

**DEPARTMENT OF BIOLOGY
GRADUATE HANDBOOK & BROCHURE**

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Faculty

Dr. T. Turner, Professor & Chair

Dr. H. A. Ahmad, Professor

Dr. G. Begonia, Professor

Dr. M. Begonia, Professor

Dr. J. Cameron, Professor

Dr. H. Cohly, Associate Professor

Ms. L. Drummond, Instructor

Dr. S. Ekunwe, Professor

Dr. I. Farah, Professor

Dr. B. Graham, Associate Professor

Dr. C. Howard, Associate Professor

Dr. H. Huang, Assistant Professor

Dr. H. Hwang, Professor

Dr. R. Kafoury, Associate Professor

Dr. R. Kulawardhana, Assistant Professor

Dr. G. Miller, Visiting Assistant Professor

Dr. K. Ndebele, Associate Professor

Dr. F. Noubissi, Assistant Professor

Dr. M. Pacurari, Assistant Professor

Dr. A. Patlolla, Assistant Professor

Dr. J. Stevens, Associate Professor

Dr. D. Sutton, Associate Professor

Dr. P. Tchounwou, Presidential Distinguished Professor

Dr. T. Wright, Instructor

Dr. C. Yedjou, Associate Professor

Degree Programs

The Department of Biology in the School of Science and Technology (SST) in the College of Science, Engineering and Technology (CSET) offers graduate studies leading toward the **1) Master of Science (M.S.) in Biology, and 2) Master of Science (M.S.) in Environmental Science degrees**. Both M.S. degrees are research-oriented and designed to satisfy academic requirements for those students intending eventually to seek degree(s) beyond the master'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 and environmental scientists 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 biology and environmental science majors to obtain the necessary classroom, laboratory and/or field experiences required for entering areas in and related to environmental science directly upon graduation.

Admissions Requirements

In addition to the requirements set forth by the Division of Graduate Studies, all applicants seeking admission to the M.S. in Biology and/or M.S. in Environmental Science programs in the Department of Biology must meet the following minimum admission requirements:

1. An undergraduate (B.S.) degree in biology or related field. For M.S. in Environmental Science program applicants, at least 16 credit hours of biology courses are required.
2. A minimum undergraduate grade point average (GPA) of 3.00 or higher as evidenced by an official transcript.
3. Application for admission to JSU Graduate School (<http://www.jsu.edu/gadmapp1/GradAp1.html>)
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 Graduate Record Examination (GRE) composite (verbal plus quantitative) score of 800 is required. For applicants with score below 800, partial credit will be assigned for score of 390 in quantitative or verbal sections. The GRE score must be sent directly to the department,
6. A minimum Test of English as Foreign Language (TOEFL) score of 520 (required for international/foreign students).
7. A career goal essay (maximum of 800 - 1200 words),
8. A complete application package submitted before or on the following deadlines: March 1 for Fall semester; March 15 for Summer; and October 15 for Spring semester. (Incomplete and late applications (received after the deadlines 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 M.S. 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.

Admission to Candidacy Requirements

When approximately 12-15 semester hours have been completed, the student should make application for advancement to candidacy. Please note that students cannot be advanced to candidacy until:

1. All admission requirements have been met.
2. Notification of the program option the student is electing, or that is required.
3. All incompletes ("I" grades) have been removed.
4. The Graduate English Competency Examination (GECE) was passed, or in the event of failure, passed ENG 500 with a grade of B or better.
5. Earned a 3.00 cumulative G. P. A.
6. Filed the Application for Graduate Degree Candidacy with the approval of the Candidacy Committee in his/her major department.

Degree Requirements

A student seeking the M.S. in Biology or M.S. in Environmental Science degree must:

1. Complete a minimum of thirty (30) semester hours, with a B or higher cumulative G.P.A. Six of the required semester hours must be in Thesis Research.
2. Pass the Graduate Area Comprehensive Examination (GACE) in 1 elective and 2 core/required courses.
3. Successfully defend the thesis before the Graduate Committee and public audience.
4. Submit an approved thesis to the Chair of the Department of Biology with one copy to the Department and one to the JSU library.
5. Completion of all departmental requirements.

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, biomedical science, toxicology, genetics, immunology, physiology, microbiology, biochemistry, anatomy and other associated areas, 3) research careers in industry, government and academic institutions, and professional degrees in medicine, dentistry, veterinary medicine, pharmacy and related health fields.

Required Course	Course Title	Semester Hours
BIO 511	Biostatistics	3
BIO 515	Molecular Biology	3
BIOL 515	Molecular Biology Laboratory	1
	or	
BIO 540	Cell Biology	3
BIO 540	Cell Biology Laboratory	1
	or	
CHEM 531	Biochemistry	3
CHML 531	Biochemistry Laboratory	1
BIO 589	Graduate Seminar	1
BIO 599	Thesis Research	<u>6</u>
	<i>Total Hours</i>	14

Elective Courses (Total = 16 semester hours)

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 Biology/Science, Anatomy and Physiology, Environmental Science, Marine Biology, and/or Invertebrate Zoology.

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 provides a cadre of trained individuals committed to using their environmental literacy toward the betterment of the environment and mankind.

Required Course	Course Title	Semester Hours
BIO 506	Human Environments and Natural Systems	3
BIOL 506	Human Environments and Natural Systems Lab.	1
BIO 511	Biostatistics	3
BIO 523	Ecology	3
BIOL 523	Ecology Laboratory	1
BIO 589	Graduate Seminar	1
BIO 599	Thesis Research	<u>6</u>
	<i>Total Hours</i>	18

Elective Courses (Total = 12 semester hours)

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.

Elective Courses

In addition to the required courses shown above, the student must complete a minimum of 16 semester hours (M.S. in Biology) and 12 semester hours (M.S. in Environmental Science) selected from some of the elective courses listed below.

BIO 509	General Genetics	4
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 513	Advanced Human Nutrition	3
BIO 524	Plant Physiology	4
BIO 530	Advanced Microbiology	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/Environmental Science	1
BIO 547	Introduction to Oceanography	4
BIO 550	Immunology and Serology	4
BIO 553	Tropical Marine Ecology	4
BIO 570	Human Physiology	4
BIO 575	Endocrinology	4
BIO 580	Limnology	4
BIO 602	Special Problems in Environmental 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

DESCRIPTION OF BIOLOGY GRADUATE COURSES

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. (3 Hours) Prerequisite; Bio 318. A study of the principal concepts of heredity to include the application of classical and modern 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.

***BIOL 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 517 Introduction to Remote Sensing for Environmental Science. (3 hours) Prerequisites: Phy201, 202, Math 111, 115, 231. 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 spectromagnetic 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 & visual presentation.

BIO 518 Application of Remote Sensing in Environmental Science. (3 hours) Prerequisite: Bio 517. This course covers the quantitative and applied aspects and analysis of remotely sensed digital data. This course 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 were covered in Bio 417/517 as well as thematic information extraction and change detection.

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: Bio 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 the 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 the 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 and 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 617 / BIOL 617 (Introduction to Remote Sensing for Environmental Science) (4 hours) Prerequisites: Phy 201, 202, Math 111, 115, 231. 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 spectromagnetic 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 & visual presentation.

BIO 618 Application of Remote Sensing in Environmental Science. (3 hours) Prerequisite: Bio 617)

This course covers the quantitative and applied aspects and analysis of remotely sensed digital data. This course 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 were covered in Bio 617 as well as thematic information extraction and change detection.

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.

*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.