having special application to students in both marine sciences program. No separate laboratory.

***BIO 547 Introduction to Oceanography.** (3 Hours) Prerequisites: Bio 407, Biol 407. CHEM 254 and CHML 254, or consent of instructor; open to advanced undergraduates. Broad view of the marine world, geological, geographical, chemical, physical and biological; field trips aboard research vessels and laboratories introducing applied uses of oceanographic gear, instruments and sampling techniques. Lecture and laboratory to be taken during same semester.

***BIOL 547 Introduction to Oceanography Laboratory.** (1 Hour) Prerequisite: Must be taken with lectures in Bio 547. Introduction to oceanographic gear, its application methodology arid sampling techniques; field work in practical applications.

BIO 550 Immunology and Serology. (3 Hours) The study of antibodies that are elicited in response to antigens and the difference between the protoplasm of one organism and another as reflected in the blood.

BIOL 550 Immunology and Serology Laboratory. (1 hour) Prerequisite: Bio 313 Experimental application of immunology and serology in diagnosis of microbial diseases In vitro and in vivo techniques in immune response will be investigated.

BIO 553 Tropical Marine Ecology (3 hours) Opportunity for practical field exercises in selected tropical environments.

BIO 570 Human Physiology. (3 Hours) Prerequisites: Bio 115, CHEM 242. The study of physiological processes related to the human. The physiological systems to be examined are: gastro-intestinal, renal, endocrine, neural, and reproductive.

BIOL 570 Human Physiology Laboratory. (1 Hour) Selected studies of the physiological processes of mammals with emphasis on man. Must be taken concurrently with Bio 570.

BIO 575 Endocrinology. (3 Hours) Prerequisites: Bio 115, 218; CHEM 142, 242. The basic fundamentals of endocrinology. The role of the endocrine glands and their products (hormones) in the maintenance of a constant internal environment in living organisms.

BIOL 575 **Endocrinology Laboratory.** (1 Hour) Prerequisites: Bio 115, 218; CHEM 142, 242. Must be taken concurrently with Bio 575, or with the consent of .instructor. Experimental analysis of normal and abnormal endocrine functions. Emphasis is placed on basic laboratory techniques employed in the study of endocrine function.

BIO 576 Histopathology. (3 Hours) Prerequisites: Bio 115, 218, and 441. Provides general consideration of the principal concepts of tissues and cellular pathology, with emphasis on human tissues and pathology. The course prepares students for further studies in medicine, dentistry, and allied health fields.

BIOL 576 Histopathology Laboratory. (1 Hour) Exercises studying gross and microscopic diseased tissues and clinical cases.

BIO 580 Limnology (3 hours) Physical and chemical factors affecting the biology of ponds, reservoirs, and streams is presented. A research project in limnology will be required.

BIOL 580 Limnology Lab. (1 hour) Both chemical and biological monitoring of aquatic systems will be explored. Hack kits, conductivity meters, oxygen probes, BOD's, COD's and map surveys will be utilized.

BIO 587 Independent Study. (2 for M.S. students) Prerequisite: Graduate standing in biology. Students will elect a specific topic that is not covered in other biology courses. The student, working independently, will be required to submit a research paper that includes an exhaustive review of literature.

BIO 589 Graduate Seminar. (1 for M.S. students) A course designed for survey of biological literature. The student will be required to prepare and present reports and assigned projects. Required of all students.

BIO 590 Reproductive Physiology. (3 Hours) Prerequisites: Bio 115, CHEM 142, 242. Some prerequisites may be waived with approval of instructor. An advanced assessment of the physiology metabolism and histology of the reproductive system. The etiology of abnormal functions will be presented.

BIOL 590 Reproductive Physiology Laboratory. (1 Hour) Prerequisites: Bio 112, 218, CHEM 142, 242. Must be taken concurrently with Bio 590 or with consent of instructor. Experimental analyses of the mammalian reproductive system. Emphasis is placed on basic methodologies employed in anatomical and physiological studies of the reproductive system.

BIO 591 Advanced Developmental Biology. (3 Hours) Prerequisites: Bio 112, CHEM 242. Current experimental findings in the field of developmental biology will be presented. Theories on the mechanisms regulating differentiation and abnormal growth pattern will be discussed.

'BIOL 591 Advanced Developmental Biology Laboratory. (1 Hour) Advanced laboratory techniques in the field of developmental biology will be presented and analyzed.

BIO 599 Thesis Research, (required for M.S. students) (6 Hours) Thesis representing original research.

BIO 600 Graduate Seminar Advanced topics investigated are presented by students. The student will be required to prepare and present reports and assigned projects. Required of all students.

BIO 601 Environmental Science Seminar Advanced topics of special interest, current research, field trips, demonstrations, and guest lectures in the areas of environmental science, limnology, ecology, water and air pollution, populations, solar energy, earth resources, and others.

BIO 602 Environmental Science Special Problems (4 hours) Each student will select an aspect of the environment beyond the limits of the campus. The student will define the problem, analyze it, and report on his findings and possible solutions. This problem will sometimes include on the job training with an environmental agency.

BIO 609 Advanced Genetics. (4 Hours) Prerequisite: Bio 509. Provides detailed considerations of genetic analysis, quantitative inheritance, chromosomal engineering and some concepts in genetics.

BIO 610 Environmental Microbiology (3 hours) The study of the roles of microorganisms in natural systems with attention given to the examination of nutrient cycles, methods of analysis of microbial biomass and activities as well as the functional roles of microorganisms.

BIOL 610 Environmental Microbiology Lab. (1 hour) Laboratory is designed to acquaint students with modern techniques for measuring microbial biomass and microbial degradative activities of natural and xenobiotic chemicals in natural environments. Specific projects of microbial analysis will be assigned to students.

BIO 615 Principles of Bioremediation (3 Hours) This course uses modern knowledge in life sciences, as well as new developments in biotechnology to address important issues related to environmental clean-up of hazardous wastes. The nature of environmental pollution is reviewed, and basic concepts in molecular biology, biochemistry, and microbiology and plant physiology are applied to demonstrate the significance of bioremediation and phytoremediation in pollution control. Therefore, an emphasis is put on the use of biological methods and processes for the remediation of contaminated soils and water resources.

BIOL 615 Principles of Bioremediation (1 Hour) Laboratory and field experiments conducted to familiarize students and methodologies. Identification and classification of microorganisms, use of bacteria in toxicity assessment, biodegradation of organic contaminants, and phytoremediation of toxic metals are discussed.

BIO 620 Independent Study Students will elect a specific topic that is not covered in other biology courses. The student, working independently, will be required to submit a research paper that includes an exhaustive review of literature.

BIO 621 Advanced Plant Morphology. (4 Hours) Prerequisite: Bio 521. Analysis and morphology of vascular plants ranging from pteridophyta through angiosperms with phylogenetic considerations.

BIO 650 Analysis of Hormone Action. (3 Hours) Prerequisite: Graduate status and consent of the instructor. An analysis of the cellular mechanisms of hormone action. The role of target tissues, receptors, hormone analogs and, metabolic inhibitors in studies of hormone action will be discussed.

BIO 630 Thesis Research. Thesis representing original research.

**These courses (or close equivalents) also may be taken during summers at the Gulf Coast Research Laboratory, Ocean Springs, Mississippi; Dauphin Island Sea Laboratory, Alabama, or other coastal teaching/research laboratory for credit at JSU subject to approval on individual basis by JSU administration and coastal laboratory administrators.*

Doctor of Philosophy
ENVIRONMENTAL SCIENCE

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Faculty
(Interdisciplinary, listed by their Primary Department)
Biology:
Dr. G. Begonia, Professor
Dr. M. T. Begonia, Professor
Dr. H. Cho, Assistant Professor
Dr. E. Cruz-Rivera, Assistant Professor
Dr. I. Farah, Associate Professor
Dr. M. Hardy, Professor
Dr. H. Hwang, Professor
Dr. R. Isokpehi, Assistant Professor
Dr. R. Kafoury, Associate Professor
Dr. A. Mohamed, Professor Emeritus
Dr. A. Patolla, Assistant Professor
Dr. D. Sutton, Assistant Professor
Dr. C. Yedjou, Assistant Professor
Chemistry and Biochemistry:
Dr. Z. Arslan, Assistant Professor
Dr. A. Hamme, Associate Professor
Dr. J. Leszczynski, Presidential Distinguished Professor
Dr. Y. Liu, Professor
Dr. H. Tachikawa, Professor
Dr. H. Yu, Professor
Civil and Environemtal Engineering
Dr. F. Amini, Professor
Dr. Y. Li, Associate Professor
Computer Engineering
Dr. M. Manzoul, Professor
Dr. R. Whalin, Professor
Computer Science
Dr. W. Brown, Associate Professor
Dr. Q. Malluhi, Professor
Dr. L. Moore, Professor
Mathematics
Dr. T. Kwembe, Professor
Dr. R. Gompa, Professor
Physics, Atmospheric Sciences and Geoscience
Dr. Y. Li, Assistant Professor
Dr. S. Reddy, Associate Professor
Dr. Q. Williams, Associate Professor
Technology
Dr. J. Colonias, Professor
Dr. P. C. Yuan, Professor

Program Mission
To produce highly skilled environmental scholars who in turn will provide for policy makers and the general public, scientific and factual information derived from laboratory and field applied research encompassing basic sciences, engineering and technology. As such, it is related to the assessment of water contamination, food contamination, air pollution, global warming, toxic and hazardous substances releases and associated environmental issues; and the development of cost-effective methodologies and strategies to protect the environment and human health.

Program Objectives
1. To provide graduate students with essential knowledge, skills and aptitudes needed for successful careers in environmental science related jobs at various institutions including government agencies, academia and the environmental industry.
2. To protect the environment and human health by educating and training students on the interactions between the various components/ systems of the environment, the complex and fragile nature of the environment, and how to sustain ecosystem integrity and protect human health.
3. To establish applied environmental science research initiatives that will lead to an authoritative base of knowledge concerning the State of Mississippi's environment and natural resources; by assessing and understanding the mechanisms by which physical, chemical, and biological agents generated by nature many cause alterations of ecosystem integrity, disability and diseases in man and other life forms.
4. To develop and understand cost-effective methodologies and means whereby the impact of various environmental pollutants may be prevented and/or controlled, and to integrate important knowledge and technologies in the physical, chemical, biological and social

sciences needed to set policies and guidelines for appropriate utilization and management of vital resources.
5. To render services to the community through outreach programs, technology transfer for the protection of natural resources and the development of the economy, and communication to convey environmental science education to the public.

Admission Requirements

Admission to the doctoral program in Environmental Science is open to persons holding the master's degree in science, technology, engineering, or agriculture; demonstrated satisfactory performance on the Graduate Record Examination (GRE), and the Test of English as Foreign Language (TOEFL) for international students; and acceptable academic records.

All students seeking admission to this Ph.D. Program must meet the following criteria:

1. A Master's degree in natural sciences or related sciences from an accredited university. *An applicant with a Bachelor's degree only may be admitted when that student shows exceptional potential as determined by a GPA of 3.5 or better, a satisfactory GRE, and extraordinary work experience*,
2. A completed program application submitted to the Graduate School,
3. An official score on the Graduate Record Examination (GRE),
4. An overall GPA of 3.25 or above (on a 4.0 scale) on he highest earned degree,
5. Transcripts for all post secondary and graduate work attempted prior to a program application,
6. Recommendations from three major graduate professors knowledgeable of the applicant's professional academic ability, job experiences, and leadership and research potential,
7. Acceptable evidence of a student's writing ability as determined by a writing sample,
8. A satisfactory TOEFL score for international students,
9. A successful interview with the program screening committee, and
10. Recommendation for admission by the program screening committee.

All applications received are reviewed by a standing Environmental Science Doctoral Advisory Committee which recommends acceptance or denial of admission to the Graduate School. The Graduate School officially informs the prospective student of its decision for the University.

Transfer Credits

A maximum number of nine credit hours can be transferred into the Program. Courses for which transfer credits are sought must be at least 700-Level; must have been completed with a grade of B or better; and must be approved by the student's Advisory Committee, the Environmental Science Advisory Committee, the Dean of the School of Science and Technology, and the Dean of the Division of Graduate Studies. Credit for thesis or dissertation research as well as "internship" course work in any form is not transferable.

Time Limit

No student will be granted a doctoral degree unless all requirements are completed within a period of ten (10) consecutive calendar years from the time of admission to the program.

Financial Aid

Graduate research and teaching assistantships are available on a competitive basis to highly qualified students.

Residence

Students are required to spend one academic year in resident study on the campus. One academic year may include two adjacent regular semesters or one regular semester and one adjacent summer session. To satisfy the continuous residence requirement, the student must complete a minimum of eighteen (18) hours for the required period.

Candidacy Requirements

To be admitted to candidacy for the doctoral degree, a student must have:

1. Completed the formal coursework with a GPA of 3.0 or better.
2. Passed the Comprehensive Examination.
3. Filed with the Dean of the Graduate School, the dissertation proposal approved by the student's Advisory Committee, the Program Director and the Academic College Dean.

Degree Requirements

The program requires approximately two years of course work (40 semester hours) and a minimum of twenty (20) semester hours of dissertation research credit beyond the MS degree. The exact program of study will be determined by the student's graduate committee. Additional requirements include:

1. Satisfactory performance on the Comprehensive Examination administered after the student has completed all course work; and
2. Successful defense of the dissertation research. The final basis for granting the degree shall be the candidate's grasp of the subject matter in a specialized area of environmental science, and a demonstrated ability to express thoughts clearly and forcefully in both oral and written languages.

Required Courses

Course	Title	Semester Hours
ENV 700	Environmental Systems	3

ENV 701	Environmental Chemistry	4
ENV 702	Environmental Health	3
ENV 711	Applied Environmental Biostatistics	3
ENV 751	Water Quality Management	3
ENV 755	Air Quality Management	3
ENV 800	Environmental Toxicology	4
ENV 801	Risk Assessment and Management	3
ENV 900	Environmental Science Seminar	2
ENV 999	Dissertation Research	20
	Total Hours	48

In addition to the required courses shown above, the student must complete a minimum of 12 semester hours selected from the elective courses listed below. Other electives in biological sciences, physical sciences, engineering, technology, and public policy will be added as developed.

Elective Courses

Course	**Title**	**Semester Hours**
CSC 700	Computer modeling	3
CSC 800	Image Interpretation	3
MATH 700	Statistics and Experimental Design	3
MET 800	Environmental Meteorology	3
ENV 715	Principles of Bioremediation	4
ENV 717	Introduction to Remote Sensing For Environmental Science	3
ENV 718	Application of Remote Sensing In Environmental Science	3
ENV 721	Solid Waste Management	3
ENV 780	Environmental Epidemiology	3
ENV 802	Environmental Physiology	4
ENV 803	Wetland Ecology	4
ENV 830	Environmental Microbiology	4

The minimum total semester hours required for the doctoral degree is 60.

DESCRIPTION OF COURSES

ENV 700 Environmental Systems. (3 hours). A groundwork of environmental science, environmental awareness and ecological literacy for the incoming Ph.D. students is presented. The environment and its living and non living components, and the interactions of these component areas studied. The course is set in a thermodynamic perspective and is based on a nested hierarchy of systems. Key concepts and principles that govern how we think the environment works are presented while learning how to apply these concepts to possible solutions of various environmental degradation, pollution and resource problems.

ENV 701 Environmental Chemistry. (3 hours). Prerequisites: One year of general Chemistry and one year of organic chemistry. Studies of the basic concepts of environmental chemistry; the nature of chemical compounds; organic and inorganic; chemical reactions; their effects, and fate of chemical species, in aquatic systems. This include: Studies of equilibrium phenomena of acids, bases, salts, complex compounds, and oxidation/reduction reactions. Studies of water pollution, environmental chemistry of water and its properties.

ENVL 701 Environmental Chemistry (1 hour). Experiments done for the purpose of water quality control and assessment, such as the determination of alkalinity, acidity, water hardness, biochemical oxygen demand (BOD), and other important parameters. The laboratory is coordinated to go with the lecture material.

ENV 702. Environmental Health. (3 hours). This course focuses on the impact of environmental problems on human health. Health issues related to water pollution/contamination by physical, chemical and biological agents; wastewater discharges; radiations; air pollution; municipal, and industrial wastes; food contamination; pesticides; occupational hazards; and vector-borne diseases are discussed.

ENV 711 Applied Environmental Biostatistics. (3 hours) Prerequisite: Biostatistics (Bio 511) or equivalent. This course is designed as an applied, advanced biostatistics course for students in the Environmental Science Ph.D. Program. Students will learn how to apply important concepts and principles of environmental biostatistics in the conduct of their research, from the initial designing of experiments to proper data collection and analysis, inferences, interpretation of results in applied terms, reporting and presentation of the results. The statistical computer software (SAS) will be used to analyze and interpret results.

ENV 751 Water Quality Management. (3 hours). This course provides students with basic concepts and principles in Water Quality Management. The effects of organic, inorganic, biological and thermal pollutants/contaminants in various systems of the hydrologic cycle including streams, reservoirs, and estuaries; eutrophication; water quality criteria and standards; monitoring concepts; methods in water quality management; regulatory considerations; and non point source pollution control, are discussed.

ENV 755 Air Quality Management. (3 hours). This course provides students with basic concepts and principles of air quality management. Contaminant classification, pollutant sources, criteria pollutants, health effects, exposure and risk assessment are discussed. Pollutant measurements and air quality assessment techniques are considered with regard to atmospheric effects on dispersion and transport. Identification of, and control strategies for, stationary and mobile sources, and environmental regulations are studied, and indoor air quality considered.

ENV 800 Environmental Toxicology. (3 hours). Prerequisites: ENV 701, ENV 702. This course is designed to provide an overview of the basic principles and concepts of toxicology including : exposure characterization, dose-response relationship, kinetics and distribution of toxicants in a biological system; to understand the fate, behavior and toxicities of xenobiotic chemicals, and the mechanisms by which they affect cells and organs; and to identify the sources and discuss the effects of various groups of

environmental toxicants including heavy metals, pesticides and other industrial byproducts.

ENVL 800 Environmental Toxicology. (1 hour). This course is designed to familiarize the students with important laboratory and field procedures and methods used in toxicological testing of environmental toxicants; and to discuss the strengths and weaknesses of major methodologies including acute, subacute, subchronic and chronic bioassays.

ENV 801 Risk Assessment and Management. (3 hours). Prerequisites: ENV 800, MATH 700. This course is designed to provide students with qualitative and quantitative skills necessary to evaluate the probability of injury, disease and death in humans and other life forms, from exposure to various environmental contaminants. Hazard identification, exposure assessment, dose-response evaluation and risk characterization are emphasized. Regulatory and technical aspects of risk assessment in the promulgation of public and environmental safety standards are discussed.

ENV 900 Seminar. (0.5 hr x 4 semesters =2) (Lecture). This course focuses on contemporary issues in environmental health science. The student is expected to review, discuss, and present orally a report on a topic related to contemporary environmental issues. Topic areas for selection include (but not limited to): environmental biology, environmental chemistry, environmental microbiology, environmental toxicology, atmospheric science, water quality management, solid and hazardous waste management, computer modeling and remote sensing. Students are required to attend all scheduled seminars.

ENV 999 Dissertation Research. (20 hours). Original research in one of several subdisciplines in Environmental Science. Credit per academic session allowable is 1-6 hours. Student must produce, present and defend a document of publication quality.

Elective Courses

CSC 700 Computer Modeling. (3 hours). The purpose of this course is to provide the student with the fundamental knowledge of simulation models, writing programs to generate random numbers from various probability distributions using differential methods, and testing the statistical properties of random number generators. The student will also be trained to write simple programs to simulate real life situation models using GPSS language.

CSC 800 Image Interpretation. (3 hours). This course presents a broad overview of various image processing concepts and techniques. Topics include the history of remote sensing, image digitation, data formats, hardware and software functions, commercial and public available digital processing systems, image preprocessing (radiometric and geometric correction), image enhancement, image classification, change detection, interfaces of remote sensing and geographical information system (GIS), and the future of digital image processing.

MATH 700 Statistics and Experimental Design. (3 hours) Prerequisite: MATH 272. Or 2 semesters of Introductory Statistics. Probability; random variables; expectation of a function of random variables; sampling distribution; estimation; hypothesis testing; designed experiments; completely randomized design; randomized complete block design; Latin square design; factorial experiments; statistical software application to statistical analysis, are discussed.

MET 801 Environmental Meteorology. (3 hours). Principles of atmospheric science as applied to gaussian modeling of pollutants. Includes source review and receptor identification and modeling, National Ambient Air Quality Standards and human health and welfare impacts, plume behavior, and access of EPA models, running of EPASCREEN, and web site information. Special topics covered include: scavenging; acid precipitation; weather modification, green house enhancement; stratospheric ozone; scrubbers; and indoor air quality.

ENV 715 Principles of Bioremediation. (3 hours). This course uses modern knowledges in life sciences, as well as new developments in biotechnology to address important issues related to environmental clean-up of hazardous wastes. The nature of environmental pollution is reviewed, and basic concepts in molecular biology, biochemistry, microbiology and plant physiology are applied to demonstrate the significance of bioremediation and phytoremediation in pollution control. Therefore, an emphasis is put on the use of biological methods and processes for the remediation of contaminated soils and water resources.

ENVL 715 Principles of Bioremediation. (1 hour). Laboratory and field experiments conducted to familiarize students with relevant bioremediation techniques and methodologies. Identification and classification of microorganisms, use of bacteria in toxicity assessment, biodegradation of organic contaminants, and phytoremediation of toxic metals are discussed.

ENV 717 Introduction to Remote Sensing for Environmental Science (3 hours). This course introduces the theory and techniques of remote sensing and their application to environmental analysis. Topics include the concepts of remote sensing; characteristics of spectro-magnetic waves; types of remotely sensed data; sensor types; the theory of photogrammetric techniques; digital image analysis for acquisition of geographical information. Several lab activities involve: learning of basics of ERDAS Imagine; data acquisition through internet search for satellite images; importing datasets, band characteristics and visual presentation.

ENV 718 Application of Remote Sensing in Environmental Science (3 hours). Prerequisite: ENV 717. This course covers the quantitative and applied aspects and analysis of remotely sensed digital data. It is designed to provide an understanding of digital image processing, analysis, and interpretation techniques. Topics include digital data visualization; geometric, radiometric, and atmospheric correction; image enhancement and manipulation; information extraction; digital change detection; integration of GIS

and remotely sensed data, and spatial modeling. Laboratory exercises are in-depth applications of the exercise topics that have been covered in ENV 717, as well as thematic information extraction and change detection.

ENV 721 Solid Waste Management. (3 hours). This course emphasizes on waste control methodologies for both municipal and industrial wastes including hazardous and nonhazardous waste under the Resource Conservation and Recovery Act (RCRA). The students are familiarized with environmental legislation regulating these wastes at state and federal levels. A thorough review is done on waste handling, transport, treatment technologies including chemical, physical, biological and thermal treatments, and disposal options such as land disposal of wastes. Waste minimization techniques such as source reduction and recycling are also discussed.

ENV 780 Environmental Epidemiology. (3 hours) This course is designed to provide students with the basic knowledge and skills required to develop and apply epidemiologic principles and concepts to the study of adverse effects of various environmental factors on both human and ecological health. Emphasis is put on the study of the health effects of physical, chemical and biologic factors in the external environment, broadly conceived from the epidemiologic point of view. As such, it enables students to interpret epidemiological data and understand the approaches used in the epidemiologic investigations of acute and chronic diseases. The course also covers the basic methods and issues involved in epidemiologic investigation of disease conditions in human populations.

ENV 802 Environmental Physiology. (3 hours). This course provides students the basic concepts of homeostasis and adaptation to the environment. Discussions are designed to provide an understanding of the physiological responses to various types of pollutants in The different environmental systems including aerospace, hyperbaric, marine and terrestrial environments. Emphasis is placed on homeostatic responses at cellular, organ and organ system levels to various environmental stresses.

ENVL 802 Environmental Physiology. (1 hour). Laboratory exercises are performed to introduce students to instrumental techniques necessary in the understanding of homeostatic regulatory mechanisms that permit adaptation of organisms to varied and peculiar habitats.

ENV 803 Wetland Ecology. (3 hours). This course is designed to provide scientific knowledge for a better understanding of interactions between biological, physical and chemical components of wetlands. The structure and function of various types of wetlands; their biodiversity, biogeochemistry, and the impact of pollution on their ecological characteristics are discussed. Discussions are also done on how constructed wetlands can be used as water quality enhancers.

ENVL 803 Wetland Ecology. (1 hour). Emphasis is placed on field works designed to evaluate the physical, chemical and biological characteristics of wetlands.

ENV 830 Environmental Microbiology. (3 hours). The general objective of this course is to study the roles of microorganisms in natural ecosystems. Attention is given to the examination of nutrient cycles, methods of analysis of microbial biomass and activities, and the functional roles of microorganisms. In addition, this course offers in-depth examination of the role of microbial processes related to environmental deterioration, its control and remediation, and ultimately its prevention.

ENVL 830 Environmental Microbiology. (1 hour). Laboratory designed to acquaint students with modern techniques for measuring microbial biomass and microbial degradative activities of natural and xenobiotic chemicals in natural environments. Specific projects of microbial analysis will be assigned to students.