
BIOLOGY

Chair: Richard Beckwitt

Professors: William E. Barklow, Richard Beckwitt,
Paul Cotter, Joseph Previte, *Phillip Stanton

Associate Professor: Margaret Carroll

Assistant Professors: Luis Malaret, Roger N. Morrissette,
Eugene Muller, Ben W. Snyder,
Charlotte Zampini

Instructor: Virginia Bliss

*Sabbatical: Spring 2000

23.108	Biology II
23.301	Genetics
23.406	Methods in Biological Research I
33.107	Principles of Chemistry
33.108	Principles of Chemistry and Quantitative Analysis
33.207	Organic Chemistry I
* 43.200	Precalculus
43.208	Biostatistics
** 53.201	Introductory Physics

*If the student is proficient at the precalculus level, it is recommended that the student enroll in 43.219 Calculus I to satisfy the college mathematics requirement.

**Those electing 53.211-2 Principles of Physics I-II may substitute Principles of Physics I for Introductory Physics.

Clinical Adjunct Faculty

The following adjunct faculty members are program officials at a School of Medical Technology affiliated with Framingham State College's program in Clinical Laboratory Science.

Boston Veterans Administration Medical Center

John A. Hayes, M.D.
Joanne Trovato, MT (ASCP)

In addition to the Biology major, the Department of Biology offers a Pre-Professional curriculum for pre-medical, pre-dental, and pre-veterinary studies in cooperation with the Department of Chemistry and Food Science (see page 30).

The General Education Requirement

Biology majors must satisfy a general education requirement consisting of twelve (12) courses (see page 32). General Education Goal 7 (Life Science) and the laboratory requirement are covered in courses taken by Biology majors, and are therefore considered fulfilled through the major.

BIOLOGY MAJOR

Departmental Requirements

The following courses are required of Biology majors in all programs, except the Clinical Laboratory Science concentration:

A. Core Courses (two of the required courses not offered by the Biology Department may be used to satisfy general education requirements)

23.107 Biology I

B. Subcore - one (1) course from each of the following groups:

- 23.234 Comparative Vertebrate Physiology
23.272 Human Physiology and Anatomy I
- 23.307 Principles of Microbiology
23.310 Cell Biology
- 23.402 Processes of Organic Evolution
23.408 Ecology
- 23.407 Methods in Biological Research II
23.496 Internship in Biology

C. At least three (3) additional biology courses. These may include courses not chosen to fulfill the subcore requirement above, with the stipulation that students may not receive credit for both 23.234 Comparative Vertebrate Physiology and 23.272 Human Physiology and Anatomy I. In addition, students who choose Human Physiology and Anatomy I above must elect 23.273 Human Physiology and Anatomy II in category C.

PROGRAMS IN BIOLOGY

General Biology (BIG):

Biology majors may wish to take a broad spectrum of courses covering the three major areas of biology: cellular and molecular biology, organismal biology, and population biology, possibly combined with a minor according to the student's interests. Such a curriculum will fulfill the requirements for teacher certification in Massachusetts (see below), as well as prepare students for the Advanced Graduate Record Examination in Biology, a prerequisite for admission to many graduate programs in biology. Opportunities for employment in-

clude positions in high school and college teaching, scientific illustration, technical writing, educational computing, and public relations.

Biology Secondary Teaching Program (BIT):

Students will fulfill the Commonwealth's requirements for secondary education certification in biology by completing:

- A. The core requirements for Biology majors
- B. The following additional courses:

- 23.272 Human Physiology and Anatomy I
- 23.273 Human Physiology and Anatomy II
- 23.____ A Plant course
- 23.307 Principles of Microbiology **or**
33.301 Biochemistry
- 23.402 Processes of Organic Evolution
- 23.408 Ecology

- C. Courses required for a minor in Secondary Education, as described on page 82.

Note: Before registering for 14.315 Professional Preparation and Field Study II - High School or 14.316 Professional Preparation and Field Study II - Middle School, students must have completed all department requirements for the program except for the following, which are to be taken concurrently:

- 23.407 Methods in Biological Research II **or**
23.496 Internship in Biology
- 23.307 Principles of Microbiology **or**
33.301 Biochemistry

Before enrolling in 14.410-11 Student Teaching Seminar and Practicum I-II - High School or 14.414-15 Student Teaching Practicum and Seminar I-II - Middle School, students must have completed all courses in the major and 14.315 or 14.316.

Wildlife and Environmental Management (BIW):

For those who choose to concentrate in wildlife and environmental biology, courses in plant, animal, and microbial systems, ecology, geography, and communications skills are appropriate. Students following the curriculum requirements of the Wildlife Society will meet the standards for certification as a Wildlife Biologist upon graduation. Graduates of this program are employed as wildlife biologists, aquatic or marine biologists, park rangers, zookeepers, refuge managers, sanitarians, conservation specialists and environmental consultants.

Biology courses suggested to satisfy subcore and elective requirements include: 23.200 Introduction to Environmental Science, 23.232 Invertebrate Zoology, 23.234 Comparative Vertebrate Physiology, 23.251 Vascular Plant Taxonomy, 23.252 Biology of Non-Vascular Plants, 23.307 Principles of Microbiology, 23.335 Principles of Wildlife Biology, 23.336 Ornithology, 23.338 Ichthyology, 23.341 Marine Biology, and 23.408 Ecology. Courses in geology, geography,

computer science, journalism, and communication arts are recommended as free electives or to fulfill general education requirements.

Biomedical Science (BIM):

Students may elect to concentrate in biomedical science, a curriculum that emphasizes cellular and molecular biology. Courses covering microbiology, immunology, genetics, recombinant DNA techniques, and cell culture are appropriate for those interested in research positions in the biotechnology industry, medical centers, and government agencies. Graduates of the program are also employed in such diverse areas as product development, sales and marketing, quality control, and technical training.

Biology courses suggested to satisfy subcore and elective requirements include: 23.272-3 Human Physiology and Anatomy I and II, 23.307 Principles of Microbiology, 23.340 Immunology, 23.371 Medical Microbiology, 23.414 Cell Culture, 23.423 Virology, and 23.435 Recombinant DNA Techniques. Additional courses in chemistry, physics, computer science, and technical writing may be taken as free electives or to fulfill general education requirements.

Microbiology (BIB):

The Department offers courses in all subdisciplines of microbiology: virology, bacteriology, immunology, and the study of algae, fungi, and protozoa. Students concentrating in microbiology may qualify for national certification as specialists by such agencies as the American Society of Clinical Pathologists. Graduates are employed as microbiologists in hospital and other clinical laboratories, as well as in positions similar to those held by alumni of the Biomedical Science program.

Biology courses suggested to satisfy subcore and elective requirements include: 23.237 Parasitology, 23.252 Biology of Non-Vascular Plants, 23.272-3 Human Physiology and Anatomy I and II, 23.307 Principles of Microbiology, 23.310 Cell Biology, 23.340 Immunology, 23.371 Medical Microbiology, 23.414 Cell Culture, 23.423 Virology, and 23.435 Recombinant DNA Techniques. To be eligible for the ASCP examination for certification as a technologist in microbiology, persons must have a B.S. in Biology, including 20 semester hours of microbiology coursework, and one year of clinical experience.

Preprofessional Program (BIP):

In this program, students especially interested in pursuing graduate studies in medicine, veterinary medicine, osteopathic medicine, dentistry, chiropractic, or optometry are prepared to meet the standards of admission to one or more of these specific areas of post-baccalaureate study (see page 31 for more information).

Concentration in Clinical Laboratory Science (BIC)

In this program, three years of liberal arts study in the

Biology Department are followed by a fourth calendar year in a hospital-based school of medical technology. On completion of the clinical training, the student receives a B. S. in Biology with a concentration in clinical laboratory science and is eligible to take certifying examinations administered by the American Society of Clinical Pathologists and the National Certifying Agency for Medical Laboratory Personnel.

Students apply for the senior hospital internship during the fall of their junior year. Since class sizes are limited in hospital-based schools of medical technology and admission is competitive, the College cannot guarantee placement. Students who wish to use the clinical year as their fourth or senior year must have spent a minimum of three full academic semesters in residence at Framingham State College. During the first three years, Biology majors in this concentration must complete all general education and department requirements for the major.

Departmental Requirements

A. Core Courses

- 23.001 Orientation to Clinical Laboratory Science
- 23.107 Biology I
- 23.272 Human Physiology and Anatomy I
- 23.273 Human Physiology and Anatomy II
- 23.307 Principles of Microbiology
- 23.340 Immunology
- 33.107 Principles of Chemistry
- 33.108 Principles of Chemistry and Quantitative Analysis
- 33.207 Organic Chemistry I
- 33.301 Biochemistry
- 43.200 Precalculus (or higher math)
- 43.208 Biostatistics **or** a course in computer science **or** a second math course
- 53.201 Introductory Physics

B. Electives: Choose at least two (2) (substitutions may be made with the approval of the Clinical Laboratory Science Program coordinator):

- 23.237 Parasitology
- 23.301 Genetics
- 23.371 Medical Microbiology
- 23.423 Virology
- 33.208 Organic Chemistry II

C. 23.495 Senior Hospital Internship. During the fourth year, students in the Clinical Laboratory Science program are enrolled in a hospital-based School of Medical Technology. After completion of the internship, students receive eight (8) course credits distributed as follows:

Clinical Chemistry	Two (2) course credits
Clinical Hematology	Two (2) course credits
Clinical Microbiology	Two (2) course credits
Clinical Immunology	One (1) course credit
Immunohematology	One (1) course credit

MINOR IN BIOLOGY (5 courses):

A minimum of four (4) biology courses including an introductory biology laboratory course plus a chemistry laboratory course. These courses are to be chosen under the guidance of a member of the Biology Department. The introductory courses may be waived by an examination or advanced placement. In this case another guided biology elective will be taken.

Biology Courses Appropriate for General Education (Gen.Ed.)

Courses	Goal
23.101 Biological Concepts	7, Lab
23.103 Ecological Imps. of Conservation	7
23.106 Backgrounds of Modern Biology	7
23.112 Biology of Marine Organisms	7
23.114 A Human Perspective on Genetics	7
23.142 Introduction to Human Biology	7
23.200 Intro. to Environmental Science	7
23.203 Plants in Relation to Man	7

COURSE DESCRIPTIONS

23.001 Orientation to Clinical Laboratory Science (no course credit)

An introduction to the professional goals and opportunities in clinical laboratory science. Guest participants include coordinators of hospital-based educational programs, and alumni who have pursued various careers in the field. Requirements include an externship in a hospital laboratory. Recommended in the freshman year.

23.101 Biological Concepts (Gen.Ed. Goal 7, Lab)

An approach to the study of life that emphasizes how conceptual thinking is involved in understanding the problems encountered in the major areas of biology. These areas include evolution and the origin of life, cellular processes, Mendelian and molecular genetics, ecology, behavioral science, and basic physiological systems. The interrelationship of these areas and their effects on

human biology are stressed. Laboratory course, primarily for non-majors.

Prerequisite: 43.095 General Mathematics **or** a satisfactory score on the mathematics placement exam.

23.103 Ecological Implications of Conservation (Gen.Ed. Goal 7)

An introduction to the scientific principles on which conservation should be based. Methods of conservation practice are stressed. The course includes

a discussion of the development and future of the conservation movement. Occasional field trips. This course is not open to Biology majors.

23.105 Social Implications of Modern Biology

A consideration of biological concepts which form the basis for current and future health practices. Patient's rights and professional responsibilities, life and death issues (including abortion and euthanasia), genetic engineering, eugenics, psychosurgery and behavior control are some of the issues which are explored from biomedical, legal, and ethical perspectives. Case studies are examined in small group seminars. This course is not open to Biology majors.

23.106 Backgrounds of Modern Biology (Gen.Ed. Goal 7)

Designed to introduce three areas of biology - genetics, evolution, and ecology - from a historical perspective. We discuss the lives of scientists and the social contexts in which they worked to understand the development of modern ideas in biology. This course covers basic biological concepts as well as the process by which scientific knowledge is acquired. This course is not open to Biology majors.

23.107 Biology I

An introductory course for students intending to major in Biology. Emphasis is placed on basic skills and knowledge needed by the student who intends to study further in the life sciences. Subject matter concentrates on the cellular and molecular levels of organization. Processes of energy release, photosynthesis, heredity, and molecular control of cells are considered. Laboratory periods concentrate on developing basic skills of observation, measuring and interpreting data, and the reading and reporting of experimental work. **Fall.**

23.108 Biology II

An introduction to the organismal and population levels of biological organization, which includes a survey of the plant and animal world. In addition, principles of ecology, population biology, and processes of organic evolution

are examined. **Spring.**

Prerequisite: 23.107 Biology I.

23.112 Biology of Marine Organisms (Gen.Ed. Goal 7)

An introduction to life in the oceans, including basic principles of ecology, a description of the important organisms, and the impact of man on marine life. Laboratory demonstrations and field trips. This course is not open to Biology majors. This course does not supplant 23.341 Marine Biology or 73.246 Oceanography.

23.114 A Human Perspective on Genetics (Gen.Ed. Goal 7)

An exploration of the field of genetics from the rediscovery of Mendel's work in 1900 up to the present. Once the fundamentals of the discipline are established, the emphasis is on genetics and its human ramifications. Topics include the efforts to create a DNA blueprint for humans, the prenatal diagnosis of some genetic disorders, the cloning of genes whose products are used as pharmaceuticals, and the ability to alter the genetic properties of important crop plants. This course is not open to Biology majors.

23.142 Introduction to Human Biology (Gen.Ed. Goal 7)

An exploration of the functional aspects of the human body at the molecular, cellular, organ and systems levels. Emphasis is on the development and evolution of homeostatic mechanisms which allow the body to respond and adapt to physical and emotional stresses under changing environmental conditions. This course is not open to Biology or Food and Nutrition majors, except for students in the Applied Nutrition concentration.

23.200 Introduction to Environmental Science (Gen.Ed. Goal 7)

A comprehensive survey of the environmental principles concerning the interactions of humans and world resources. The role of technology in meeting the problems of growth, pollution, energy and agriculture is examined in the context of present capabilities and the prospects for future development.

23.201 The Brain and Behavior

An introduction to the organization of the brain and the nervous system, and its interaction with other body systems to influence behavior. Topics include the effects of drugs and nutrition on brain development, the biological basis for emotional disorders and intellectual development, and an introduction to the principles of neuropathology. **Note:** This course is designed for non-science majors and is not open to Biology majors.

23.202 Physiology of Exercise

An introduction to the effects of aerobic and anaerobic exercise on functions of the human body. Relationships among bodily functions, exercise, and neural, hormonal, and nutritional factors are discussed. Structural and functional aspects of the skeletomuscular, cardiovascular, respiratory, and immune systems to exercise are emphasized. Demonstrations illustrate selected principles. Laboratory.

Prerequisite: An introductory college biology course.

Note: Students may not receive credit for both 23.202 and 23.273 Human Physiology and Anatomy II.

23.203 Plants in Relation to Man (Gen.Ed. Goal 7)

An exploration of the dependency of man on plants and plant products. The beginning of agriculture and its consequences for human evolution are discussed. The origins, dispersals, improvements, and uses of economically valuable plants are considered along with their relationships to the world's economy. Occasional field trips.

23.210 Introduction to Marine Mammals

An exploration of the biology and natural history of marine mammals in the North Atlantic, including whales, dolphins and seals. Topics include evolution, anatomy, behavior, field identification, the history of whaling and contemporary conservation issues. Demonstration laboratory work focuses on smaller marine mammals. One Saturday field trip on Massachusetts Bay is required. **Note:** This course is not open to Biology majors. Application to the campus representative of the Marine Studies Consortium must be made one

semester prior to the experience.

Prerequisites: One college biology course.

23.220 Animal Behavior

A study of the influence of natural selection on the behavior of animals. This course emphasizes the distinction between the immediate causes of behavior, including external stimuli and internal physiological mechanisms, and the ultimate consequences or survival value of behavior. Topics such as learning and instinct, aggression, territoriality, communication, and social behavior are discussed. Laboratory.

23.232 Invertebrate Zoology

An introduction to the diversity of invertebrate animal phyla, with reference to their phylogenetic relationships. The course focuses on the common structural and functional features of all animal groups, as well as the major variations that occur among them. Laboratory.

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I.

23.234 Comparative Vertebrate Physiology

An introduction to the functions and relationships of vertebrate organs and organ systems. The course emphasizes physiological adaptations and mechanisms by which vertebrates compensate for environmental variations. Laboratory.

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I, and one chemistry course. **Note:** Students may not receive credit for both 23.234 and 23.272 Human Physiology and Anatomy I.

23.237 Parasitology

An introduction to the morphology, life cycles, clinical manifestations, and laboratory diagnosis of protozoan and helminthic parasites of public health importance.

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I.

23.250 Horticulture

Designed as an introduction to basic horticultural principles and practices, the course gives the student an opportunity to develop skills in the care, propagation, and identification of horticul-

tural plants. Emphasis also is given to the basic structure, growth, and development of plants. Acceptable for majors as a free elective, but not in place of a required plant course.

23.251 Vascular Plant Taxonomy

An historical view of plant classification; concepts of nomenclature, goals of phylogenetic and biosystematic investigations; anatomical and morphological characteristics important in classification; key characteristics of important temperate plant families; collection and identification techniques; and introduction to the local flora. Laboratory.

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I.

23.252 Biology of Non-Vascular Plants

An examination of structure, life histories, physiology, taxonomy, evolution, and economics of the non-vascular plants. Special attention is given to the algae and the fungi. Laboratories, in addition to morphological studies, introduce the student to the methods of collecting, culturing and identifying these organisms. Laboratory.

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I.

23.272 Human Physiology and Anatomy I

A study of the structure and function of the human body. Principles of homeostasis are emphasized in initial studies of cells, tissues, and organs. The anatomy and physiology of the endocrine, nervous, muscular, and skeletal systems are analyzed. Laboratory. **Fall.**

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I; a college chemistry course is strongly recommended.

23.273 Human Physiology and Anatomy II

A continuation of 23.272 Human Physiology and Anatomy I. Major emphasis is on the cardiovascular, respiratory, excretory, digestive, and reproductive systems. Laboratory. **Spring.**

Prerequisite: 23.272 Human Physiology and Anatomy I.

23.301 Genetics

A study of the principles governing heredity in all living things, including

microorganisms, plants, and animals. Topics covered include Mendelian inheritance, molecular genetics, cytogenetics, human hereditary disease, and population genetics. Laboratory.

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I.

23.305 Cetacean Biology and Conservation

An examination of the biology and conservation of cetaceans: whales, dolphins, and porpoises. Topics include physiology, population biology and life history analysis, molecular genetics, morphology, distributional ecology, and social behavior. Early lectures focus on the biology of cetaceans and how they are adapted to the marine environment. Later lectures use case studies to review how biological principles can be applied to the conservation of a wide range of cetacean species.

Prerequisites: One year of general biology and two upper level biology courses. Application to campus representative of the Marine Studies Consortium must be made one semester prior to experience.

23.307 Principles of Microbiology

An examination of the structure, reproduction, physiology and taxonomy of microorganisms. Special attention is given to the bacteria and viruses. Emphasis is placed on those aspects of microbiology of economic significance, including pathogenesis, immunity, industrial utilization, food microbiology and pollution control. Laboratories introduce the student to standard techniques of observation, cultivation and identification of microorganisms, as well as encouraging independent investigations. Laboratory. **Fall and Spring.**

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I; one chemistry course.

23.310 Cell Biology

A study of the functional anatomy of cells from the microscopic level to the molecular level. Special emphasis is given to cellular energetics and molecular mechanisms. Laboratory.

Prerequisite: 23.101 Biological Concepts **or** 23.107 Biology I; one chemistry course.

23.333 Principles of Human Physiology

A study of the functional anatomy of the human body and its physiology. Basic concepts concerning the skeletal, muscular, nervous, respiratory, cardiovascular, digestive, urinary, endocrine, and reproductive systems are studied. Selected laboratory exercises, demonstrations, and videos are used to supplement assigned readings and lecture material.

Prerequisite: 23.101 Biological Concepts or equivalent.

23.335 Principles of Wildlife Biology

A study of the distribution of major wildlife groups in the United States. The principles of wildlife management and evaluation of land and water habitats are stressed, as well as population growth dynamics and field procedures. Laboratory.

23.336 Ornithology

General principles and fundamentals of ornithology. Stress is placed on anatomy, behavior, and economic relationships. Laboratory course. Field trips required.

23.338 Ichthyology

A study of freshwater and marine fishes with particular emphasis on those species occurring in the northeastern states. Laboratory.

Prerequisite: 23.107 Biology I and permission of the instructor.

23.339 Psychobiology

An examination of factors which influence the development of stress and emotional systems, psycho-physiological models for aggression, sexual differentiation, response to stress, mental disorders, and effects of drugs and nutrition on brain development. Factors which influence intellectual and perceptual development also include psycho-physiological models for sensory coding, learning and memory, and language acquisition.

Prerequisite: Introductory course in psychology and an approved physiology course.

23.340 Immunology

A study of the principles of immunology. The immune response, antibody formation in cells and the whole animal,

immuno-suppression, blood group antigens, and the kinetics of antigen-antibody reactions are described. The structure of the antibody and its active site are examined at the molecular level. The role of complement, hypersensitivity (allergy), autoallergic reactions and transplantation immunity are discussed. Laboratory.

Prerequisite: 23.307 Principles of Microbiology or permission of instructor.

23.341 Marine Biology

An introduction to the variety of marine environments and the biological and physical factors which contribute to the productivity of these areas. Oceanic habitats are compared to other ecosystems including tropical and temperate estuaries, coral reefs and salt marshes. Problems of human interaction with the marine environment are emphasized. Laboratory.

Prerequisite: 23.101 Biological Concepts or 23.107 Biology I.

23.350 Vascular Plant Anatomy and Morphology

Structure, organization, and differentiation of tissues and organs of higher vascular plants with special emphasis on the angiosperms, and a survey of vascular plants in terms of structure, reproduction, and phylogeny. Laboratory.

23.371 Medical Microbiology

An overview of infectious diseases in man and higher animals caused by bacteria and yeasts, emphasizing pathogenesis, transmission, and diagnosis. Laboratory focuses on the procedures for isolation and identification of pathogenic microbes common in the United States and tests for antimicrobial susceptibility to chemotherapeutic drugs.

Prerequisite: An introductory course in microbiology.

23.402 Processes of Organic Evolution

The historical development of evolutionary thought in the pre- and post-Darwinian periods; the interplay among mutations, recombination, gene flow, natural selection, and genetic drift in determining the direction of evolutionary change; isolating mechanisms and the origins of species; the role of poly-

loidy in plant evolution; the significance of hybridization in evolution and speciation; evidences of evolution from various disciplines.

Prerequisite: 23.301 Genetics.

23.406 Methods in Biological Research I

Designed to develop a working appreciation of methods of scientific inquiry through development of an original research proposal. Topics included are: problem definition, literature survey, resource bibliography, and research design, including proposed data analysis. Normally taken in the spring term of the junior year, this course is open only to Biology majors.

Prerequisite: 43.208 Biostatistics, or substitution of an equivalent course with the approval of the department chair.

23.407 Methods in Biological Research II

A continuation of Methods I (23.406) in which the students implement their research design under the supervision of a department faculty member. The research may be conducted off-campus with approval of course coordinator. Open only to Biology majors.

Prerequisite: 23.406 Methods in Biological Research I.

23.408 Ecology

An advanced treatment designed for science majors, which synthesizes knowledge gained in other courses and applies it to ecological problems. Emphasis is placed on the interaction of the organism with its biological and physical environments. Concepts of succession, the biological community, the ecosystem, and man's influence on the ecosystem are considered. Occasional weekend field trips. Laboratory.

Prerequisite: Four (4) science courses, including one (1) laboratory course in biology and one (1) laboratory course in chemistry, or permission of the instructor.

23.409 Developmental Biology

A study of developing organisms. Growth, regulation, differentiation and morphogenesis are considered. Emphasis is placed on molecular mechanisms. Laboratory exercises include both descriptive and experimental em-

bryology.

Prerequisite: 23.301 Genetics and 33.207 Organic Chemistry I

23.411 Food Microbiology

A focus on those microorganisms involved in food production, food spoilage, and the transmission of diseases through foods. The effect of various methods of food preservation is evaluated in terms of public health, food spoilage, food quality, and nutritional value of foods. Laboratory.

Prerequisite: 23.307 Principles of Microbiology.

23.414 Cell Culture

An introduction to the basic methodology used in the preparation, production, and maintenance of primary and established cell lines, tissues, and organ cultures. Lectures and laboratory, with individual special projects.

Prerequisite: Advanced standing and permission of the instructor.

23.417 Endocrinology

A study of endocrine glands, the hormones they secrete, and the effects these hormones have on their target tissues. The course examines the mechanisms of action of hormones at the molecular, cellular, organ, and physiological levels, as well as their effects on development of the individual. Topics covered include the role of hormones in male and female reproduction, pregnancy, parturition, lactation, growth, diabetes, and exercise. In the laboratory, students perform experiments involving small animal surgery and injection of hormones.

Prerequisite: One (1) chemistry course and one (1) upper-level biology course selected from: 23.234 Comparative Vertebrate Physiology, 23.272 Human Physiology and Anatomy I, 23.310 Cell Biology; or permission of the instructor.

23.423 Virology

Introduction to the study of animal, plant, and prokaryotic viruses. Description of morphological, physiological, and pathological properties of viral organisms. Discussion of the techniques for laboratory propagation.

Prerequisite: A course in microbiology or immunology.

23.435 Recombinant DNA Techniques

Designed to familiarize the student with the processes and techniques employed by the biotechnology industry to produce recombinant products. The theoretical foundations for recombinant DNA methodology as well as medical, forensic, and commercial applications of genetic engineering are considered. Laboratory exercises include DNA isolation, restriction enzyme mapping, cloning to selectable vectors, gel electrophoresis, polymerase chain reaction, DNA sequencing, and selected protein purification methodologies.

Prerequisites: 23.301 Genetics and 23.307 Principles of Microbiology.

23.457 Quantitative Plant Ecology

An introduction to the principles and techniques of ecology as they apply to plants in terrestrial and aquatic habitats. The course covers physiological ecology, as well as population- and community-level processes. Laboratories emphasize techniques for quantitative sampling and analysis. Occasional field trips. Laboratory.

Prerequisite: 23.251 Vascular Plant Taxonomy or permission of the instructor.

23.490 Independent Study in Biology

For the Biology major who would like the opportunity and experience of working independently in an area relevant to his or her special interests. Each student's experience is to be planned in cooperation with a department member and must be approved by the chair. Progress reports and final written and oral reports will be required.

Prerequisite: Biology major of junior or senior standing, two semesters completed at Framingham State College, overall QPA of 2.5, and approval of the department chair. The independent study option is reserved for those students who demonstrate sufficient motivation and self-discipline by successful completion of traditional courses.

23.496, 23.497 Internship in Biology

A supervised field study in the area of the student's interest which complements formal course work. The internship program is offered through cooperation of participating institutions which provide guidance for the interns. A minimum of 160 on-site hours is necessary to complete the internship in Biology. The 160 hours must be completed within one semester.

The internship in Biology may be taken for one (1) course credit in the major as an elective; however, students in the Wildlife Biology concentration may use an internship to substitute for one of the required courses. A student may not enroll in an internship more than twice (two course credits). Any student interested in participating in an internship must consult with the Biology Department chair prior to the middle of the semester preceding the semester of the desired internship.

Prerequisite: Biology majors of senior standing, two semesters completed at Framingham State College, overall QPA of 2.5 with a 2.75 average in courses for the major, and approval of the department chair.