

Biology

246 Science Building II
503-725-3851
www.bio.pdx.edu

B.A., B.S.
Minor
Secondary Education Program
M.A., M.S.
M.A.T. and M.S.T. (Science/Biology)
Ph.D.—Biology

Undergraduate programs

The biology program is designed to prepare students for careers in biological research, development, and teaching, and in health sciences, nursing, biotechnology, conservation biology and wildlife management, forestry, and other applied fields. It also provides the necessary background for prospective teachers and for advanced study leading to graduate degrees in the more specialized fields of the biological sciences.

A student planning to enter medicine, dentistry, or other professional fields should consult the catalog of the professional school to which the student intends to apply following pre-professional work in biology and other sciences at Portland State. Biology is also a teaching endorsement area in the program of secondary education.

The Oregon University System maintains the Institute of Marine Biology near Coos Bay and the Hatfield Marine Sciences Center in Newport on the Oregon coast. PSU also participates in programs at the Malheur Field Station in southeastern Oregon. Biology majors are encouraged to spend a summer at one of these institutions.

Admission requirements

Admission to the department is based on general admission to the University. See page 37 for more information.

Degree Requirements

Requirements for major. In addition to satisfying general University requirements, a student majoring in biology must meet general department major requirements and specific requirements in one of the biology major options.

General requirements are completion of two terms of statistics or two terms of calculus; three terms of science majors' introductory chemistry with laboratory; one term of organic chemistry; Ph 201, 214; and 12 elective credits from geology, physics, or

chemistry at the 200 level or higher. All biology majors must complete at least 60 credits in biology including three terms of science majors' introductory biology with laboratory. Of the 60 credits in biology at least 44 must be upper-division, including one term of genetics (Bi 341, Introduction to Genetics) and fulfillment of one of the options listed below. Students must receive a grade of C- or better in all upper-division courses specifically listed in the four options.

Biology courses taken pass/no pass are not acceptable toward fulfilling departmental major requirements, with the exception of courses numbered Bi 401, 404, 405, 406, and 407 which are only offered pass/no pass. Of the 60 credits required in biology, at least 46 credits must be in courses other than Bi 401, 404, 405, 406, and 407. The remaining 14 credits may include no more than a total of 6 credits in Bi 401, 404, 405, and 406.

Biology majors interested in the Biology honors track may obtain information on that in the Biology Dept. Office.

Option I: General Biology

	Credits
Bi 251-253 Principles of Biology.....	15
Bi 341 Genetics.....	4
At least two of the following courses:	
Bi 336 Cell Biology.....	4
Bi 344 Molecular Biology.....	5
Bi 357 General Ecology.....	4
Upper-division electives.....	32-33

Courses taken as upper-division biology electives must include at least one other upper-division course in each of the following areas:

Botany

Bi 433 Morphology of Vascular Plants
Bi 435 Plant Systematics
Bi 441 Plant Physiology
Bi 471 Plant Ecology
ESM 445 Phytoplankton Ecology

Zoology

Bi 387 Vertebrate Zoology
Bi 413 Herpetology
Bi 414 Ornithology
Bi 415 Mammalogy
Bi 416 Marine Mammals
Bi 461 Invertebrate Zoology

Microbiology

Bi 421 Virology
Bi 430 Theory of Recombinant DNA Techniques
Bi 480, 488 Microbiology and Techniques

Evolutionary biology

Bi 358 Evolution
Bi 427 Evolutionary Genetics
Bi 428 Human Genetics
Bi 476 Population Biology

Several different avenues of study may be followed under the general track. These include emphases in ecology, evolution, bota-

ny, microbiology, and field biology. Please consult your adviser for more details. The remaining courses taken to meet upper-division elective requirements in biology may be selected from any upper-division courses offered by the Department of Biology (courses with a "Bi" prefix).

Option II: Organismal Biology

	Credits
Bi 251-253 Principles of Biology.....	15
Bi 341 Genetics.....	4
Bi 336 Cell Biology.....	5
Bi 357 General Ecology.....	4
Bi 358 Evolution.....	4
Upper-division electives.....	28

Courses taken as upper-division biology electives must include at least one course from each of the following sub-areas:

Systems physiology

Bi 301, Bi 302, Bi 303 Human Anatomy and Physiology (4, 4, 4)
Bi 417 Mammalian Physiology (4)
Bi 418 Comparative Animal Physiology (4)
Bi 419 Animal Physiology Laboratory (4)
Bi 441 Plant Physiology (5)
Bi 462 Neurophysiology (4)
Bi 463 Sensory Physiology (4)

Structure/systematics/development

Bi 326 Comparative Vertebrate Embryology (5)
Bi 328 Comparative Vertebrate Anatomy (5)
Bi 387 Vertebrate Zoology (6)
Bi 413 Herpetology (6)
Bi 414 Ornithology (6)
Bi 415 Mammalogy (6)
Bi 416 Marine Mammals (6)
Bi 433 Morphology of Vascular Plants (4)
Bi 435 Plant Systematics (4)
Bi 455 Histology (6)

Ecology/genetics/evolution/behavior

Bi 360 Introduction to Marine Biology (3)
Bi 412 Animal Behavior (4)
Bi 427 Evolutionary Genetics (4)
Bi 428 Human Genetics (4)
Bi 471 Plant Ecology (4)
Bi 472 Natural History (3)
Bi 476 Population Biology (4)
ESM 475 Limnology and Aquatic Ecology (4)

The remaining courses taken to meet upper-division elective requirements in biology may be selected from any upper-division courses offered by the Department of Biology (courses with a "Bi" prefix).

Option III: Microbiology/ Molecular Biology

	Credits
Bi 251-253 Principles of Biology.....	15
Bi 336 Cell Biology.....	5
Bi 337 Cell Biology Lab.....	2
Bi 344 Molecular Biology.....	4
Bi 341 Genetics.....	4
Bi 358 Evolution.....	4
Bi 480, 488 Microbiology and Techniques.....	6
Upper-division electives (must include at least 12 credits from the following list):.....	20
Bi 421 Virology	
Bi 423 Microbial Ecology	
Bi 424 Molecular Genetics	
Bi 428 Human Genetics	

Bi 430, 431 Recombinant DNA Techniques and Laboratory
 Bi 456 Developmental Biology
 Bi 481 Microbial Physiology
 Bi 486 Pathogenic Bacteriology
 Bi 487 Immunology
 Bi 450 Phylogenetic Biology
 Selected Bi 410/510 courses with advisor approval.

The remaining courses taken to meet upper-division elective requirements in biology may be selected from any upper-division courses offered by the Department of Biology (courses with a "Bi" prefix).

Option IV: Botany

	Credits
Bi 251-253 Principles of Biology.....	15
Bi 341 Genetics.....	4
At least two of the following courses:	
Bi 344 Molecular Biology.....	4
Bi 336 Cell Biology.....	5
Bi 357 Ecology.....	4
Upper-division biology electives.....	32-33

Courses taken as upper-division biology electives must include at least four courses from the lists below and at least one course from each of the following sub-areas.

Structure and function

Bi 330 Introduction to Plant Biology
 Bi 433 Morphology of Vascular Plants
 Bi 434 Plant Anatomy
 Bi 441 Plant Physiology
 ESM 445 Phytoplankton Ecology

Evolution and systematics

Bi 426 Evolution
 Bi 435 Plant Systematics
 Bi 476 Population Biology

Ecology

Bi 471 Plant Ecology
 ESM 475 Limnology and Aquatic Ecology

The remaining courses taken to meet upper-division elective requirements in biology may be selected from any upper-division courses offered by the Department of Biology (courses with a "Bi" prefix).

Requirements for minor. To earn a minor in biology, a student must complete at least 27 credits (at least 9 credits of which must be taken in residence at PSU), to include the following:

	Credits
Bi 251, 252, 253 Principles of Biology.....	15
Upper-division credits to include at least one course from each of the following three areas.....	12-15

Area I: Cellular Biology

Bi 336 Cell Biology
 Bi 341 Introduction to Genetics
 Bi 480 Microbiology

Area II: Organismal Biology

Bi 301, 302, 303 Human Anatomy and Physiology
 Bi 326 Comparative Vertebrate Embryology
 Bi 328 Comparative Vertebrate Anatomy
 Bi 330 Introduction to Plant Biology
 Bi 387 Vertebrate Zoology
 Bi 433 Morphology of Vascular Plants
 Bi 434 Plant Anatomy
 Bi 455 Histology
 Bi 461 Invertebrate Zoology

Area III: Ecology and Evolutionary Biology

Bi 357 General Ecology

Bi 358 Evolution
 Bi 360, 361 Introduction to Marine Biology and Laboratory
 Bi 423 Microbial Ecology

Total 27-30

Courses taken under the undifferentiated grading option (pass/no pass) will not be accepted toward fulfilling department minor requirements. Bi 401, 404, 405, 406, and 407 are not allowed for the minor. Additional courses may be required as pre-requisites.

SECONDARY EDUCATION

Adviser: S. Eppley, L. Weasel

Students who wish to teach biology in secondary schools should complete one of the two programs shown. Courses are to be taken for differentiated grades, except for those offered for pass/no pass only. Students must have at least a 3.00 GPA in the recommended science courses and must earn at least a C in each course of the endorsement area. Students should also take Ed 420 Introduction to Education and Society; Psy 311; and one of the following: Comm 100, 229, 220, 262, or 324.

Biology majors. The student must complete a biology major's program as outlined above, to include a course each in microbiology, ecology, genetics, and evolution. (*See adviser.*)

	Credits
Biology (see adviser).....	60
Mathematics (see above).....	8
Chemistry (see above).....	19
Physics (see above).....	5
Electives (see above).....	12
Total	104

Nonbiology majors

One year-long sequence in introductory biology.	9
Bi 234, 235 Elementary Microbiology.....	6
One course each in both anatomy and physiology	8
Bi 341 Introduction to Genetics.....	4
Bi 357 General Ecology.....	4
Bi 426 Evolution.....	4
Biology elective in botany or field-oriented course.....	4
Biology total	39

Physical science electives as approved by adviser.....	18
Total	57

Graduate programs

The Department of Biology offers graduate degrees leading to the Master of Arts or Master of Science, and the Master of Arts in Teaching or Master in Teaching Science/Biology. The department also offers an advanced Ph.D. degree in biology. The latter specialized degree is attained through the successful completion of requirements as stipulated by the department and the student's research committee (see below).

Admission requirements

In addition to the instructions for admission to the graduate program as they appear on page 59, the department requires the following information from each applicant to the M.A./M.S. program in biology and the Ph.D. program:

1. Satisfactory scores on the general Graduate Record Examination (GRE), satisfactory scores on the advanced biology examination if applicant does not have a degree in biology.
2. Three letters of evaluation from persons qualified to assess the applicant's promise as a graduate student.

The student should contact the department for a statement of current admission policy.

The prospective student should realize that a high GPA and acceptable GRE scores do not guarantee admission to the graduate programs in biology. This is because of the many departmental factors which must be taken into consideration, such as availability of appropriate advisers and research space.

Degree requirements

University master's degree requirements are listed on page 67. Specific departmental requirements are listed below. All M.S., M.S.T., M.A.T. and Ph.D. students are required to take Bi 598 Graduate Research Prospectus, and Bi 599 Graduate Grant Writing, in the fall and winter quarters, respectively, following admission to the program.

Master of Arts or Master of Science. Satisfactory completion of at least 45 credits of approved graduate-level courses required for a master's degree. The student must complete at least 30 credits in the field of biology. No more than 9 credits may be in Bi 503 Thesis. No more than a total of 12 credits may be in research (Bi 501) and reading and conference (Bi 505). No more than a total of 9 credits may be in seminar (Bi 507). A maximum of 12 credits may be programmed as electives in fields related to biology in consultation with the degree adviser. Successful completion of a final oral examination and a thesis is required. Full time students must complete their degree within 4 years of entry into the program.

Master of Arts in Teaching or Master of Science in Teaching. The College of Liberal Arts and Sciences offers the M.A.T./M.S.T. degrees in Science/Biology. In consultation with the graduate adviser, the student should establish the degree program before the completion of 15 credits of coursework. The program must include a minimum of 45 credits in approved graduate courses, to include a minimum of 24 credits in the area of concentration. At least 9 credits, but no more than 15 credits, must be in

education courses and must include Ed 520 Introduction to Education and Society. The 45 credits required must include 6 credits in either Bi 501 Project Track: Research Project relating to biology teaching (i.e. curriculum module, grant proposal, community development project) as approved by student's committee; or Bi 504 Practicum Track: 6 credits in practicum/internship/ community outreach experience as approved by student's committee. In order to fulfill requirements for the degree, the student must satisfactorily complete the degree program and pass both a final written examination and a final oral examination.

Continuing teaching license. The requirements for the continuing teaching license include satisfactory completion of 45 credits of upper-division and graduate work earned subsequent to receipt of a bachelor's degree. The 45 credits are in addition to those required for the initial teaching license. For the continuing endorsement in biology, the student must take at least 15 credits of adviser-approved graduate-level work distributed to strengthen the student's background in science. Although no specific courses in science are required for the continuing endorsement, combined undergraduate and graduate preparation must include at least 36 credits in biology and must include specific courses. Each student's program is tailored to meet the needs of the individual and the requirements of the continuing endorsement and the continuing license. See page 99 for the required education courses.

Doctor of Philosophy. Prospective Ph.D. students are required to take Bi 598 (Graduate Research Prospectus), Bi 599 (Graduate Grant Writing) in the fall and winter quarters, respectively, of their first year of admission to the program. The student must also have taken a departmental comprehensive exam by the fifth quarter after entering the program, followed the next quarter by a formal defense of their Ph.D. prospectus. Successful completion of the degree is contingent on the completion of original research, and presentation of results in a public oral defense and production of a formal dissertation that is submitted to and approved by the student's research committee and the University's Office of Graduate Studies. Students must complete their degree within seven years of entry into the program.

Courses

Courses with an asterisk () are not offered every year.*

Bi 101, 102, 103

General Biology (3, 3, 3)

The fundamental principles of life as they apply to both plants and animals. If taken after completing courses with similar materials credit will

be restricted Concurrent enrollment in Bi 104, 105, 106 required.

Bi 104, 105, 106
General Biology Labs (1, 1, 1)

Laboratory to accompany General Biology (Bi 101, 102, 103). Previous or concurrent enrollment in 101, 102, 103 is required. One 2-hour laboratory per week.

***Bi 161**
Food, Plants, and People (3)

The role of plants in human affairs as sources of food, fiber, fuel, beverages, and drugs. This course does not satisfy the Department of Biology botany course requirement and is intended for nonmajors.

***Bi 175**
Evolutionary Concepts (3)

This class is designed to provide background in evolutionary concepts for nonmajors and to address current issues in evolution as they are perceived and are being investigated by various members of our faculty in biology and geology. It is a combined lecture and discussion class and will include occasional guest lecturers presenting their research and views on various topics in evolution.

Bi 199
Special Studies (Credit to be arranged.)

Bi 234
Elementary Microbiology (4)
Introduction to the basic and applied aspects of microbiology, with special emphasis on the role of microorganisms in human affairs. Such fields as nursing, environmental protection, food technology, and public health are given special attention. Topics will include microbial growth and death, human disease, environmental microbiology, food and industrial microbiology, microbial aspects of water and sewage treatment, aspects of microbial gene flow, genetic engineering, and vaccine development.

Bi 235
Microbiology Laboratory (2)

The laboratory is designed for science majors and others who need practical experience in culturing and observation of microorganisms. Topics will include culture techniques, use of the microscope for observation of microorganisms, and procedures for study of microorganisms in the laboratory and field. Two 2-hour laboratory periods.

Bi 251, 252, 253
Principles of Biology (5,5,5)

Study of the basic principles of living organisms. The course will study both plants and animals and topics will include cell structure, energy production synthesis, nutrition, genetics, evolution, classification, excretion mechanisms of response, reproduction and development, and ecology. Lab investigations will use laboratory, field study, and special readings. Four hours lecture and one 3-hour laboratory. Recommended prerequisite: Ch 221, 227 or concurrent enrollment in Ch 221, 227.

Bi 299
Special Studies (Credit to be arranged.)

Bi 301, 302, 303
Human Anatomy and Physiology (4, 4, 4)

Fundamental principles of microanatomy, macroanatomy, genetics, embryology, and physiology, as applied to the human organism will be presented and correlated to provide a comprehensive understanding of man as a functionally integrated biological entity. One 3-hour laboratory period. A previous course in chemistry is recommended.

Recommended prerequisite: one year of college biological science.

***Bi 326**
Comparative Vertebrate Embryology (5)
Comparative study of the development of representative vertebrates, including the cellular mechanisms responsible for early morphogenesis. One 4-hour laboratory period. Recommended prerequisite: one year of introductory biology.

***Bi 328**
Comparative Vertebrate Anatomy (5)
Gross dissection and comparison of organ systems in representative vertebrate forms. Two 4-hour laboratory periods. Recommended prerequisite: Bi 252.

***Bi 330 Introduction to Plant Biology (4)**
Plant diversity, structure and function in relationship to evolution, habitat, and interactions with other organisms. Historical impacts of plants on human culture, including conservation, biotechnology, and world food supply. Recommended prerequisites: Bi 251, 252, 253.

Bi 334
Molecular Biology (4)
The principles, concepts and methods of molecular biology focusing on structure, biochemistry, biosynthesis and regulation of cellular macromolecules-DNA, RNA and proteins. Topics covered include the nature, structure, regulation and expression of genes, molecular aspects and regulation of translation, DNA replication and repair, mutagenesis, and an introduction to molecular techniques. Expected preparation: Bi 251.

Bi 336
Cell Biology (5)
An introduction to the biology of eukaryotic (plant/animal) and prokaryotic cells (bacteria, etc.) with emphasis on physiology, biochemistry, morphology, and energetics. Four hours of lecture and one hour of recitation. Recommended prerequisites: one year of introductory biology and one year of introductory chemistry.

Bi 337
Cell Biology Laboratory (2)
Experiments in cell biology to complement lecture. One three-hour laboratory. Recommended prerequisite: prior completion of/or concurrent enrollment in Bi 336.

Bi 341
Introduction to Genetics (4)
A study of the mechanism of biological inheritance. One 2-hour recitation period. Recommended prerequisite: one year of biological science.

Bi 343
Genes and Society (4)
Explores the principles of genetics, molecular biology, and biotechnology within social and historical context. Emphasis on the ethical issues arising from the intersection of genetics, technology, and society, with attention to the role of gender, race, and class in the formation and application of scientific knowledge.

Bi 357
General Ecology (4)
The study of the interrelationships of plants and animals with their environment. Emphasis is on basic ecological principles and concepts, not on current environmental problems. Recommended prerequisite: one year of biological science.

Bi 358**Evolution (4)**

Examination of processes underlying evolutionary change and patterns of biodiversity generated by these processes. Introduction to elementary population genetics, quantitative genetics, and phylogenetics. Emphasizes methods of reasoning and experimentation used in evolutionary research. Recommended prerequisite: Bi 341.

Bi 360*Introduction to Marine Biology (3)**

Introduction to the marine environment and its life forms. Survey of organismal diversity with emphasis on structural and physiological adaptations to the marine realm. Recommended prerequisite: one year of biological science.

Bi 361*Introduction to Marine Biology Laboratory (1)**

Laboratory and field work in marine biology. One 3-hour laboratory period. Recommended prerequisite: completion of or concurrent enrollment in Bi 360.

Bi 387**Vertebrate Zoology (6)**

Introduction to the classification, anatomical characteristics, distribution, and life habits of fishes, amphibians, reptiles, birds, and mammals. Two 2-hour lectures, one 3-hour laboratory. Recommended prerequisite: one year of college-level biology or zoology.

Bi 399**Special Studies (Credit to be arranged.)****Bi 401/501****Research (Credit to be arranged.)****Bi 404/504****Cooperative Education/internship (Credit to be arranged.)****Bi 405/505****Reading and Conference**

(Credit to be arranged.) Pass/no pass only.

Bi 406**Laboratory Project (Credit to be arranged.)****Bi 407/507****Seminar (Credit to be arranged.)**

Selected topics in biology.

Bi 410/510**Selected Topics (Credit to be arranged.)**

Consent of instructor.

Bi 412/512**Animal Behavior (4)**

An evolutionary approach to the study of animal behavior. The importance of ecological, physiological, and social variables will be examined in relation to the behavior of the individual animal. Recommended prerequisites: one year of introductory biology and upper-division standing.

Bi 413/513*Herpetology (6)**

Study of the distinguishing features, anatomy, physiology, origins, evolution, and ecology of amphibians and reptiles. North American species are emphasized. Two 2-hour lectures, two 2-hour laboratories. Recommended prerequisite: Bi 387.

Bi 414/514*Ornithology (6)**

Study of the evolution, diversity, ecology, physiology, and behavior of birds. Two 2-hour lectures and one 3-hour laboratory. The laboratory emphasizes species identification and exposes students to techniques used in museum and field studies. Students are required to conduct a research project outside of scheduled laboratory time. Recommended prerequisite: Bi 387.

Bi 415/515**Mammalogy (6)**

Study of the diversity, characteristics, evolution, structure, function, distribution, and life habits of mammals. North American Species are emphasized. Two 2-hour lectures, two 2-hour laboratories. Recommended prerequisite: Bi 387.

Bi 416/516*Marine Mammals (6)**

Study of the distinguishing features, classification, origins, evolution, physiology, anatomy, behavior, ecology, and status of groups of marine mammals. Two 2-hour lectures, two 3-hour laboratories. Expected preparation: upper-division physiology course.

Bi 417/517**Mammalian Physiology (4)**

Physiology of the mammalian cardiovascular, respiratory, renal and digestive systems with emphasis on homeostatic control and integration of these systems in normal and pathophysiological states. Recommended prerequisite: upper-division physiology course.

Bi 418/518**Comparative Animal Physiology (4)**

Physiology of metabolic, respiratory, circulatory, excretory, muscle, and nervous systems with emphasis on a comparative ecological approach. Recommended prerequisite: upper-division physiology course.

Bi 419/519*Animal Physiology Laboratory (4)**

Laboratory experiments on the physiology of animals from the cell through organismic levels. Two 3.5-hour laboratory periods. Recommended prerequisite: Bi 336, 417 or 418. May be concurrent.

Bi 421/521**Virology (4)**

A study of the classification, structure, genetics, molecular biology of replication, cell interactions, and host response of representative groups of bacterial, plant, and animal viruses, and the medical aspects of important human viruses. Recommended prerequisite: Bi 338.

Bi 423/523**Microbial Ecology (4)**

Study of the interaction of microorganisms with each other and plants and animals; soil and aquatic systems; microbial evolution; cycles of matter; biodegradation and microbial pest control. Recommended prerequisite: Bi 480.

Bi 424/524**Molecular Genetics (4)**

The nature of the gene and its mode of action, organization of the genetic material, and the regulation of gene action. Recommended prerequisite: Bi 338.

Bi 427/527*Evolutionary Genetics (4)**

An introduction to population genetics theory and an examination of the genetic techniques that are used to look at populations, speciation, and phylogenetic relationships. Recommended prerequisite: Bi 341, Bi 426.

Bi 428/528*Human Genetics (4)**

The organization of the human genome, pedigree analysis, gene mapping, chromosome abnormalities, sex determination, and gene defects (metabolic and hemoglobin). Topics are discussed from the point of view of clinical applications and current research. Recommended prerequisite: Bi 341.

Bi 429/529**Conservation Biology (4)**

Examination of the principles of conservation biology and applications of theory to conservation issues, globally and in the Northwest. Recommended prerequisites: Bi 341, 357, 387, 426.

Bi 430/530**Theory of Recombinant DNA Techniques (4)**

Lectures on the principles and theory of recombinant DNA and molecular cloning techniques. Topics will cover use of restriction and other DNA modifying enzymes, host-vector systems, DNA fragment and plasmid isolation techniques, gene mapping, subcloning techniques, in vitro mutagenesis, cDNA and genomic cloning, screening of clones, blot hybridizations, DNA transfection and use of reporter genes, DNA sequencing and PCR. Recommended prerequisite: Bi 338.

Bi 431/531**Recombinant DNA Techniques****Laboratory (2)**

Laboratory of recombinant DNA and molecular cloning techniques. Corequisite: Bi 430/530.

Bi 432/532*Plant Diversity and Evolution (5)**

Study of the morphology, structure, and life history of green algae, bryophytes, and vascular plants from an evolutionary point of view. Two 2-hour lectures and one 3-hour laboratory. Recommended prerequisite: Bi 253

Bi 433/533*Morphology of Vascular Plants (4)**

Study of the gross morphology, development, and structure of roots, stems, leaves, and flowers from an evolutionary point of view. One 3-hour laboratory. Recommended prerequisite: Bi 330.

Bi 434/534*Plant Anatomy (5)**

Study of the structure of meristems, cells, tissues, and tissue systems of roots, stems, leaves, flowers, and fruits from the developmental and comparative standpoint. One 3-hour laboratory. Recommended prerequisite: Bi 330.

Bi 435/535**Plant Systematics (4)**

Study of angiosperm classification, diversity, and evolutionary relationships. Methods of phylogenetic analysis and current hypotheses regarding angiosperm phylogeny are emphasized. Lab will focus on the form and floral structure of about 30 local plant families. One 3-hour laboratory. Recommended prerequisite: Bi 330.

Bi 441/541**Plant Physiology (5)**

An introduction to the metabolic activities of plants. Two 3-hour laboratory periods. Recommended prerequisite: Bi 336 or one term of biochemistry.

Bi 442/542*Plant Physiology (3)**

Biochemical activities of plants, photosynthesis, and respiration. Course is intended to be taken in sequence with Bi 441. Recommended prerequisite: Bi 441.

Bi 450/550**Phylogenetic Biology (4)**

Study of the history of life's diversification through the use of phylogenetic trees, with a focus on how genes, organisms, and traits have evolved. Includes hands-on computer analyses of DNA sequences. Recommended prerequisites: Bi 424, 426.

Bi 455/555

Histology (6)

Systemic study, description, and identification of histological structures. Two 3-hour laboratory periods. Recommended prerequisite: two years of biology.

Bi 456/556

Developmental Biology (4)

Explores basic principles of how organisms develop from a fertilized egg into a complex, multicellular adult. Focuses on contemporary issues in developmental biology, including pattern formation, morphogenesis, determination, and differentiation in vertebrates and invertebrates. Recommended prerequisite: Bi 336, 341.

***Bi 461/561**

Invertebrate Zoology (5)

A survey of invertebrate animal diversity, with a focus on species of the Pacific Northwest. Emphasis on evolution of adaptations in anatomy, physiology, and behavior. Two 2-hour lectures, one 3-hour laboratory, with some field trips outside of class time. Recommended prerequisite: one year of introductory biology.

Bi 462/562

Neurophysiology (4)

Lectures covering the basic anatomy of the vertebrate central nervous system (CNS) and the cellular bases for resting, graded and action potentials. Also, chemical and electrical signaling between cells of the nervous system is discussed, including pharmacological intervention in the CNS. Lastly, several model systems for integrative neuroscience are described including the visual and somatosensory systems, learning, memory, and simple motor pattern generators. Recommended prerequisite: Bi 336.

Bi 463/563

Sensory Physiology (4)

An exploration of the range of animal senses with lecture and discussion of the principles of sensation and sensory communication in general, and the detailed physiology of transduction for mechanical, electromagnetic, chemical, nociceptive, and thermal senses. Recommended prerequisite: Bi 462/562.

***Bi 471/571**

Plant Ecology (4)

A study of the interrelationships between plants and their environment with emphasis upon individual adaptation and community dynamics. One 3-hour laboratory period. Recommended prerequisite: Bi 357 or equivalent.

***Bi 472/572**

Natural History (3)

A study of plant and animal interrelationships, emphasizing maintenance of proper field records, identification, distribution, and ecology of vertebrates in Oregon. Includes one two-hour laboratory. Recommended prerequisite: one year of biology.

Bi 473/573

Field Sampling (4)

An introduction to the methods commonly employed for collecting and interpreting ecological data. One 3-hour laboratory. Recommended prerequisite: Bi 357.

***Bi 476/576**

Population Biology (4)

A study of classical and modern theories of the growth and regulation of natural populations of plants and animals. Emphasis will be placed on quantitative models. Topics will include: age-spe-

cific population growth; population growth in a limited environment; competitive and predator-prey interactions; biotic diversity; data collection and mathematical modeling of actual populations. Recommended prerequisite: Bi 357.

Bi 480/580

Microbiology (4)

Fundamental concepts and techniques of microbiology. The general principles of microbial cell structure and function, physiology and biochemistry, growth, survival, classification, and diversity are emphasized. Expected preparation: Bi 334 and Bi 336.

***Bi 481/581**

Microbial Physiology (3)

Physiology and biochemistry of microorganisms. Modern contributions to microbiology emphasized. Micro- and macro-molecular anatomy of microbial cells; energy metabolism, biosynthetic pathways and their regulation, kinetic and molecular aspects of growth, genetics, evolution, and ecology. Recommended prerequisites: Bi 480, 488, and either Bi 336 or one term of biochemistry.

***Bi 486/586**

Pathogenic Bacteriology (4)

Study of bacteria pathogenic to humans and their relationship to infectious disease. Emphasis on the biochemical mechanism of infection and laboratory diagnosis. Recommended prerequisite: Bi 480.

Bi 487/587

Immunology and Serology (4)

The study of resistance to infectious disease and the properties and behavior of antisera formed within an animal in response to foreign antigenic substances. Recommended prerequisite: Bi 480.

Bi 488/588

Microbiology Techniques (2)

Techniques in microbiology, including staining and microscopy, isolation and maintenance of bacteria, counting techniques, and methods for a wide range of physiological and morphological tests. Prerequisites: Bi 235, or Bi 337, or Bi 431/531, or consent of instructor.

Bi 489/589

Microbiology Physiology Laboratory (1)

Application of the principles of microbiology in the laboratory. One 3-hour laboratory period. Recommended prerequisite: concurrent with Bi 481/581.

Bi 503

Thesis (Credit to be arranged.)

Bi 526

Principles of Evolution (4)

Lectures and discussions on advanced topics in evolutionary biology: evaluation of historical and current trends in this field. Recommended prerequisite: Bi 358 or equivalent.

***Bi 543/643**

Advances in Plant Physiology (3)

Lectures and discussions on selected topics in plant physiology; evaluation of current trends in this field. Recommended prerequisite: Bi 442 (or concurrently). May be repeated once for credit.

***Bi 585/685**

Advances in Microbiology (3)

Analysis of new developments in microbiology including metabolic pathways, anaerobic systems, mechanisms of pathogenicity, and the exploitation of microorganisms to generate products for mankind. Recommended prerequisite: Bi 480.

***Bi 590/690**

Advanced Comparative Physiology (4)

Advanced topics and current research on various aspects of comparative physiology. Recommended prerequisites: Bi 417 or Bi 418 and Bi 419.

***Bi 592/692**

Advanced Topics in Marine Mammals (2)

A study of one or more advanced topics in marine mammals; covering new developments in regard to their evolution, physiological and anatomical adaptations, echolocation, population structure and dynamics, and behavior.

Recommended prerequisite: Bi 416.

***Bi 595/695**

Advanced Topics in Genetics (2)

New developments in genetics: Topics to include current research in the areas of genetics, human genetics, evolutionary genetics, and molecular genetics. Recommended prerequisite: Bi 341.

***Bi 596/696**

Advanced Topics in Evolution (2)

New developments in evolution. A study of one or more advanced topics relating to the patterns and processes of microevolution and macroevolution. Recommended prerequisite: Bi 426.

***Bi 597/697**

Advanced Topics in Mammalogy (3)

Study of one or more advanced topics in mammalogy.

Bi 598/698

Graduate Research Prospectus (3)

Each student develops and presents a thesis prospectus. The prospectus is to include a review of the literature and a detailed statement of significance, specific aims, research design, and methods. All entering biology graduate students (M.S.T., M.A./M.S. and Ph.D.) are required to take this course.

Bi 599/699

Graduate Grant Writing (3)

Each student is required to write a major grant proposal based on their research prospectus. All biology graduate students (M.S.T., M.A./M.S. and Ph.D.) are required to take this course. Recommended prerequisite: Bi 598.

Bi 601

Research (Credit to be arranged.)

Bi 603

Dissertation (Credit to be arranged.)

Bi 604

Cooperative Education/Internship (Credit to be arranged.)

Bi 605

Reading and Conference (Credit to be arranged.)

Pass/no pass only.

Bi 607

Seminar (Credit to be arranged.)

Bi 610

Selected Topics (Credit to be arranged.)