Division of Science and Mathematics

Biological Sciences

FACULTY

**Year of initial appointment at Binghamton*

Andrus, Richard E., *Associate Professor*, PhD, 1974, State University of New York College of Forestry at Syracuse: Taxonomy, ecology, biogeography of bryophytes. (1973)*

Baust, John G., *Professor*, PhD, 1970, Institute of Arctic Biology, University of Alaska: Physiological mechanisms of adaptation to low temperatures and survival at environmental extremes, mechanisms of cryopreservation of mammalian tissues. (1987)

Bonamo, Patricia M., *Bartle Professor*, PhD, 1966, Cornell University: Paleobotany, plant morphology, origin and evolution of the land flora. (1967)

Clark, Anne Barrett, *Associate Professor*, PhD, 1975, University of Chicago: Evolutionary biology and behavior. (1989)

Gal, Susannah, *Assistant Professor,* PhD, 1986, Johns Hopkins University: Molecular biology of plants. (1994)

Haber, Alan H., *Professor*, PhD, 1956, University of Wisconsin: Radiation biology. (1973)

Horwath, Kathleen L., *Associate Professor*, PhD, 1982, University of Notre Dame: Comparative and environmental biochemistry, cell and molecular biology, circadian and insect physiology. (1988)

Landry, Stuart O., *Professor Emeritus*, PhD, 1954, University of California at Berkeley: Functional anatomy, musculoskeletal system of mammals; rodent taxonomy. (1963)

Lazaroff, Norman, *Associate Professor Emeritus*, PhD, 1961, Yale University: General and applied microbiology, autotrophic and photophysiology. (1966)

Madison, Dale M., *Associate Professor*, PhD, 1971, University of Maryland: Mammalian behavior and ecology. (1977)

McGee, Dennis W., *Assistant Professor,* PhD, 1987, Texas A&M University: Cellular immunology. (1993)

Michael, Sandra D., *Professor and Department Chair*, PhD, 1970, University of California at Davis: Endocrinology of female reproduction and behavior, thymus gland involvement in ovarian aging and tumorigenesis. (1974)

Mueller, August P., *Associate Professor Emeritus*, PhD, 1960, University of Wisconsin: Serology, genetics. (1962)

Murrish, David E., *Associate Professor and Director of Graduate Studies*, PhD, 1968, University of Montana: Ecological physiology, avian metabolic and respiratory physiology. (1977)

Parker, Matthew, *Associate Professor*, PhD, 1983, Cornell University: Plant population biology, coevolution of plants and pathogens, population dynamics of plant-herbivore interactions. (1985)

Posner, Herbert B., *Professor and Director of Undergraduate Studies*, PhD, 1962, Yale University: Physiology of plant growth and development. (1964)

Pueschel, Curt, *Associate Professor*, PhD, 1978, Cornell University: Ultrastructure and systematics of algae. (1981)

Schumacher, George J., *Professor Emeritus*, PhD, 1953, Cornell University: Ecology, economics, distribution, taxonomy, and morphology of freshwater algae. (1953)

Shepherd, Julian, *Associate Professor*, PhD, 1972, Harvard University: Developmental biology, insect physiology, sperm activation. (1975)

Stamp, Nancy E., *Professor*, PhD, 1980, University of Maryland: Insect/plant interactions, animal ecology. (1985)

Stein, William, *Associate Professor,* PhD, 1980, University of Michigan: Vascular plant evolution. (1988)

Tan-Wilson, Anna L., *Distinguished Professor*, PhD, 1973, State University of New York at Buffalo: Plant biochemistry, storage protein and trypsin inhibitor metabolism during seed development and germination. (1976)

Titus, John E., *Associate Professor*, PhD, 1977, University of Wisconsin: Physiological plant ecology. (1977)

Van Buskirk, Robert, *Professor*, PhD, 1983, Harvard University: Protein biochemistry, plant biochemistry. (1986)

Wilcox, R. Stimson, *Associate Professor*, PhD, 1969, University of Michigan: Behavioral ecology, communication systems. (1976)

Wilson, David S., *Professor*, PhD, 1975, Michigan State University: Evolutionary and theoretical ecology. (1988)

Wilson, Karl A., *Professor and Director of the Biochemistry Program*, PhD, 1973, State University of New York at Buffalo: Primary structure of enzymes and biochemical evolution. (1976)

Adjunct Faculty

Button, Elizabeth E., *Adjunct Lecturer,* PhD, 1984, Binghamton University: Biological sciences. (1984)

Ferrari, George P., *Adjunct Professor,* MS, 1960, St. John's University: Microbiology. (1991)

Freeh, Steven Michael, *Adjunct Assistant Professor,* PhD, 1984, Binghamton University: Biological sciences. (1994)

French, Alan R., *Adjunct Assistant Professor*, PhD, 1975, University of California at Los Angeles: Physiological ecology, mammalian hibernation: energetics, daily and annual rhythms, physiological control of body temperature. (1985)

Richardson, John B., *Adjunct Professor*, PhD, 1960, Sheffield University, England: Paleontology. (1987)

Roe, Eunice M., *Adjunct Assistant Professor (CSL),* PhD, 1989, University of Pittsburgh: Communication. (1994)

UNDERGRADUATE PROGRAMS

The Biological Sciences Department offers BA and BS degrees in biological sciences, both of which are liberal arts degrees and preparatory degrees for graduate study and professional employment. A BS degree offers a greater concentration in biology and the opportunity for special concentration in a subdiscipline of biology. Students wishing to concentrate in biochemical sciences and environmental studies may wish to choose the degree programs offered under those rubrics.

Students are advised to declare their major in biological sciences by the end of their sophomore year. A year of physics and a year of calculus are considered beneficial or prerequisite to postgraduate study in most of the biology-related fields.

The department also offers a minor.

Requirements for BA and BS Degree Programs

1. For either degree, BIOL 113, 114 and 115.
2. For either degree, CHEM 107-108 or 111, and CHEM 231, 332 and 335. (Students considering CHEM 111 instead of CHEM 107-108 should consult with an adviser in the biology department or with the pre-health adviser, as appropriate.)
3. For the BA degree, a minimum of 20 credits and for the BS degree, a minimum of 28 credits in courses numbered 200 or above (except BIOL 224, 251, 252 and 491) in the biological sciences. Advanced students may wish to consider 500-level courses (consent of instructor required). Enrollment in independent work and the honors program is encouraged for qualified students. For the BA a maximum of four credits, and for the BS, a maximum of eight credits of BIOL 495, 496 and 497 combined will be accepted toward the biology degree requirements. Credit for BIOL 496 or 497 for work done at other institutions is given only if prior permis sion is obtained from the departmental undergraduate committee. The student's attention is called to the existence of courses taught at field stations during the summer. Credit toward the BA and BS degrees for such courses will be accepted if approved in advance by the undergradu ate committee.
4. Among the required biology courses numbered 200 or above, at least three for a BA, or four for a BS degree, must include at least one weekly laboratory session. Courses fulfilling the laboratory requirement are identified by the designation (L) following their titles. Note that any half-course (two-credit course) that includes at least one weekly laboratory session may be counted as fulfilling this requirement. BIOL 495 or 497 for at least two credits may also be counted. BIOL 251 and 252 combined count as one laboratory toward the laboratory requirement. These courses, however, do not count as courses toward the biology degree major course requirements.
5. For the BA, three courses (12 credits) and for the BS, four courses (16 credits) from the following list of cognate sciences:
   CHEM 200-489, except 231, 332, 335, 391, 397
   GEOL 111-489
   MATH 147, 221-489, except 391
   PHYS 121-489, except 391

PSYC 220, 243, 306, 343, 344, 351, 353, 356, 358, 362.

Students may petition the Undergraduate Committee for courses not on this list.

6. Courses in biological sciences other than BIOL 490, 495, 496 and 497 may not be taken on the Pass/Fail grading option for credit toward either the BA or BS degree. A student must have approval of the faculty supervisor to take BIOL 496 or BIOL 497 on the Pass/Fail option.
7. A minimum of four courses (16 credits) in the biological sciences must be taken in Harpur College in order to qualify for either the BA or BS degree. A sample schedule for a BA in biology follows.

Year	Fall	Spring
Freshman	BIOL 114 or 113 CHEM 107	BIOL 113 or 114 CHEM 108
Sophomore	CHEM 231 MATH 221	BIOL course CHEM 332 MATH 222
Junior	BIOL course PHYS 131 (or 121)	BIOL course PHYS 132 (or 122) CHEM 335 (2 credits)
Senior	BIOL course	BIOL course

Note: BIOL 115 should be taken in the second or third semester.

Honors Program

Students in this program are required to do a year-long research project under the guidance of a departmental faculty member. To be accepted into the program, a student must have junior standing, at least a 3.0 GPA overall and 3.3 GPA in biology courses, the consent of a faculty supervisor and the approval of the undergraduate committee. The aforementioned GPAs must be maintained during the honors research. Students doing honors research should register for BIOL 497.

The student's work, summarized and interpreted in a thesis, must be submitted for approval to a thesis committee consisting of the supervising professor and two other faculty members. The satisfactory completion of the project and thesis earns the recognition at graduation of Distinguished Independent Work in Biology.

Formal application for the honors program must be made no later than the last day of the registration period at the beginning of the senior year. The thesis committee must be set up no later than the add deadline in the fall semester of the senior year. Applications and additional details of the program are available in the department office.

Biological Sciences Minor

Requirements for the minor are:

1. Two (8 credits) introductory-level courses in biology (courses numbered in the 100s).

2. Four courses (16 credits) of biology numbered 200 or above. At least two of these courses must be numbered 300 or above. The required 16 credits must include two courses with laboratory or fieldwork. BIOL 491 (Practicum in College Teaching) does not count toward the minor.

Note: Many advanced biology courses require the entire basic freshman sequence: BIOL 113, 114 and 115.

GRADUATE PROGRAMS

The Biological Sciences Department offers programs leading to the degrees of master of arts and doctor of philosophy. These programs provide training in the areas of (i) molecular biology and genetics, (ii) organismal physiology and ultrastructure, and (iii) ecology, behavior and evolution, including paleobotany. The programs stress flexibility and especially encourage communication and collaboration among the subdisciplines of biology. Experience in teaching, considered important for graduate students, is encouraged.

Admission

Admission to the graduate program is open to qualified students with a bachelor's degree or its equivalent. All applicants should submit a complete set of official transcripts, at least two letters of recommendation, a statement of professional interests and goals, and scores for the Graduate Record Examination aptitude and advanced tests.

Master of Arts Program

The master of arts degree allows students to expand their background in a particular area of the biological sciences and to gain experience in research. Entering students are expected to affiliate with a professor, form a three-member supervising committee, and begin research in the first year. Soon after formation, the committee meets with the student to establish the nature and scope of the research. The committee should meet two to four times per year to assess the student's progress.

COURSE REQUIREMENTS

A minimum of 30 semester-credit hours beyond the bachelor's degree is required for completion of the master of arts degree. These credits are distributed as follows:

Sixteen to 24 credit hours of courses numbered 500 or above (exclusive of BIOL 591, 599 and all MAT/MST courses). A maximum of 12 credit hours of BIOL 597, Independent Study, is allowed.

Zero to eight credit hours of elective courses outside of the biological sciences. Approval of the departmental graduate committee is required. Six credit hours of BIOL 599, Investigations in Biology-Thesis, are required.

GRANTING OF THE DEGREE

The department requires that each candidate for the degree of master of arts in biological sciences complete the following additional requirements:

1. Maintain a 3.0 average in all graduate credit courses (exclusive of BIOL 599).
2. Complete a thesis acceptable to the supervising committee.
3. Pass a final oral examination on the subject matter of the thesis and related biological knowledge.
4. Present a formal seminar to the department based on his or her thesis research.

Doctor of Philosophy Program

The Biological Sciences Department is made up of many subdisciplines, each with its own special requirements. Graduate students entering these subdisciplines have a variety of backgrounds and future needs. The department recognizes these differences by stressing maximum flexibility for the program of each individual student. This flexible planning is the province of the committee supervising the research program of the graduate student.

The PhD is a research degree. Entering graduate students are expected to associate themselves with a professor and establish a research program as early as possible after entering the department. The major steps leading to the granting of the degree are to:

1. Affiliate with a supervising professor.
2. Establish a supervising committee.
3. Take the qualifying exam.
4. Take the comprehensive exams.
5. Submit a dissertation prospectus.
6. Submit the dissertation.
7. Take the final oral dissertation defense.
8. Give a departmental seminar.

AFFILIATION AND SUPERVISING COMMITTEE

The student must affiliate with a supervising professor, agree on a research topic, and establish a four-member supervising committee within the first year following admission to the department's graduate program. This committee and particularly the chairperson, who is the supervising professor, is responsible for the direction of the student. There should be regular meetings with the student to ensure adequate direction and progress.

COURSE REQUIREMENTS

The number of semester-credit hours required for completion of the PhD is determined for each student by the supervising committee.

QUALIFYING EXAMINATION

Completion of the qualifying examination is the formal entry into the PhD program. Prior to the examination, the student must prepare a two-three page preliminary research proposal, an outline of the research to be done for the degree. This examination must be completed within the first year after entry into the department.

The purposes of the examination are:

1. To determine if the student should be formally entered into the PhD program.
2. To determine at an early stage the appropriateness and feasibility of the research proposal.
3. To establish the language requirement. The need for the ability to read and/or speak a foreign language varies considerably within the different subdisciplines of biology. The requirement is therefore flexible (usually one or no language) and is determined by the individual supervising committee.
4. To evaluate the academic strengths and weaknesses of the student. Particular emphasis should be placed on the background needed for the research project. The committee may require courses and outside readings to strengthen the student in his research area.

COMPREHENSIVE EXAMINATIONS

The comprehensives are a series of oral examinations. The number of examinations will vary among students and is determined by the individual supervising committee. The purposes of this series of examinations are to determine the breadth and depth of the student's knowledge and research ability and to advise on the research project.

The comprehensive examinations are completed when the supervising committee is satisfied that the student has the appropriate background to complete the proposed research. These examinations should be completed by the

end of the fifth semester after entering the department.

DISSERTATION PROSPECTUS

A dissertation prospectus must be submitted within six months following the completion of the comprehensive examinations. This prospectus, usually an updated version of the research proposal submitted to the supervising committee, must be approved in writing by the four-member supervising committee. Meetings between the student and supervising committee should continue on a regular basis to allow committee members to monitor the progress of the research.

FINAL ORAL DEFENSE

After the dissertation is submitted, the research must be defended in an oral examination. This exam is conducted by a five-member committee made up of the supervising professor, the other three members of the supervising committee, and an outside examiner appointed by the vice provost. This examination covers the details and implications of the student's research.

SEMINAR REQUIREMENT

PhD candidates are expected to present a formal seminar to the department based on their research dissertation.

COURSE OFFERINGS/ UNDERGRADUATE

NOTE: Unless otherwise noted, all undergraduate courses carry 4 credits and are offered every year.

BIOL 103. UNITY OF LIFE
Principles of cell biology and genetics, with emphasis on problems society faces. Main themes are cellular structure, energy and chemical transformations (metabolism), information transfer (genetics), chance (probability), evolution, and the history and politics of science. Three one-hour lectures and one one-hour discussion per week. Does not satisfy any requirement for the major in biological sciences or biochemistry. No prerequisites. Not open to students who have had BIOL 113 or its equivalent.

BIOL 104. DIVERSITY OF LIFE
A survey of the diversity of plants, animals and other organisms. Intended for nonmajors and aimed at developing an appreciation for the beauty and intricacy of organisms and their relationships. Problems of preservation of critical ecosystems such as tropical rain forests and coral reefs, and the impact of extinction of organisms and ecosystems, will be addressed from scientific and humanistic points of view. Certain especially threatened animals, e.g. whales and primates, will receive special attention. Three hours of lecture and one 1 1/2-hour discussion section/field trip per week. No prerequisites. Not open to students who have had BIOL 114 or its equivalent.

BIOL 113. INTRODUCTORY BIOLOGY: CELL AND MOLECULAR *every semester*
Survey of cell and molecular biology: origins and evolution of cells; prokaryotes and eukaryotes; ultrastructure; energetics; metabolism; membranes; motility; endoplasmic reticulum; cell cycle, mitosis, meiosis; Mendelian genetics; molecular genetics. Lecture and discussion. Prerequisite: high school chemistry. BIOL 113 and 114 may be taken in either order.

BIOL 114. INTRODUCTORY BIOLOGY: ORGANISMS AND POPULATIONS *every semester*
Survey of organismal and population biology; history of life; structure and physiology of plants and animals; homeostasis, integration, growth, ecology; animal behavior; evolution. Lecture and discussion. Prerequisite: high school chemistry. BIOL 113 and 114 may be taken in either order.

BIOL 115. INTRODUCTORY BIOLOGY LABORATORY *every semester, 2 credits*
Laboratory and field experiments covering molecular, cellular, organismal and population biology. Emphasis on scientific method, independent investigation, report writing and techniques. Prerequisites or corequisites: BIOL 113 and 114.

BIOL 180. FRESHMAN SEMINAR *2 credits*
Discussion of selected topics. Does not satisfy any requirement for the major.

BIOL 215. CELL BIOLOGY LABORATORY (L) *2 credits*
Laboratory course designed to introduce students to techniques and approaches in cell biology. Each set of exercises teaching basic procedures will be followed by short research investigation. Prerequisite: BIOL 115. Corequisite: CHEM 231.

BIOL 224. BASIC MICROBIOLOGY FOR NONMAJORS
Fundamentals of microbiology, stressing clinical relevance. Required of students in the Decker School of Nursing. Not for credit toward degrees in the biological sciences. Lecture and laboratory. Prerequisite: CHEM 102 or equivalent.

BIOL 240. BOTANY (L)
Interrelationships and evolution of major plant groups at organismic level. Lecture and laboratory.

BIOL 241. FLORA (L) *every semester, 2 credits*
Examination of local native and introduced species of higher plants via discussion and fieldwork. An appreciation of the taxonomy, ecology, and economics of those plants. Discussion and field trips (two hours) twice a week during half of semester. Prerequisite: BIOL 114 or 240, or consent of instructor.

BIOL 250. ZOOLOGY (L)
Diversity in animal kingdom; representatives of major animal phyla. Basic understanding and appreciation of animals through consideration of their ecology, evolution, behavior and physiology. Laboratories acquaint students with structure of selected representative types, provide additional knowledge of functioning of animal body. Lecture and laboratory. Prerequisite: BIOL 114.

BIOL 251. HUMAN ANATOMY AND PHYSIOLOGY I
First part of one-year course covering normal human structure and function. Topics include physical-chemical basis of life processes, integrative function of the nervous system, anatomical and physiological interaction of the skeletal-muscular systems, and basic endocrinology. Lec-

ture and laboratory. Prerequisite: BIOL 113. Prerequisites or corequisites: CHEM 101-102 or 107-108. Does not satisfy the requirements for the major in biological sciences. BIOL 251 and 252 combined count as one laboratory toward the laboratory requirements for majors.

BIOL 252. HUMAN ANATOMY AND PHYSIOLOGY II
Second part of one-year course covering normal human structure and function. Topics include circulatory dynamics, respiration, digestion, metabolism, temperature regulation, salt and water balance, reproduction and development. Lecture and laboratory. Prerequisite: BIOL 251. Does not satisfy the requirements for the major in biological sciences. BIOL 251 and 252 combined count as one laboratory toward the laboratory requirements for majors.

BIOL 260. PHYSIOLOGICAL ECOLOGY OF ANIMALS
The biological, physical and chemical nature of various environments and the physiological, morphological and behavioral adaptations of animals that occupy them. Lecture and discussion. Prerequisite: BIOL 114.

BIOL 266 (also GEOL 266). PALEOBIOLOGY (L)
Characteristics of fossils and of biological and geological systems that produced them. Development, form, mode of life, chronology of major fossil plant and animal groups; evolution and adaptation. Techniques in paleobiology. Interpretation of functional morphology and ancient environments. Laboratory and field studies. Prerequisite: GEOL 111, 112 or 113, or BIOL 114.

BIOL 301. (also BCHM 301) BIOCHEMISTRY: MOLECULAR BIOLOGY
Structure and function of nucleic acids. Mechanism and regulation of DNA replication, transcription, and protein synthesis in prokaryotic and eukaryotic cells. Viral replication, recombinant DNA techniques. Lecture and discussion. Prerequisites: BIOL 113, 114, 115, CHEM 111 (or 107 or 108), 231. Corequisite: CHEM 332.

BIOL 302. (also BCHM 302). BIOCHEMISTRY: METABOLIC ASPECTS
Cellular constituents, their role in life process. Molecular logic, water, structure, and function of proteins/enzymes, vitamins, hormones, other biomolecules. Metabolism of carbohydrates, lipids, nitrogenous compounds. Energetic and regulatory consideration of metabolism. Prerequisites: BIOL 113, 115, CHEM 111 (or 107 and 108), 231, and CHEM 332.

BIOL 303. (also BCHM 303). BIOCHEMISTRY: MOLECULAR BIOLOGY LABORATORY (L) *2 credits*
Molecular biology laboratory techniques: sterile technique and manipulation of microorganism, preparation of DNA libraries, subcloning DNA into vectors, detection of specific DNA and RNA sequences with nucleic acid and immunochemical probes, and sequencing of DNA. Lecture and laboratory. Prerequisite or corequisite: BIOL 301 or BCHM 301.

BIOL 304 (also BCHM 304). BIOCHEMISTRY LABORATORY (L) *2 credits*
Biochemistry laboratory techniques: isolation and purification of macromolecules, characterization of enzymes, chromatography, other methods of analysis. Lecture and laboratory. Prerequisite or corequisite: BIOL 302 or BCHM 302.

BIOL 310. CELLULAR ULTRASTRUCTURE
Structural approach to the organization and functioning of animal, plant and microbial cells, emphasizing results from electron microscopy. Among the topics discussed in detail are chromosome structure, the cytoskeleton, the photosynthetic apparatus, origin and evolution of the eukaryotic cell. The discussion period is devoted to developing skills in interpreting electron micrographs. Lecture and discussion. Prerequisites: BIOL 113, 114 and 115.

BIOL 311. PRINCIPLES OF CELL BIOLOGY *every semester*
Structure and function of cells. Emphasis on anatomy, biochemistry and biophysics of organelles to provide thorough understanding of intracellular and cell-to-cell regulation. Current research problems and special methods concurrently used to explore problems in cell biology. Prerequisites: BIOL 113 and 114; prerequisite or corequisite: CHEM 332.

BIOL 312. ANIMAL HISTOLOGY (L)
Microscopic study of mammalian tissues and organs. Microstructure of organs in relation to function. Recognition of tissues under the light microscope. Lecture and laboratory. Prerequisites: BIOL 113, 114, 115 and junior standing.

BIOL 313. CELLULAR NEUROBIOLOGY
Introduction to the organization and function of nervous systems in vertebrates and invertebrates. Topics include cell biology of neurons, physiology of excitable membranes and electrical signaling by neurons, sensory mechanisms, simple circuits and behavior, development and regeneration of nervous tissue. Emphasis will be placed on molecular neurobiology as it relates to understanding the function of ionic channels, second messenger systems, and learning and memory. Prerequisite: BIOL 113.

BIOL 318. DEVELOPMENTAL BIOLOGY (L)
Developmental biology of plants and animals from zygote to maturity, including such phenomena as embryogenesis, growth, regeneration, metamorphosis, gametogenesis and senescence. Cellular and molecular basis of determination and differentiation. Lecture and laboratory. Prerequisites: BIOL 113, 114, and 115.

BIOL 320. BIOLOGY OF MICROORGANISMS (L)
Diversity of microbes. Bacteria and their viruses. Interrelationships of bacteria and higher organisms, especially in regard to disease. Lectures, laboratory exercises; fundamental microbial techniques, such as sterility, pure cultures and use of microscope. Prerequisites: two semesters of biology and CHEM 231 (last may be taken concurrently).

BIOL 323. HISTOLOGICAL MICROTECHNIQUE (L)
Introduction to the theory and methods of microscope use and slide preparation. Students will gain practical experience in tissue sampling, fixation, sectioning, slide preparation, staining and analysis. Lecture and laboratory. Prerequisite or corequisite: BIOL 312 or permission of instructor.

BIOL 330. GENETICS *every semester*
Principles and problems of heredity. Elementary biometric tests and their interpretation. Introduction to microbial and molecular genetics. Genetic control of cellular function and differentiation. Lecture, discussion-demonstration. Prerequisites: BIOL 113, 114 and 115, or permission of instructor.

BIOL 335. MECHANISMS IN EVOLUTION
Fundamental principles of synthetic theory of evolution and its development. Sources of variability; organization of genetic variability in populations; differentiation of populations; reproductive isolation and origin of species; role of hybridization in evolution; major trends of evolution; processes of evolution in man. Prerequisites: BIOL 113 and 114. BIOL 330 recommended.

BIOL 341. PLANT ANATOMY (L)
Growth and structure of plant cells, tissues and organs. Phylogenetic relation between structure and function in spermatophytes. Lecture and laboratory. Prerequisite: BIOL 240 or consent of instructor.

BIOL 342. PLANT SYSTEMATICS (L)
Synthesis of evidence on relationships and evolutionary history of vascular plants. Emphasis is placed on important characters, field identification, determination of family and higher-level classification, and methods of analysis. Two lectures and one laboratory session per week.
Prerequisite: BIOL 114 or consent of instructor.

BIOL 343. EVOLUTIONARY HISTORY OF LAND PLANTS (L)
Comparative morphology and evolutionary history of major groups of land plants will be synthesized with an emphasis on evidence from the fossil record. Current problems, general theories, and experimental procedures stressed through readings, laboratory study and fieldwork. Lecture and laboratory. Prerequisite: BIOL 114 or BIOL 240, or permission of instructor.

BIOL 344. PHYCOLOGY (L)
Biology and diversity of the algae, including cell structure, importance in freshwater and marine communities, and use of algae as models for study of fundamental biological questions. Students will become familiar with common freshwater and marine algae. Lecture and laboratory. Field trips, exams and a project. Recommended prerequisite: BIOL 240.

BIOL 346. PLANT PHYSIOLOGY
Principles of physiology of green plants. Photosynthesis; water relations; mineral nutrition; translocation; cellular metabolism; growth and development. Lecture and discussion. Prerequisites: BIOL 113, 114, and 115. Prerequisite or corequisite: CHEM 332.

BIOL 350. ANIMAL PHYSIOLOGY
Structure and function of major physiological systems of vertebrate animals, from a comparative viewpoint. Effect of the physical and chemical environment at cellular, systemic and organismal levels. Lecture and discussion. Prerequisites: BIOL 113 and 114. Prerequisites or corequisites: BIOL 115 and CHEM 231.

BIOL 353. MAMMALIAN PHYSIOLOGY
Comparative approach to the design and function of the mammalian body, to include the skeletal, nervous, muscular, circulatory, respiratory, digestive, excretory and reproductive systems of mammals. Prerequisites: BIOL 113, 114 (or equivalent), and CHEM 107-108 (or equivalent). [Note: Either BIOL 350 or 353 may be counted toward the major, but not both.]

BIOL 358. AVIAN ECOLOGY AND CONSERVATION
2 credits
Basic biology of birds, focusing on characteristics affecting their ecological role. Conservation issues involving birds. Six to eight field trips emphasizing identification, behavior and ecology; two of these field trips on weekends. Prerequisite: BIOL 114.

BIOL 360. ECOLOGY (L) *every semester*
Relation of animals and plants to environment. Biological communities and physical factors acting on them, studied through lectures, readings, field and laboratory exercises. Field trips scheduled some weekends during semester. Prerequisite: BIOL 114.

BIOL 361. FRESHWATER WETLAND ECOLOGY (L)
2 credits
Structure and function of various freshwater wetland types, including swamps, marshes, fens and bogs. Use of indicator plants to identify wetland types. Laboratory time will involve field trips to different wetland types, learning to identify wetland plants and making a collection. Lecture and laboratory. Prerequisite: BIOL 114.

BIOL 363. ANIMAL BEHAVIOR (L)
Behavior of invertebrate and vertebrate animals from ecological and evolutionary viewpoint. Laboratory exercises explore behavioral research methodology, including independent project. Lecture and laboratory. Prerequisite: BIOL 250.

BIOL 366. ECOLOGICAL FIELD METHODS (L)
Experimental design in ecological field studies. Procedures for sampling populations (abundance, dispersion, diversity) will be discussed and several class projects and an individual field project will be conducted. Prerequisites: BIOL 360 and permission of instructor. Familiarity with basic statistics and computers is helpful.

BIOL 368. (also GEOG 422). BIOGEOGRAPHY
Ecological principles applied to the study of past, present and future distribution patterns of living organisms. Effects of earth history, spatial pattern, plate tectonics, climate and climate change, and human impacts on biota. Prerequisite: BIOL 360.

BIOL 369. (also GEOL 369). HISTORY OF TERRESTRIAL COMMUNITIES (L)
Interpretation of organism environment relationships. Reconstruction of terrestrial fossil assemblages in light of modern analogues. History of terrestrial communities, dynamics of community evolution. Lecture and occasional laboratory session. Prerequisite: any one of BIOL 114, 240, 266, or GEOL 266.

BIOL 415. BIOLOGICAL ACTIONS OF RADIATIONS
Physical and biological principles of radiation actions from atomic to organismic levels, including health effects, ecological effects, biological applications. Effects of ionizing radiations (e.g., subatomic charged particles, neutrons, x-rays, gamma rays) and nonionizing radiations (e.g., ultraviolet, infrared, microwaves, extremely low frequency waves). Prerequisites: BIOL 113, 114, CHEM 107 and 108, and high school physics.

BIOL 420. MICROBIAL GENETICS
Current understanding of the genetics of bacteria and bacteriophages. Primary focus on molecular genetic aspects of microbes with application to biotechnology. Structure of bacterial chromosome, DNA replication, damage and repair; strain construction, biochemical basis of mutations, transposable elements, mechanism of genetic transformation, transduction and conjugation; gene expression, regulation, expression of foreign genes in bacteria and yeast; application of engineered microorganisms in medicine, industry, and agriculture. Lecture and discussion. Prerequisite: one of BIOL 300, 301, 302, 320, 330, or equivalent.

BIOL 421. IMMUNOLOGY
Introduction to the immune mechanisms, which protect the body from invading microorganisms and disease. Topics include antibody production and function, cell-mediated immunity, hypersensitivity, and cytokines and their relation to disease. Prerequisites: One of BIOL 301, 302, 311, 320, BCHM 301, or 302.

BIOL 422. IMMUNOLOGY LABORATORY (L) *2 credits*
A survey of techniques and concepts currently used in experimental immunology. Methods will include immunoprecipitation, immunoelectrophoresis, enzyme linked immunosorbent assay, mitogenesis and cytokine secretion/quantification. An independent group project will also be required. Lecture and laboratory. Prerequisite or corequisite: BIOL 421.

BIOL 424. PHYSIOLOGY OF NUTRITION
Emphasis will be on the biochemical, cellular and physiological aspects of human nutrition as it relates to health and disease. Topics will include: metabolism and function of macro- and micronutrients, effect of diet on cancer and heart disease, weight control, nutrition in specific life stages, as well as practical information on a healthy diet. Prerequisites: BIOL 113 and 114; CHEM 231, or consent of instructor.

BIOL 432. MODEL BUILDING IN ECOLOGY, BEHAVIOR AND EVOLUTION
Mathematical, graphical and computer simulation models in ecology, animal behavior, and evolution. Emphasis on model-building as a conceptual skill that is used in conjunction with empirical research to answer important biological questions. Individual and/or group projects in which students review a subject and construct models. Prerequisite: A 300-level (or higher) course in ecology, evolution or behavior. Nonbiology majors should obtain permission of instructor.

BIOL 433. ADVANCED THEORETICAL BIOLOGY
Advanced topics and methods in theoretical biology. Students will conduct an independent project that involves reading the theoretical literature on a specific subject and building a theoretical model that extends the literature. Class will also meet as a group to discuss papers and learn methods in model building and computer simulation. Prerequisite: BIOL 432 or permission of instructor.

BIOL 452. BIOLOGY OF EXTREME ENVIRONMENTS
Physiological and ecological adaptations of organisms, especially vertebrates, to environments that represent the extremes compatible with life. Extremes of heat and cold, dry and wet, pressure and sound, salt and water concentrations, gases, electromagnetic radiation, gravity, size, nutrient availability as well as others will be considered. Prerequisite: either BIOL 350, 360, or BIOL 363, or consent of instructor.

BIOL 457. VERTEBRATE ENDOCRINOLOGY
Structure and function of major endocrine organs; roles of hormones in regulation of physiological processes, including reproduction, differentiation, growth, metabolism, and ion, mineral and water balance, mechanisms of hormone synthesis and action. Emphasis on basic knowledge derived from mammalian endocrine systems: some consideration of other vertebrates and applied and clinical aspects. Lecture and discussion. Prerequisite: BIOL 350 or equivalent, or consent of instructor.

BIOL 459. ENTOMOLOGY (L)
Physiology, morphology, development, behavior, ecology and agricultural/medical significance of insects. Lecture and laboratory or field trip. Prerequisites: BIOL 113, 114, and 115.

BIOL 460. TROPICAL MARINE BIOLOGY (L)
Fauna, flora and ecology of tropical marine communities, including coral reefs, seagrass beds, rocky shorelines and mangrove swamps. Prepares students for a week-long field trip to a tropical marine laboratory. Lecture/discussion/laboratory. Prerequisites: BIOL 114, 115, swimming skills, and consent of the instructor. Recommended prerequisite: BIOL 250 or 344.

BIOL 461. AQUATIC BIOLOGY (L)
Primary focus on environmental relations of and interactions among lake-dwelling populations. Lab option: basic field and lab procedures used to compare different lake types. Seminar option: oral presentations on eutrophication, pollution, species introduction, other applied topics. Prerequisites: BIOL 114 and 115; CHEM 108 or 111.

BIOL 463. TROPICAL ECOLOGY (L)
Ecology of tropical environments, emphasizing ecology of rain forests, cloud forests and disturbed areas. Special attention given to insect-plant interactions, bird ecology and the place of humans in the environment. Includes a 10-day field trip to Costa Rica over spring recess. Prerequisites: Permission of instructor; two of BIOL 240, 241, 250, 342, 358, 360 (preferred), 361, 363, 367, 368, 459.

BIOL 464. SOCIOBIOLOGY
Social behavior, social structure and evolution of social organization in animals from a naturalistic perspective. Emphasis on genetic determinants of social behavior and organization, evolution of different grades of social complexity in the ecological context. Brief treatment of controversy over application of sociobiological principles to humans. Prerequisite: One of BIOL 335, 360, 363, 459, or 462.

BIOL 466. BEHAVIORAL ECOLOGY OF PRIMATES
Behavioral adaptations and characteristics of primates—from prosimians to man—in relation to their ecology. Course stresses how foraging, mating and parental behaviors, behavioral development, cognition and social behavior are all interrelated and understandable in the context of the environment in which they evolved. By applying basic principles of behavioral ecology to this single taxonomic group, the influence of ecology on even complex behavioral characteristics can be clarified. Lecture and discussion. One required field trip during semester. Recommended prerequisites: familiarity with primate taxonomy (e.g. ANTH 338) and a course in animal behavior (BIOL 363, BIOL 464 or PSYC 227).

BIOL 470. EVOLUTION AND HUMAN BEHAVIOR
Implications of evolutionary theory for understanding human nature, including: a) the relationship between human behavior and biological fitness in modern and premodern societies, b) evolutionary psychology, c) evolutionary ethics and d) theories of culture as an evolutionary process. Prerequisites: Junior or senior standing and an introductory course in BIOL, PSYC, ANTH or SOC.

BIOL 479. SCIENTIFIC WRITING: TAKING THE CRAMP OUT *every semester, 2 credits*
The primary aim is to help students develop writing skills for professional success and personal satisfaction. Secondary aims are to help develop reading skills, speaking skills and general scientific literacy. Writing assignments and exercises introduce students to various types of scientific writing. Whenever possible, each student's interests determine the topics she or he covers. Prerequisites: BIOL 113, 114, and four advanced science courses.

BIOL 480. SEMINAR TOPICS *every semester, 2 credits*
Topics vary from semester to semester, and are in specialized areas. May be repeated for credit. Prerequisites may differ from section to section. Topics covered during recent academic years include aging, avian predators, genetic engineering, male reproduction, medical genetics and trace elements. Prerequisites vary.

BIOL 481. THE RESEARCH PROPOSAL IN BIOLOGY *2 credits*
Complements experience in independent research in biology, biochemistry, or biophysics. Guides students through the process of writing research proposals and of reviewing and evaluating their merits. Prerequisite: one summer or one semester of independent research in biology or related scientific discipline.

BIOL 482. THE ETHICS OF BIOLOGICAL RESEARCH *2 credits*
Discussion and debate on the regulations governing biological research and on the ethical questions that arise as a result of advances in molecular biology. Prerequisite: one summer or one semester of independent research in biology, biochemistry, or related discipline.

BIOL 490. SEMINAR TOPICS *2 credits*
Same as BIOL 480 but restricted to the Pass/Fail option by the instructor. Does not satisfy major or all-college requirements. Course is not included in the 24-credit limit of Harpur College.

BIOL 491. PRACTICUM IN COLLEGE TEACHING *every semester*
Independent study by assisting in a course. Various assignments directed by instructor, including laboratory instruction. May be repeated for total of no more than 8 credits. Credit may not be earned in conjunction with course in which student is currently enrolled. Does not satisfy major, minor or all-college requirements. Prerequisites: consent of instructor and department approval. P/F only.

BIOL 495. LABORATORY OR FIELD INTERNSHIP (L) *every semester, variable credit*
Internship or study, involving laboratory or field work, usually off campus, that is not independent research. A faculty member must approve in advance both the proposed work and the off-campus supervisor. The student must write a proposal before approval, keep a log during the work and submit a paper after the experience. Prerequisites: Permission of the instructor and departmental approval. P/F only.

BI0L 496. INDEPENDENT STUDY *every semester, variable credit*
Individual work, not involving field or laboratory research, under direct supervision of faculty member. Prior to registration, student must consult instructor and receive approval of problem to be investigated, and amount of credit to be received. Prerequisites: consent of department and junior standing.

BIOL 497. INDEPENDENT FIELD OR LABORATORY RESEARCH (L) *every semester, variable credit*
Individual field or laboratory research under direct supervision of faculty member. Prior to registration, student must consult instructor and receive approval of problem to be investigated, and amount of credit to be received. An application must be submitted to the departmental office. Prerequisites: consent of department and junior standing. Students in the honors program should register for this course.

COURSE OFFERINGS/ GRADUATE

BIOL 501. BIOCHEMISTRY: MOLECULAR BIOLOGY
Mechanism and regulation of DNA replication, transcription, biosynthesis of proteins, viral replication. Application of recombinant DNA techniques. Prerequisites: cell biology and organic chemistry.

BIOL 502. BIOCHEMISTRY: METABOLIC ASPECTS
Cellular constituents: their biosynthesis, roles in nutrition and energy metabolism, relations to structure, function, development and regulation. Four 1-hour lectures per week. Prerequisites: cell biology and organic chemistry, or consent of instructor.

BIOL 503. MOLECULAR BIOLOGY LABORATORY *2 credits*
Preparation of DNA libraries and subcloning, detection of specific DNA and RNA sequences, and sequencing of DNA. One 1-hour lecture and one 4-hour laboratory. Prerequisites: BIOL 501 and 504 or equivalents.

BIOL 504. BIOCHEMISTRY LABORATORY *2 credits*
Laboratory techniques including the purification of proteins, characterization of enzymes and other methods of analysis. One 1-hour lecture and one 4-hour laboratory per week. Prerequisite or corequisite: BIOL 502 or equivalent.

BIOL 510. BIOLOGICAL ULTRASTRUCTURE
An inquiry into the organization of cells and organelles and the relationship of structure to function. Discussion of methods of modern microscopy and interpretation of electron micrographs. Student presentations based on topics selected from current ultrastructural literature. Three hours of lecture, two hours of discussion per week. Prerequisite: college-level course dealing with cell biology at the introductory level.

BIOL 511. TECHNIQUES IN TRANSMISSION ELECTRON MICROSCOPY
Lecture course on principles of operation of transmission electron microscope, techniques used in preparation of biological specimens for examination. Prerequisite: consent of instructor. Recommended prerequisite: BIOL 510 or equivalent.

BIOL 512. PRINCIPLES OF SCANNING ELECTRON MICROSCOPY
2 credits
Training in the theory and operation of a scanning electron microscope and specimen preparation of biological and nonbiological samples. After achieving proficiency in the operation of the microscope, students will prepare and examine a variety of specimens. One quiz, one exam, a written report including micrographs. Prerequisite: consent of instructor.

BIOL 513. CELL AND MOLECULAR BIOLOGY I
A detailed study of various specific topics which transverse a broad range of fields in biochemistry, cell and molecular biology. Topics can vary but may include recent trends in molecular biology, intercellular communication, developmental genetics, and cell trafficking.

BIOL 514. CELL AND MOLECULAR BIOLOGY II
A continuation of BIOL 513 with detailed study of various specific topics in biochemistry, cell and molecular biology. Topics can vary but may include recent trends in molecular biology, the cell cycle and database information systems.

BIOL 515. BIOLOGICAL ACTIONS OF RADIATION
Physical and biological principles underlying interactions of ionizing and nonionizing radiations with living organisms. Modulation of radiation sensitivity, radiation damage, environmental hazards, applications to medicine and biology. Prerequisites: general physics and cell biology.

BIOL 516. TRANSMISSION ELECTRON MICROSCOPY LABORATORY
2 credits
Laboratory course in operation of transmission electron microscope, instruments and techniques used in preparing specimens for examination. Enrollment limited. Two 4-hour laboratory sessions per week. Prerequisite: consent of instructor. Corequisite: BIOL 511.

BIOL 520. MICROBIAL GENETICS
Current understanding of the genetics of bacteria and bacteriophages. Primary focus on molecular genetic aspects of microbes with application to biotechnology. Structure of bacterial chromosome, DNA replication, damage and repair; strain construction, biochemical basis of mutations, transposable elements, mechanism of genetic transformation, transduction and conjugation; gene expression, regulation, expression of foreign genes in bacteria and yeast; application of engineered microorganisms in medicine, industry, and agriculture. Lecture and discussion. Graduate students required to write an extra term paper for graduate credit. Prerequisite: Permission of instructor.

BIOL 521. IMMUNOLOGY
Introduction to the immune mechanisms, which protect the body from invading microorganisms and disease. Topics include antibody production and function, cell-mediated immunity, hypersensitivity, and cytokines and their relation to disease.

BIOL 522. IMMUNOLOGY LABORATORY
2 credits
A survey of techniques and concepts currently used in experimental immunology. Methods will include enzyme linked immunosorbent assay, immunoprecipitation, immunoelectrophoresis, mitogenesis and cytokine secretion/quantification. An independent group project will also be required. Lecture and laboratory.

BIOL 532. MODEL BUILDING IN ECOLOGY
The fields of ecology, animal behavior and evolution have become increasingly theoretical in their orientation. This course will review mathematical, graphical and computer simulation models on a variety of topics ranging from the behavior of individuals to the dynamics of multi-species communities. The emphasis will be on model-building as a conceptual skill that is used in conjunction with empirical research to answer important biological questions. Mathematical sophistication is not required, although students should be prepared to work through simple equations in detail. The course includes individual and/or group projects in which the students review a subject and construct their own models. Prerequisites: At least one 300-level (or higher) course in ecology, evolution and/or behavior, or permission of instructor.

BIOL 533. ADVANCED THEORETICAL BIOLOGY
Advanced topics and methods in theoretical biology. Students will conduct an independent project that involves reading the theoretical literature on a specific subject and building a theoretical model that extends the literature. Class will also meet as a group to discuss papers and learn methods in model building and computer simulation. Prerequisite: BIOL 432 or permission of instructor.

BIOL 535. PRINCIPLES OF EVOLUTIONARY BIOLOGY
Synthetic theory of evolution: sources of variability in populations; natural selection and random genetic drift; gene flow and population structure; differentiation among populations; reproductive isolation and the origin of species.

BIOL 537 (also GEOL 563). HISTORY OF TERRESTRIAL COMMUNITIES
Interpretation of organism-environmental relationships and reconstruction of ancient terrestrial communities. Prerequisite: one or more of following: paleobiology, biology of organisms-animals, botany, prehistoric archaeology, human evolution, ecological anthropology.

BIOL 546. PHYSIOLOGY OF PLANTS
Physical, chemical, structural bases for the functioning of plants, with emphasis on flowering plants. Recent advances in water relationships; mineral uptake and transport; photosynthesis; photomorphogenesis; recombinant DNA plant research, among other topics. Prerequisites: cell biology, organic chemistry and physics.

BIOL 547 (also GEOL 567). PALEOBOTANY
Fossil plants and their geologic history. Morphology and evolution of major plant groups. Plant microfossils, floral migrations, paleobotanical evidence of climatological change. Field trips. Three class periods, one 3-hour laboratory per week. Prerequisites: two upper-level botany courses.

BIOL 550. ANIMAL STRUCTURE AND FUNCTION
Morphological and physiological adaptations of animals to their environment. Physical, chemical, evolutionary principles. Three 1-hour lectures, one recitation/discussion session per week. Prerequisite: consent of instructor.

BIOL 552. BIOLOGY OF ANIMALS IN EXTREME ENVIRONMENTS
The study of physiological and ecological adaptations of animals to environments that represent the extremes compatible with life. Extremes of heat and cold, dry and wet, pressure and sound, salt and water concentrations, gases, electromagnetic radiation, gravity, size, nutrient availability as well as others will be considered. Prerequisite: a course in ecology, behavior or animal physiology, or consent of instructor.

BIOL 561. LIMNOLOGY
Physical, chemical, biological features of freshwater ecosystems. Environmental control of distribution and abundance patterns of lake and stream populations, competition and predator-prey relations, lake euthrophication and acidification. Prerequisite: basic chemistry.

BIOL 561L. LIMNOLOGY LABORATORY *2 credits*
Basic limnological field sampling and laboratory analysis procedures, comparative study of differing lake types in southern New York and northern Pennsylvania. May be taken concurrently with BIOL 561. Prerequisites: basic chemistry and consent of instructor.

BIOL 562. ADVANCED COMMUNITY ECOLOGY
Focus on patterns in structure of natural communities. Interactions of plants and animals, energy flow, community changes in time and space, major biomes and current experimentation. Three 1-hour lectures/discussions and one 4-hour laboratory per week. Prerequisite: consent of instructor.

BIOL 563. TROPICAL ECOLOGY
Ecology of tropical environments, emphasizing ecology of rain forests, cloud forests and disturbed areas. Special attention given to insect-plant interactions, bird ecology and the place of humans in the environment. Research paper on tropical ecology topic. Includes a 10-day field trip to Costa Rica over spring recess. Prerequisites: Permission of instructor, a basic ecology course and at least one other upper-level field biology course. Offered spring semester with field trip in January before semester begins. Fixed course.

BIOL 564. SOCIOBIOLOGY
Adaptive significance of animal social organization. Vertebrate intraspecific interactions, ecological perspectives. Mating systems, reproductive strategies and energetics, aggression, altruism, life history strategies and other topics. Prerequisite: consent of instructor.

BIOL 566. FIELD METHODS IN ECOLOGY
Ecological methods for studying plants and animals in natural populations; series of field studies. Population estimates, life history tables, patterns of dispersion, measurements of diversity and interactions. Class meets four hours per week. Prerequisite: consent of instructor.

BIOL 567. ADVANCED PLANT ECOLOGY *2 credits*
Environmental relations of plants, quantitative approaches to carbon gain and energy balance. Labs emphasize vegetation sampling and analysis. One lecture/discussion, one laboratory per week. Prerequisites: general ecology and graduate standing, or consent of instructor.

BIOL 568. BEHAVIORAL ECOLOGY OF PRIMATES
Behavioral adaptations and characteristics of primates—from prosimians to man—in relation to their ecology. Course stresses how foraging, mating and parental behaviors, behavioral development, cognition and social behavior are all interrelated and understandable in the context of the environment in which they evolved. By applying basic principles of behavioral ecology to this single taxonomic group, the influence of ecology on even complex behavioral characteristics can be clarified. Conservation issues will also be addressed. Three lecture hours and one discussion hour per week. One required field trip during semester. Recommended prerequisites: Familiarity with primate taxonomy (e.g. ANTH 338) and a course in animal behavior (BIOL 363, 464 or PSYC 227). Prerequisite: consent of instructor. (Taught simultaneously with BIOL 466.)

BIOL 570. EVOLUTION AND HUMAN BEHAVIOR
Despite the fact that Darwin's theory is more than 130 years old, attempts to understand human behavior in terms of evolutionary theory remain controversial. This course will critically examine the latest developments including: a) human sociobiology, b) theories of culture as an evolutionary process, c) evolutionary approaches to psychology and d) evolutionary approaches to morality. Three hours of lecture per week. No prerequisites. A brief tutorial of evolutionary theory will be offered at the beginning of the course for nonbiology graduate students.

BIOL 579. SCIENTIFIC WRITING FOR GRADUATE STUDENTS IN THE BIOLOGICAL SCIENCES *2 credits*
For graduate students in biological sciences faced with the arduous task of "writing up" research data for publication in scientific journals. Prerequisites: should have completed much of research and be ready to start writing manuscripts as part of the thesis or dissertation; permission of instructor.

BIOL 591. THE TEACHING OF COLLEGE BIOLOGY
2-4 credits/semester
Can be taken by teaching assistants or fellows as necessary. Course credit but no grade.

BIOL 595. SPECIAL STUDIES FOR MAT/MST STUDENTS
Open only to students enrolled in MAT and MST programs. Investigation in depth of some specific area of biology. Prerequisite: consent of faculty member under whom work is to be done.

BIOL 597. INDEPENDENT STUDIES IN BIOLOGY
1-4 credits/semester
Special training in subjects not offered in courses. Requires consent of instructor and departmental graduate committee. This course designation may be used only twice with student's major adviser as instructor, only three times in a degree program. Proper designation for thesis or dissertation research is BIOL 599 or 699.

BIOL 599. INVESTIGATIONS IN BIOLOGY—THESIS
1-6 credits/semester
Independent work and preparation of MA thesis on approved problem. Credit granted only after thesis is approved by student's committee.

BIOL 601A, B, C, D. DISCUSSIONS IN CELL AND MOLECULAR BIOLOGY *1 credit*
This class will discuss concepts and techniques used in modern cell and molecular biology research using published papers and research presentations by students, faculty and occasional outside speakers. It is expected that all graduate students in the cell, molecular and physiology fields will participate each semester of residence in the department. Pass/Fail grading.

BIOL 603. SCIENTIFIC INTEGRITY *1 credit*
Issues of scientific integrity will be examined using a case study approach. Topics will include authorship, ownership of data, care of research subjects, research conduct, mentoring, conflict-of-interest. Prerequisite: permission of instructor; completion of a semester of research recommended.

BIOL 604. SURVIVAL KIT FOR SCIENTISTS: PART I - TEACHING ISSUES
Various teaching issues will be addressed, such as how to develop a lecture, a course, a laboratory exercise, a cooperative learning exercise, and critical thinking and the art of synthesis in your students. Other topics include how to lead a discussion, how to supervise student researchers, how to teach for scientific literacy, and how to evaluate students and your own course. By the end of the course, students will have assembled a teaching portfolio. Permission of instructor required.

BIOL 605. SURVIVAL KIT FOR SCIENTISTS: PART II - RESEARCH ISSUES
Research issues will be addressed, such as the philosophy and application of the scientific method, lab management, how to supervise graduate research, strategies for short- and long-term projects, identifying projects suitable for students. Other topics will be how to present a seminar, high-technology acquisition of information, the art of publishing, postdoctoral strategies and getting a job. Prerequisite: permission of instructor; completion of two semesters of research recommended.

BIOL 606. HOW TO WRITE A GRANT PROPOSAL *3 credits*
The process of writing a proposal is broken into a series of steps. Funding by various agencies will be discussed. Strategies for writing proposals will be developed. Each student will produce a research proposal by the end of term, which will be reviewed by the class acting as the review panel. Prerequisite: permission of instructor; completion of one semester of research recommended.

BIOL 680. TOPICS IN BIOLOGY *2 credits*
Topics vary from semester to semester and are in specialized areas. In recent years, following topics have been given one or more times:

Allometry: Importance of Body Size
Aquatic Botany
Behavioral Ecology
Biochemical Basis of the Immune Response
Biological Statistics
Biotechnology
Cell Organelle Development
Chemical Evolution and the Origin of Life
Community Ecology
Control of the Immune Response
Current Research in Animal Behavior
Current Topics in Paleoecology
Current Topics in Theoretical Ecology
Developmental Biology
Eukaryotic Protein Biosynthesis
Evolution of Vascular Tissue
Gymnosperms
Human Nutrition, Health and Disease
Image Analysis
Mammalian Population Regulation
Membrane Trafficking
Molecular Biology and Biochemistry of Seed Proteins
Molecular Biology of Nitrogen Fixation
Molecular Evolution
Paleobotanical Techniques
Protein, Protein Interactions and Catalysis
Protein Trafficking in Cells
Topics in Cellular Differentiation
Topics in Endocrinology
Topics in Global Ecology
Topics in Plant Ecology
Topics in Protein Chemistry
Topics in Regulatory Genetics
Topics in Reproductive Biology
Topics in Vertebrate Ecology

May be repeated for credit. Prerequisite: consent of instructor.

BIOL 696. RESEARCH IN BIOLOGY *1-9 credits*
Original laboratory or field research leading to preparation of dissertation prospectus. May be taken only by PhD track students prior to admission to candidacy for doctor of philosophy degree. Prerequisite: consent of instructor.

BIOL 698. PREDISSERTATION RESEARCH *1-9 credits/semester*
Independent reading and/or research in preparation for comprehensive examinations for admission to PhD candidacy, and/or preparation of dissertation prospectus. May be taken only with permission from director of graduate program. Graded on S/U basis only.

BIOL 699. INVESTIGATIONS IN BIOLOGY—DISSERTATION *1-9 credits/semester*
Independent work and preparation of PhD dissertation on approved problem. Credit granted only after dissertation is approved by student's committee.

BIOL 700. CONTINUOUS REGISTRATION *1 credit/semester*
Required for maintenance of matriculated status in graduate program. No credit toward graduate degree requirements.

BIOL 707. RESEARCH SKILLS *1-4 credits*
Development of research skills required within graduate programs. May not be applied toward credits for any graduate degree. Prerequisite: approval of relevant graduate program directors or department chairs.