
Biology

Faculty and Fields of Interest

Biology Major

BS degree

The biology major provides opportunities for building the foundation of a career in one of the many specialties in private industry and in federal and state agencies which employ biologists.

Students planning to enter graduate school should, in consultation with their advisor, strongly consider electing a foreign language, analytic geometry, and calculus. For those students interested in pursuing such broad fields of study as ecology, courses which stress computer literacy and database management are good foundation courses. Students looking toward such disciplines as cell and/or molecular biology and developmental biology should take genetics, molecular and cell biology, and biochemistry.

Modern biology requires a wide range of supporting courses in such other fields of study as statistics, computers, physics, chemistry, electronics, meteorology, and geology. Student biology majors should consult with their advisors early in their program of study as to possible career choices and plan to take appropriate elective supporting courses for their selected field of study.

Richard C. Connor marine mammal biology

Debra J. Ellis microbial and molecular ecology, soil biogeochemistry, biotechnology

Marta Concha Frisardi molecular genetics of parasites

Robert Griffith environmental physiology, vertebrate anatomy and physiology

Frederick Y. Kazama microbiology, cell biology, organismal biology

Palma Longo science education

Barton M. Matsumoto entomology, statistics

Donald J. Mulcare developmental biology, gerontology, embryology

Nancy J. O'Connor invertebrate biology, marine ecology, biology of marine larvae

Dorothy Read (chairperson) molecular biology, bacterial genetics, biotechnology

Jefferson Turner biological oceanography, marine plankton, biogeography

Students may prepare for admission to medical, dental, and veterinary colleges and for admission to graduate work in the life sciences. Increasing numbers of students elect to major in biology as a means of providing themselves with a general framework of ideas concerning the interactions of living things. A substantial number of these students proceed toward vocational objectives that do not require a specialist's knowledge of biology.

Biology Major

Marine Biology Option

The marine biology option is designed to meet the needs of students who aspire to careers in ecology, marine biology, fisheries biology, and biological oceanography. Students who elect the Marine Biology Option are urged to plan their program in close cooperation with their advisors. Biology majors who choose the marine biology option have an opportunity to elect marine-oriented courses during their junior and senior years and must meet college degree requirements for the BS degree.

Requirements

First Two Years

(common to both options)

Semester Credits

First Year

BIO 121, 131	Biology of Organisms I with Lab	4	
BIO 122, 132	Biology of Organisms II with Lab		4
CHM 151, 152	Principles of Modern Chemistry	3	3
CHM 161, 162	Introduction to Applied Chemistry	1	1
ENL 101, 102	Critical Writing and Reading	3	3
MTH 101, 102*	Elements of College Mathematics	3	3

First Second

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* Math course to be selected in consultation with the advisor. MTH 111, 112 (Calculus) is recommended for students whose math background is good, and required for later entrance to graduate programs with a molecular orientation. It is also a prerequisite for Physical Chemistry. MTH 111, 112 is required for PHY 113, 114 but can be taken concurrently with it.

Second Year

BIO 210, 211	Biology of Populations with Lab		4
BIO 234, 244	Biology of Cells with Lab	4	
CHM 251, 252	Organic Chemistry	3	3
CHM 263, 264	Bio-organic Chemistry Lab	1	1
PHY 101, 102**	Introduction to Physics	3	3
	Humanities/Social Science Electives	6	6

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** PHY 113, 114 may be substituted for PHY 101, 102.

Junior/Senior Electives for Marine Biology Option

Eighteen credits should be elected from upper-division biology courses. At least 12 of these credits must come from the following list of courses.

BIO 317	Biology of Invertebrates
BIO 413	Biology of Fishes
BIO 414	Biology of Marine Mammals
BIO 416	Biology of Algae
BIO 424	Biology of Animal Parasites
BIO 429	Aquaculture
BIO 454	Biology of Sharks
BIO 471	Marine Microbiology
BIO 526	Marine Benthic Ecology
BIO 531	Advanced Ichthyology
BIO 536	Estuarine Ecology
BIO 545	Biological Oceanography
BIO 546	Biology of Marine Larvae

Third and Fourth Years

(common to both options)

Course selection for the third and fourth years of the biology major must be determined in consultation with an advisor. During the third and fourth year all majors are required to elect at least 18 credits in upper-division biology courses (courses numbered 300 or higher). Upper-division courses in physics, chemistry, engineering, or mathematics may be substituted with the written approval of the advisor and the department chairperson prior to registration in the course. A maximum of 3 credits in biology proseminar may be included in the 18 credits. The requirements of the College of Arts and Sciences must also be met prior to graduation.

Students who have completed the first two years of the biology major may elect to concentrate in courses dealing with the ecology of the coastal zone, its estuaries and inshore waters.

General Education Departmental Requirements

Students majoring in Biology will meet their departmentally-controlled General Education requirements as follows:

Area E: Students may choose a course from the approved list

Area I, Tier 2: Satisfied by BIO 210, 211

Area W, Tier 2: Satisfied by BIO 234

Area O: Students may take any two of the following: BIO 321, 413, 422, 471

Biology Courses

BIO 101 three credits **S**

General Biology I

3 hours lecture

An introductory human biology course emphasizing energy flow and the function of cells and molecules, basic genetics, and selected aspects of human physiology.

BIO 102 three credits **S**

General Biology II

3 hours lecture

Prerequisite: BIO 101 or permission of instructor

Continuation of introductory biology with emphasis on the reproduction and genetics of organisms, their evolution, behavior, and interactions within ecosystems.

BIO 103 three credits **S**

Topics in Biology

3 hours lecture

Prerequisite: BIO 101 or permission of instructor

Study in specific areas of biological science such as human genetics, microbes, and the insect world. Not offered for credit to biology majors.

BIO 105, 106 three credits each **S**

Readings In Modern Biology I, II

Selected books and articles for the general public by scientists and science writers on ideas and research in modern biology. This is a course for non-majors focusing on two or three topics of current interest to biologists: evolution, human evolution, the human brain, genetics and the human genome project interaction of biology and society, and biodiversity. Other topics will be introduced as new books appear. Students will learn how to use the World Wide Web and library in preparing a term project in an area of personal interest.

BIO 111 four credits **S**

Introduction to Human Physiology

4 hours lecture

Introduction to the general physiological principles involved in human body functions with homeostasis as the unifying theme. Not offered for credit to biology majors.

BIO 112 three credits **S**

The Ocean Environment

3 hours lecture

The study of the ocean environment as an integrated ecosystem: The biology of marine organisms and the related physical, chemical, and geological processes of the sea with attention given to the exploitation of marine resources and pollution. Not offered for credit to biology majors.

BIO 113 three credits **S**

The Darwinian Revolution (Honors)

An analysis of the claims, evidence, and methods of Darwinian evolutionary biology based upon an examination of Darwin's *On the Origin of Species* (1st ed., 1859).

BIO 121, 122 three credits each

Biology of Organisms I, II

3 hours lecture

The first course for biology majors is an introduction to structure, function, and behavioral adaptations in the world of living organisms. During the initial half of this two semester course cell origin, structure and chemistry, basic cellular physiology, and genetics are emphasized. The second semester covers the diversity and evolutionary relationships of living organisms, culminating in an in-depth study of a selected ecosystem. Pre-professional aspects are emphasized during both semesters for the biology major student. Field experiences, writing, and problem-solving are integrated into the course work.

BIO 125 three credits **S**

Horticulture

Integrates applied aspects of horticulture (plant propagation, cultivation, landscaping styles, soils, plant materials) with inquiries into the basic structure, reproduction, and other life processes of plants. Work in the greenhouse provides an opportunity to put theoretical questions and topics into practice. Students will develop a sense of the value of plants and gardens in current society; an understanding of horticulture and its relationship to science, technology and arts; and the confidence to work successfully with plants, gardens, and landscapes.

BIO 131, 132 one credit each

Biology of Organisms Laboratory I, II

1 hour laboratory lecture, 2 hours laboratory

The biology of organisms laboratory courses cover two semesters and are designed to provide the student with hands-on experience in investigative techniques and problem-solving. Students work closely with faculty and staff in specialized laboratory investigations in various biological disciplines.

BIO 154 three credits

Fundamentals of Biology

3 hours lecture

Prerequisite: Nursing major

Specifically designed to meet the needs and schedule of the nursing major, covering the breadth of biology in one semester. The

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ideology and approach of the biological sciences, the chemical and physical foundations of living systems, energy transformations, the origin and diversity of life, Mendelian and molecular genetics, evolution, and population and community ecology.

BIO 210 three credits

Biology of Populations

3 hours lecture

Prerequisites: BIO 121, 122, 131, 132

An introduction to the biology of groups of individuals of the same specific kind as units of evolutionary and ecological change: the characterization, origin, and maintenance of phenotypic and genetic variety and the selective and chance processes that shape this variation and effect adaptation, speciation, and the observed geographical and temporal distributions of different kinds of organisms.

BIO 211 one credit

Biology of Populations Laboratory

3 hours laboratory

Corequisite: BIO 210

Experimental approaches to selected topics in population biology are investigated by linking observations on laboratory populations with expectations generated by student-designed computer simulations using BASIC programming. Topics include selection, genetic drift, heritability, and spatial and temporal dispersion patterns.

BIO 216 three credits

Biology of Aging

3 hours lecture

Prerequisite: BIO 101 or equivalent

Presents the biological background to the aging process. This will include a description of the theories of aging and the developmental and physiological changes that occur throughout the aging process. Science elective for Liberal Arts students, free elective for Biology majors. Cross-listed as GRT 216.

BIO 221 three credits

Anatomy and Physiology I

3 hours lecture

Prerequisite: BIO 101

A systematic study of the human body emphasizing structural and functional relationships. Topics include cellular activity and tissue organization. The skeletal, muscular, and cardiovascular morphology and function are presented.

BIO 222 three credits

Anatomy and Physiology II

3 hours lecture

Prerequisite: BIO 221

Continuation of BIO 221. Study of the structure and function of the respiratory, digestive, nervous, urinary, endocrine, and reproductive systems.

BIO 223 one credit

Anatomy and Physiology Laboratory I

1 hour laboratory lecture, 2 hours laboratory
Emphasis is placed on methods of measuring physiological processes. Study of body structure is accomplished by dissection of animal specimens and by use of tissue materials.

BIO 224 one credit

Anatomy and Physiology Laboratory II

1 hour laboratory lecture, 2 hours laboratory
Prerequisite: BIO 223
Continuation of BIO 223.

BIO 234 three credits **W**

Biology of Cells

3 hours lecture

Prerequisites: two semesters Chemistry (concurrent enrollment or credit in Organic Chemistry recommended)

A study of energy transformations, gene expression and regulation, and the function of cells and their organelles. The course emphasizes how function follows structure, particularly at the level of macromolecules.

BIO 244 one credit

Biology of Cells Laboratory

1 hour laboratory lecture, 2 hours laboratory
Corequisite: BIO 234
A laboratory course emphasizing the biochemical, spectroscopic, and microscopic procedures necessary to study cell function.

BIO 251 three credits

Medical Microbiology

3 hours lecture

Prerequisites: BIO 154, CHM 101, 102; open only to students enrolled in the College of Nursing, except by special permission of instructor

Fundamentals of microbiology are presented to prepare students interested in health science field. Topics include basic microbiology, control of microorganisms, host resistance, and pathogenic microorganisms.

BIO 261 one credit

Medical Microbiology Laboratory

Prerequisite: BIO 154, CHM 101, 102
Corequisite: BIO 251

Exercises in microbiological principles and techniques, such as microscopy, staining, growth and quantitation of microbial

cultures, and identification of microorganisms by biochemical and other tests.

Intended to accompany and illustrate BIO 251 Medical Microbiology.

BIO 298 one to six credits

Experiential Learning

Prerequisites: At least sophomore standing; permission of the instructor, department chairperson, and college dean
Work experience at an elective level supervised for academic credit by a faculty member in an appropriate academic field. Terms and hours to be arranged. Graded CR/NC. For specific procedures and regulations, see section of catalogue on Other Learning Experiences.

BIO 314 four credits

General Ecology

3 hours lecture, 3 hours laboratory
Prerequisites: Biology core; MTH 101, 102; CHM 151, 152, or permission of instructor
The principles and practices of the scientific discipline of ecology. Interactions among organisms and between organisms and their environment will be emphasized. Interactions will be described and analyzed at the organismal, population, community, and ecosystem levels. In the laboratory, students will use hypothesis-testing and experimentation to examine theoretical and empirical aspects of ecology.

BIO 316 three credits

Descriptive Oceanography

3 hours lecture

Prerequisites: Biology core, or permission of instructor

An introduction to the field of oceanography. Physical, chemical, geological, and biological aspects are emphasized to provide a basic foundation for further work in biological oceanography.

BIO 317 four credits

Biology of Invertebrates

3 hours lecture, 1 hour laboratory lecture, 3 hours laboratory

Prerequisites: BIO 121, 122

This course presents an intensive survey of the taxonomy and functional morphology of the major invertebrate phyla, with special reference to adaptations of the intertidal marine invertebrates of the North Atlantic coast. Field trips to the diverse habitats of the area constitute an integral part of the laboratory.

BIO 318 four credits

General Entomology

3 hours lecture, 1 hour laboratory lecture, 2

hours laboratory

Prerequisites: BIO 121, 122

Introductory survey course in the study of insects. The taxonomy of families will be emphasized in lectures. Studies will also include the structure, habits, physiology, and ecology of insects. During some laboratories, field trips will be conducted.

BIO 320 four credits

Embryology

3 hours lecture, 3 hours laboratory, 1 hour laboratory lecture

Prerequisite: Biology core

A description of reproductive and embryological principles, followed by a study of typical vertebrate and invertebrate embryology. The organogenesis of the major vertebrate systems will be described. The laboratory will include the microscopic study of vertebrate embryos and the observation of the development of selected living vertebrate and invertebrate embryos.

BIO 321 four credits **O**

General Microbiology

3 hours lecture, 1 hour laboratory lecture, 3 hours laboratory

Prerequisite: Biology core

The nature and diversity of microorganisms. Special emphasis is placed on bacterial cytology, nutrition, physiology, and growth. Topics on the significance of microorganisms in the environment and the evolutionary relationships of microorganisms are included.

BIO 322 four credits

Medical Anatomy and Physiology

3 hours lecture, 3 hours laboratory

Prerequisites: Biology core; BIO 221, or permission of instructor

Detailed study of the structure and function of the human body concentrating on the cardiovascular, immune, respiratory, digestive, urinary, and reproductive systems with an emphasis on clinical applications. Lectures coincide with BIO 222 but exams and assignments are separate. Independent laboratory projects allow students to research, design, and execute experiments in anatomy and physiology.

BIO 333 four credits

General Genetics

3 hours lecture, 1 hour laboratory lecture, 3 hours laboratory

Prerequisite: Biology core

Introduction to the science of heredity. The lectures present an integrated concept of the gene provided from the study of Mendelian and molecular genetics. Selected

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topics in quantitative inheritance, and human genetics are included.

BIO 350 four credits

Survey of Plant Kingdom

3 hours lecture, 1 hour laboratory lecture, 3 hours laboratory and field trips
Prerequisite: One year of Biology of Organisms or equivalent

The phylogenetic relationship among members of the plant kingdom, with an emphasis on evolutionary trends among plant groups rather than on individual plant species. Toward this goal the cytology, anatomy and morphology of monerans through the angio-sperms will be covered. Representatives of most groups will be studied in the laboratory and some will be observed in their natural habitats during two field trips.

BIO 370 four credits

Animal Physiology

3 hours lecture, 1 hour laboratory lecture, 2 hours laboratory

Prerequisites: Biology of Cells (or equivalent); Organic Chemistry
A study of the general principles of animal physiology integrating molecular, cellular, organ system, and whole organism approaches. The accompanying laboratory will provide skill in the techniques used in animal physiological investigations.

BIO 411 one to three credits

Proseminar: Current Topics in Biology

1 to 3 hours
Students with senior standing (or others with consent of the instructor) report on and discuss current biological problems as presented in principle journals, abstracts and reviews. The work of each seminar is usually built upon a single unifying content area.

BIO 413 four credits **O**

Biology of Fishes

3 hours lecture, 1 hour laboratory lecture, 3 hours laboratory

Prerequisites: BIO 121, 122
Field trips and extensive laboratory work are emphasized in this course. The life histories, ecology and classification of the fishes of the coastal and inland waters of the northeastern states are studied in detail.

BIO 414 three credits

Biology of Marine Mammals

Prerequisite: Biology core
Biology of marine mammals, including cetaceans (whales and dolphins), pinnipeds (seals, sea lions, and walruses), sirenians

(dugongs and manatees), and sea otters. Fossil, anatomical, physiological, life history, behavioral, and ecological evidence is marshalled to explore marine mammal adaptations for reproduction, feeding, locomotion, diving, thermoregulation, communication, and sensing their environment.

BIO 415 four credits

Comparative Vertebrate Anatomy

3 hours lecture, 1 hour laboratory lecture, 2 hours laboratory

Structure and phylogeny of vertebrates. Laboratory work illustrates evolutionary trends and specializations.

BIO 416 four credits

Biology of Algae

3 hours lecture, 1 hour laboratory/lecture, 3 hours laboratory

Prerequisite: One year of Biology of Organisms or equivalent
The freshwater and marine algae of the northeastern United States, surveyed with an emphasis on their taxonomy, evolution and ecology. The laboratory focuses upon the identification, morphology and ecology of all major algal groups. Extended field trips into Buzzards Bay, Vineyard Sound, and the north shore are an integral part of the course.

BIO 419 four credits

Biological Scanning Electron Microscopy

1 hour lecture, 6 hours laboratory
Prerequisite: Permission of instructor
Theory and techniques of scanning electron microscopy, including optical theory, photographic darkroom techniques, and specimen preparation. Students will be expected to complete a project, the results of which will be presented in written and finished photographic form.

BIO 420 three credits

Animal Behavior

Prerequisite: Biology core
The study of comparative and evolutionary aspects of behavior of invertebrate and vertebrate animals. Structure and function of nervous systems, simple behavioral patterns including reflexes and other forms of innate behavior as well as more complex patterns including learning and social behavior are stressed.

BIO 421 four credits

Developmental Biology

3 hours lecture, 1 hour laboratory lecture, 3 hours laboratory

Prerequisite: Biology core, especially biology of cells

The molecular, cellular and morphogenetic aspects of embryology, organogenesis and other developmental phenomena of animals are considered in the lecture. Some aspects of plant development are discussed. The laboratory includes experiments that demonstrate the morphogenetic activities of the cell. Students are encouraged to design their own experiments.

BIO 422 three credits **O**

Immunology

3 hours lecture

Prerequisites: BIO 234 or equivalent, CHM 251

Molecular and cellular basis of immune phenomena with emphasis on experimental foundations of current models. Differentiation of T and B lymphocytes, cell-cell interactions, antibody structure and function with underlying genetic rearrangements, mechanisms of resistance to disease and immune dysfunction, including AIDS. Understanding of research techniques and research process is promoted.

BIO 424 four credits

Biology of Animal Parasites

3 hours lecture, 1 hour laboratory lecture, 2 hours laboratory

An introductory course in parasitology emphasizing the more important protozoan, helminth, and arthropod parasites of medical, veterinary, and marine significance. Laboratory exercises include practical and experimental techniques.

BIO 427 three credits

Molecular Biology

3 hours lecture

Prerequisites: BIO 234, 244

The methods and research that support models of cell function at the molecular level. This three credit lecture course will present current advanced research methods in molecular biology—those used to study the expression and regulation of genes, and the laboratory research on the macromolecules involved. Students will read and paraphrase current literature in the field of molecular biology.

BIO 428 three credits

Evolutionary Ecology

Prerequisite: BIO 314, 420 or 437

Natural selection theory applied to diverse problems in evolutionary biology including the levels of selection, adaptation and optimality models, kin selection, recognition systems, cooperation and altruism among

non-relatives, co-evolution, mutualism and parasitism, specialization, sex ratio evolution, genetic conflicts, the evolution of sex, sexual selection, parental care, life history evolution, game theory and animal contests, group living and social organization in birds and mammals.

BIO 429 four credits

Aquaculture

3 hours lecture, 3 hours laboratory

Prerequisites: Biology core, BIO 314, BIO 317, BIO 413, or BIO 416, or permission of instructor

The study of aquaculture in a global context with emphasis upon a few selected forms to serve as working models. The course includes a consideration of both theoretical and practical aspects of aquaculture.

Whenever possible, the laboratory work will emphasize hands-on experience in laboratory and field aquaculture techniques. A student team approach will initiate, develop and/or maintain an aquaculture project.

BIO 430 four credits

Introduction to Biological Statistics

3 hours lecture, 1 hour laboratory lecture, 2 hours laboratory

Prerequisite: MTH 101, 102 or equivalent, upper division biology standing

Statistical concepts for the planning of experiments and the summarization of numerical data. Lectures emphasize probability, testing of hypothesis and the application of different, statistical concepts and problems.

BIO 435 three credits

Methods and Materials for Secondary School Teachers of Biology

Free elective credit only

This course is designed for future teachers of biology. The course emphasizes modes of inquiry, methods of research and experimentation, and teaching strategies. MAT graduate students take this course as BIO 635.

BIO 437 three credits

Evolutionary Biology

3 hours lecture

Prerequisites: Biology Core

An overview of contemporary evolutionary biology with an emphasis on evolutionary processes. A non-introductory study of the interplay in time and space of genetic variety, ecological opportunity, and chance resulting in the evolutionary change in groups of organisms.

BIO 438 one credit

Evolutionary Biology Laboratory

3 hours laboratory

Prerequisites: Biology Core

Corequisite: BIO 437

Computer models of aspects of evolutionary processes will be designed. The models will selectively address problems in such areas as selection and polygenic inheritance, genetic drift, concerted evolution in multigene families, differentiation of protein-coding nucleotide sequences, molecular clocks, sex, stochastic processes in macroevolution and wild animal conservation genetics. A Biology of Populations-level (BIO 211) knowledge of BASIC programming is expected.

BIO 440 two credits

Research Project

Hours will be arranged.

An advanced research project in an advanced student's field of general interest conducted under the supervision of an appropriate staff member, in the form of independent research leading to the solution of a problem.

BIO 441 two credits

Research Project

Continuation of BIO 440.

BIO 442 three credits

Advanced Genetics

3 hours lecture

Prerequisite: BIO 337 or 333

A historical perspective of the concepts leading to the present theory of gene structure and function. The rigorous experimental evidence supporting this synthesis is reviewed by extensive reading and discussion of original publications. Particular emphasis is placed on papers published since 1940 and having direct bearing in elucidating the structure and function of the gene.

BIO 452 three credits

Virology

Prerequisites: BIO 234, 244 or permission of instructor

Nature of the virus as both an evolutionary entity and an obligatory cellular parasite. The structure and replicative strategies of representative viruses are studied. The approach is molecular and stresses the interaction of the viral genome with cytoplasmic and nuclear elements of the host cell.

BIO 454 three credits

Biology of Sharks

Prerequisite: Permission of instructor

The morphology, physiology, behavior and

evolutionary history of the most ancient group of living jawed fishes. The most unusual aspects of these fish, such as modes of reproduction, osmotic regulation, feeding mechanisms, and sensory physiology, will be stressed throughout.

BIO 471 four credits

O Marine Microbiology

3 hours lecture, 1 hour laboratory lecture

Taxonomy, physiology, and the role of heterotrophic microorganisms in the marine environment. The viruses will also be considered. Emphasis will be placed on the activities of the viruses, bacteria, and the fungi in the marine environment in the laboratory, exercises will be conducted on the methods of enumeration, detection of selected physiological groups, uptake and deputation of microorganisms by shellfish, marine biodeterioration, and the influence of environmental parameters on the growth and activities of marine microorganisms.

BIO 495 three credits

Independent Study

Prerequisites: Upper-division standing; permission of instructor, department chairperson, and college dean
Study under the supervision of a faculty member in an area not otherwise part of the discipline's course offerings. Terms and hours to be arranged.

BIO 196, 296, 396, 496 three credits

Directed Study

Prerequisites: Permission of the instructor, department chairperson, and college dean
Study under the supervision of a faculty member in an area covered in a regular course not currently being offered. Terms and hours to be arranged.

Note: Some graduate courses may be open to undergraduates. Please consult your department chairperson. See the *Graduate Catalogue* for graduate general and program requirements.

Graduate Courses in Biology

BIO 510 four credits **Marine Biotechnology**

Designed for persons who wish to participate in research and development within biotechnology. This course features extensive hands-on laboratory work with current techniques and experimental approaches, integrated with an exposition of the principles underlying the techniques.

BIO 511 one to four credits **Graduate Seminar in Biology**

1 to 4 hours in varied formats
Selected topics in Biology. In recent years these have included physiology and biochemistry of marine animals, evolutionary ecology, biology of marine mammals, morphometrics and phylogenetic systematics, and extremophiles.

BIO 513 four credits **Biology of Fishes**

See BIO 413.

BIO 514 three credits **Biology of Marine Mammals**

See BIO 414.

BIO 516 four credits **Biology of Algae**

(Formerly BIO 515)
See BIO 416.

BIO 518 three credits **Biogeography**

Prerequisite: Senior or graduate standing
The study of present and past global distributions of plant and animal taxa in terrestrial, marine and freshwater habitats. Distributional patterns will be considered in relation to changes of the physical environment over geological time, such as in global patterns of climate and resources. The evolution of recent association of organisms will also be examined in relation to ecological interactions between organisms, such as competition and predation.

BIO 520 three credits **Animal Behavior**

See BIO 420

BIO 524 four credits **Biology of Animal Parasites**

See BIO 424.

BIO 525 one credit **Graduate Student Seminar**

Prerequisite: Graduate status

Each student will present a seminar related to the current semester's theme and based on several contemporary publications. Students are responsible for preparing a comprehensive bibliography, an abstract, and evaluations of peers' seminars. (One semester required; maximum two credits towards MS degree.)

BIO 526 four credits **Marine Benthic Ecology**

3 hours lecture, 3 hours laboratory
Prerequisite: Graduate standing or permission of instructor
An advanced overview of the structure and function of marine benthic communities from the intertidal zone to the deep sea, focusing on the power of experimental studies in elucidating ecological processes. Students will improve writing skills via preparation of short research proposals, a term paper, and through peer review of other students' work. Students will also lead discussions of journal articles, and plan, undertake, and present the results of a field biofouling study.

BIO 527 three credits **Molecular Biology**

See BIO 427. In addition, graduate students will present two typical reviews of current problems in molecular biology, both as written expositions and as interactive lecture presentations to other class members. Pre- and post-presentation interviews with the instructor are also required.

BIO 528 four credits **Evolutionary Ecology**

See BIO 428

BIO 530 four credits **Introduction to Biological Statistics**

See BIO 430

BIO 531 four credits **Advanced Ichthyology**

3 hours lecture, 3 hours laboratory
Prerequisite: Graduate standing or consent of instructor
Studies of fish phylogeny and classification, physiological problems peculiarly faced by fish, and aspects of fisheries' hydrography. The laboratory stresses independent work on the structure of fish populations, measurement of physiological parameters, and morphometric analysis.

BIO 535 four credits **Analysis of Biological Data**

3 hours lecture, 2 1-1/2 hour laboratory meetings

Prerequisite: Introduction to biological statistics or equivalent
The processing and analysis of biological, and especially ecological data. Topics include problems encountered in processing and handling of data, distributions and transformations, associations, computer simulations, parametric and non-parametric methods, and usefulness and limitations of multivariate methods.

BIO 536 four credits **Estuarine Ecology**

3 hours lecture, 3 hours laboratory
Prerequisite: Graduate standing or permission of instructor
An overview of biological, geological, physical, and chemical factors and processes important for organisms in estuarine environments. Emphasis is on contemporary research areas, including human impacts in estuaries. Students will design, perform, analyze and present the results of semester-long field projects characterizing a local salt-marsh ecosystem.

BIO 537 three credits **Evolutionary Biology**

See BIO 437.

BIO 538 one credit **Evolutionary Biology Laboratory**

See BIO 438.

BIO 545 four credits **Biological Oceanography**

3 hours lecture, 3 hours laboratory
Prerequisite: BIO 316 or permission of the instructor
The cycle of productivity in the marine environment and the physiological and morphological adaptations of plant, animal and bacterial populations within various oceanic regions. Interrelationships of the plankton, the nekton, and the benthos are stressed.

BIO 546 four credits **Biology of Marine Larvae**

3 hours lecture, 3 hours laboratory
Prerequisite: Graduate standing or permission of instructor
An analysis of factors important for animals with complex life cycles, focusing on marine benthic invertebrates. Larval stages will be examined from a wide range of perspectives: ecological, evolutionary, oceanography, behavioral, physiological, and developmental. Students will hone verbal skills through presentations on species and topics of interest, and by leading class

Note: Some undergraduate senior-level courses are offered to graduate students under a corresponding 5xx number, with concurrent enrollment but additional work expectations.

discussion. The laboratory will examine larval types and aquacultural techniques.

BIO 552 three credits

Virology

See BIO 452.

BIO 554 three credits

Biology of Sharks

See BIO 454

BIO 571 four credits

Marine Microbiology

See BIO 471.

BIO 593 one to three credits

Graduate Research Project

Prerequisite: Graduate standing and consent of instructor

Directed research for graduate students, hours by arrangement. Graded A-F.

BIO 595 three credits

Graduate Independent Study

Prerequisites: Graduate standing; permission of instructor, graduate director, and college dean

Study under the supervision of a faculty member in an area not otherwise part of the discipline's course offerings. Terms and hours to be arranged.

BIO 596 three credits

Graduate Directed Study

Prerequisites: Graduate standing; permission of the instructor, graduate director, and college dean

Study under the supervision of a faculty member in an area covered in a regular course not currently being offered. Terms and hours to be arranged.

BIO 599 not to exceed ten credits

Graduate Thesis

Prerequisite: Graduate standing and consent of instructor

Terms and hours to be arranged.
Graded A-F.

Graduate Courses in Biology Education for Master of Arts in Teaching

BIO 600 three credits

Teaching Science in the Elementary School

Not for credit in Biology MS program.

Life, physical, and earth sciences that are involved in the development of scientific concepts and processes for elementary school science. A variety of natural phenomena, such as the plant, *Brassica rapa*, will be used as models to develop an inquiry and standards approach to the learning and teaching of science.

BIO 635 three credits

Methods and Materials for Secondary School Teachers of Biology

Not for credit in Biology MS program.

Modes of inquiry, methods of research and experimentation, and teaching strategies. This course is designed for future teachers of biology. Graduate students enroll concurrently with students in BIO 435 but do additional work.