

BS: Biology**Neuroscience Emphasis—26**

BIOL371, 372, 449, 495 (2 cr), ZOOL468, 484, three upper division electives from Biology, Psychology or BCHM422

Behavior/Mathematics Emphasis—28

BIOL371, 372, 449, 495 (2 cr), ZOOL484, MATH141, 142, 426, STAT340

BS: Psychology**Behavioral Neuroscience—24 + 3 Gen. Ed.****General Education—PSYC101**

PSYC433, 434, 460, 465, four upper division electives from Biology, Mathematics or Psychology

BIOLOGY

Price Hall, Room 216

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<http://www.andrews.edu/biology>

Faculty

David A. Steen, *Chair*

Gordon J. Atkins

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Academic Programs	Credits
BS: Biology	
Behavior/Mathematics	67
Biomedical	37-38
Botany	42
Molecular Biology	36-37
Neurobiology	38
Neuroscience	67
Special	42
Zoology	42
Minor in Biology	22
Minor in Environmental Sciences	28
MS: Biology	30
MAT: Biology	

Each degree offered by the Biology Department includes a common core curriculum and additional courses tailored to students' special needs.

Highly motivated students may compete for the Biology Undergraduate Research Traineeship (BURT) program. For full details, consult the Biology Department.

Undergraduate Programs**BS: Biology**

All biology majors must complete the following core and cognate courses:

Biology Core—24

BIOL165, 166, 348, 371, 372, 449, 451, 452.

Cognate Core—24 or 26

CHEM131, 132, 231, 232, 241, 242; PHYS141 & 142 or 241/271 & 242/272

General Education Cognates

RELT340, PSYC101. Students taking the Honors Core do not need RELT340.

Students must complete the biology core, the cognate core, and the requirements for one of the emphases listed on the following page.

Botany Emphasis—18

Upper-division biology courses; must include a botany course (BOT prefix) drawn from each of the environmental, morphological, and functional groups of courses listed below. In addition, one zoological course (ZOO prefix) must be included.

Zoology Emphasis—18

Upper-division biology courses; must include a zoology course (ZOO prefix) drawn from each of the environmental, morphological, and functional groups of courses listed below. In addition, one botany course (BOT prefix) must be included.

Biomedical Emphasis—13-14

Must include four of the following: ZOO315, 464, 465, BIOL475; or PHTH 417, 427. BCHM421 must be included in the cognate core.

Molecular Biology Emphasis—12-13

Must include BIOL418, 419, 445, 447, and **one** of the following four courses: BIOL475; BIOL444, 446; ZOO315; BOT470 or ZOO464. BCHM421 must be included in the cognate core.

Neurobiology Emphasis—14

Upper-division biology courses; must include a zoology course (ZOO prefix) drawn from each of the environmental, morphological, and functional groups of courses listed below. In addition, ZOO475 and either PSYC364 or 449 must be taken. BCHM422 must be included in the cognate core.

Special Emphasis—18

In situations where students are preparing for a specific job opportunity or a graduate or professional program, the special emphasis may be considered if other degree programs are not adequate. The credits must include one biology course each from the functional, morphological, and environmental courses listed below. Additional credits to reach a minimum of 18 are to be selected from courses in biology or other disciplines in consultation with a Biology Department advisor. Departmental approval must be received before the beginning of the spring semester of the student's junior year.

Behavior/Mathematics Emphasis—28

BIOL371, 372, 449, 495 (2 cr), ZOO484, MATH141, 142, 426, STAT340

Neuroscience Emphasis—26

See p. 109.

Minor in Biology—22

BIOL165, 166, 449 and one course each from environmental, morphological, and functional biology electives.

Minor in Environmental Sciences—28

Suggested electives chosen in consultation with the advisor include: BHSC450, BIOL479, 487, BOT468, 475, CHEM340, GEOG240, PLSC425, ZOO454, 458, 459, 484

SENIOR THESIS

A minimum of 3 credits of BIOL495 or HONS497. Biology majors may elect to complete a minimum of 3 credits of original research in a topic of mutual interest with a Biology Department staff

member and present this original work in the form of a senior thesis. This research experience may be supported by a research scholarship.

Graduate Programs

The Biology Department offers courses leading to the Master of Science degree and also cooperates with the School of Education in offering courses leading to the Master of Arts in Teaching degree. Students are strongly urged to incorporate into their programs a summer of study at the Rosario Beach Marine Station at Anacortes, Washington. During the 8-week summer session, students may earn 6 to 8 credits.

MS: Biology

In addition to the general requirements for admission to and enrollment in graduate degree programs outlined in this bulletin on pp. 45-54, students must meet the following departmental requirements.

Admission Requirements

- A bachelor's degree with major in biology or an approved, related discipline, including courses in cell/molecular biology, organismal physiology, developmental biology, genetics, and ecology.
- A minimum GPA of 3.00 (B) in the undergraduate major for admission to regular student status.
- Cognate sciences, including full-year courses in general chemistry, organic chemistry, and physics. Mathematics through calculus level is encouraged.

Degree Requirements

- The inclusion of BIOL550 or IDSC526, and BIOL681, 682.
- A written comprehensive examination completed before the third semester in residence.
- A thesis earning 6 credits.
- A final oral examination in defense of the thesis.
- A minimum of 30 credits of approved course work and thesis.

MAT: Biology

Designed to prepare students for teaching biology in secondary schools, this degree is offered through the School of Education. A minor or its equivalent in biology on the undergraduate level is a prerequisite. In consultation with the department chair or the graduate program director, a minimum of 12 (6 credits must be 500-level or above) credits from courses listed below may be applied toward this program.

Required courses are BIOL550 or IDSC526. For further information, see the School of Education section of this bulletin on p. 259.

Courses

(Credits)

See inside front cover for symbol code.

GENERAL

BIOL100 \$ (3)
Human Biology

A survey of the structure and function of the human body, for

those not requiring the depth offered in BIOL111, 112. Meets the natural science elective course requirement. Two lectures, one lab per week. Does not apply to a major or minor. *Spring*

BIOL111, 112, 113 § (4, 3, 1)

Anatomy and Physiology I, II, III

BIOL111 and 112 includes cell biology, functional anatomy and control of each organ system of the human. BIOL111 Weekly: 3 lectures and 1 lab; BIOL112 Weekly: 2 lectures and 1 lab; BIOL113 Weekly: 1 lecture and 1 lab, includes more detailed anatomy. BIOL111 is a prerequisite for BIOL112. BIOL112 or consent of the instructor is the prerequisite for BIOL113. Does not apply to a major or minor. BIOL111: *Fall*; BIOL112: *Spring*; BIOL113. *Spring*.

BIOL208 § (4)

Principles of Environmental Science

Study of basic ecological principles as applied to human activities. Discussions deal with contemporary environmental issues. Lab includes field trips, guest speakers, and experiments. Meets General Education science requirements for non-science majors and applies toward the environmental science major and certain state educational certification requirements. Weekly: 3 lectures and 1 lab. *Fall*

BIOL260 § (4)

General Microbiology

Includes history, morphology, classification, control, growth, transmission, and pathogenicity of selected bacteria, viruses, rickettsia, fungi, and parasites. Covers the nature of host defenses against pathogens, including the acquisition of specific immunity and immune disorders. Weekly: 3 lectures and two 1½ hour labs. Does not apply on major or minor. *Fall*

BIOL330 § (3)

History of Earth and Life

Survey of fundamental concepts of geology and paleontology with application to a study of the history of the earth and of life. Consideration is given to interactions of religious, philosophical, and geological ideas, within a biblical world view. Weekly: 2 lectures and 1 lab. Does not apply to a major or minor. *Spring*

REQUIRED CORE

BIOL165, 166 § (5, 5 or 4, 4)

Foundations of Biology

Provides a firm foundation for students majoring or minoring in the biological sciences. Weekly: 5 lectures and one 3-hour lab. Ten credits when offered during the academic year; 8 credits when offered at the Marine Biological Station during the summer. BIOL165: *Fall*; BIOL166: *Spring*

BIOL348 § (3)

General Ecology

Ecological principles as applied to individual, population, community, and ecosystem levels of organization. Labs feature the characterization of ecological systems using standard field and lab techniques. Weekly: 2 lectures and 1 lab. Prerequisites: BIOL165, 166 or 208. *Fall*

BIOL371 § (3)

Genetics, Cellular and Molecular Biology I

Mechanisms of heredity are considered in light of classical population and molecular genetics. Labs feature experience in *Drosophila* genetics, chromosome analysis, statistical techniques, and recombinant DNA technology. Weekly: 2 lectures and 1 lab.

Prerequisite: BIOL166, and completion of or simultaneous enrollment in CHEM131. *Fall*

BIOL372 § (3)

Genetics, Cellular and Molecular Biology II

Information from molecular biology, biochemistry, biophysics, physical chemistry, and electron microscopy are integrated to present the cell as a functional unit. Labs provide experience in the collection and analysis of quantitative data about cells. Weekly: 2 lectures and 1 lab. Prerequisite: BIOL166, and completion of or simultaneous enrollment in CHEM132. *Spring*

BIOL449 § (3)

Historical and Philosophical Biology

Examination of biological, paleontological, and geological concepts central to the study of historical events in biological systems. Considers the interactions of data, theories, and extra scientific concepts in historical biology, within the particular context of a biblical world view. Weekly: 2 lectures and 1 lab. Prerequisite: BIOL166. *Spring*

BIOL451, 452 (1, 1)

Questions in Biology: Analysis, Evaluation and Answers

Lectures, discussions, and individual work centered around asking and answering important questions in the life sciences: research in biology, discussions on important issues in origins; discussions on major topics in bioethics. Attendance at monthly research seminars required. Open to senior Biology majors. Weekly: 1 lecture. BIOL451: *Fall*; BIOL452: *Spring*

ELECTIVES

(Elective courses offered at the Marine Biological Station may be included under these electives.)

Group A: Environmental Biology

BIOL208 § (4)

Principles of Environmental Science

Study of basic ecological principles as applied to human activities. Discussions deal with contemporary environmental issues. Lab includes field trips, guest speakers, and experiments. Meets General Education science requirements for non-science majors and applies toward the environmental science major and certain state educational certification requirements. Weekly: 3 lectures and 1 lab. *Fall*

BIOL479 ◆ (3.5)

Marine Ecology (offered only at Marine Station)

A study of interspecific, intraspecific, and community relationships demonstrated by marine organisms. *Summer*

BIOL487 ◆ § (3)

Biogeography

The distribution of plants and animals in relation to their environment, including consideration of major biogeographic regions of the world and the role of distribution in adaptive change and diversification of life in the past and present. Weekly: 2 lectures and 1 conference period. *Spring* (odd years)

BOT450 ◆ § (3)

Medical Botany

Designed as an interface between botany, medicine, anthropology and pharmacology to define the impact plants have with the remedial, harmful or psychoactive health of humans. Weekly: 3 lectures & 1 lab. Prerequisites: BIOL112. *Spring*

BOT468 ◆ (3.5)**Marine Botany (offered only at Marine Station)**

A systematic study of marine plants found in Puget Sound, with a survey of marine plants from other areas. *Summer*

BOT475 ◆ \$ (4)**Biodiversity of Vascular Plants**

A taxonomic and morphological study of vascular plants emphasizing the plants found in the Great Lakes area. Field trips. Weekly: 3 lectures and 1 lab. Open to non-science majors. *Fall*

ZOOL454 S ◆ \$ (3-4)**Vertebrate Zoology**

Covers the various specialties of vertebrate biology, including herpetology, ornithology, and mammalogy. Repeatable in the different specialized areas. Open to non-science majors. Weekly: 2 lectures and 1 or 2 labs. *Vertebrate Zoology: Mammalogy (Fall, even years)* and *Vertebrate Zoology: Ornithology (Spring, even years)* both qualify as "S" courses for General Education Service Learning.

ZOOL458 ◆ (3.5)**Marine Invertebrates (offered only at Marine Station)**

Biology of invertebrates studied in the marine environment of Puget Sound. A survey of the various phyla is conducted by studying the living animals in the field, and by tide pool observation, dredging, and scuba diving. A project on a specific group or species is required. *Summer*

ZOOL459 ◆ \$ (3-4)**Entomology**

Study of the fundamental aspects of insect biology. Weekly: 2 lectures and 1-2 labs. *As scheduled*

Group B: Morphological Biology**BIOL428** ◆ \$ (3)**Paleobiology**

Covers various specialties including History of Life; Vertebrate Paleontology; Paleobiology of Dinosaurs. Origins, history, adaptations, diversity, and paleoecology of ancient organisms as documented by the fossil record. Repeatable in different areas. Weekly: 2 lectures and 1 lab. Prerequisites: BIOL166. *Fall* (odd years)

BOT430 ◆ \$ (3)**Plant Anatomy**

A study of cell and tissue structure and organ development in vascular plants. Weekly: 2 lectures and 1 lab. *As scheduled*

ZOOL315 \$ (3)**Animal Development**

A study of the cellular and tissue-level events that result in the development of integrated organisms. Vertebrate development is emphasized in the lab using frog and chick models. Weekly: 2 lectures and 1 lab. Prerequisite: BIOL166. *Spring*

ZOOL316 (1)**Human Embryology**

Acquaints students with the process of human development and embryology. Prerequisite: BIOL166. Prior or concurrent registration with ZOOL315 recommended. Weekly: 1 lecture. *Spring*

ZOOL465 ◆ \$ (3)**Histology**

Microscopic anatomy, cytology, ultrastructure of tissues and organ

systems are correlated with function. Emphasis on normal tissues of vertebrates. Weekly: 2 lectures and 1 lab. *Spring*

Group C: Functional Biology**BIOL418** ◆ (2)**Immunology**

Topics include organs and cells of the immune system, antigens, immunoglobulins, the MHC, antibody diversity, tolerance and memory, complement, cell mediated immunity, regulation, hypersensitivity, autoimmune diseases, transplantation, and tumor immunology. Weekly: 2 lectures. Prerequisites: BIOL166. *Spring*

BIOL419 ◆ \$ (1)**Immunology Lab**

A theoretical and practical study of techniques used in modern immunology. Includes immunoserological methods; isolation and detection of immunoglobulin molecules in immune serum by SDS-PAGE, western blotting, and immunofluorescence antibody (IFA) methods; enzyme-linked immunosorbent assay (ELISA), in vitro phagocytosis. Weekly: 1 lab. Pre- or corequisite: BIOL418. *Spring*

BIOL445 ◆ \$ (3)**Molecular Genetics**

An advanced consideration of the structure, function, and manipulation of nucleic acids and application of molecular information in other disciplines. Weekly: 2 lectures and 1 lab. Prerequisites: BIOL371. *Spring*

BOT470 ◆ \$ (3)**Plant Physiology**

Study of plant functions including water relations, metabolic pathways, growth regulators, and photomorphogenesis. Weekly: 2 lectures and 1 lab. Prerequisites: BIOL166; CHEM131. *As scheduled*

ZOOL464 ◆ \$ (4)**Systems Physiology**

Functional processes used by animals in adjusting to their external environment and controlling their internal environment. Labs involve the firsthand analysis of selected aspects of the major functional systems. Weekly: 3 lectures and 1 lab. Prerequisite: BIOL166, CHEM131. *Fall*

ZOOL468 \$ (3)**Systems Physiology: Organismal Maintenance**

Functional processes that control an animal's internal environment. This course is the same as ZOOL464 but excludes the material on the nervous system. Students who have taken Neurobiology begin the course later in the semester. Weekly: 3 lectures and 1 lab. Prerequisite: ZOOL475. *Fall*

ZOOL484 ◆ \$ (3)**Animal Behavior**

Behavior of animals including considerations of social interactions, learning processes, instinct, motivation, experimental methods, and the analysis of behavior patterns characteristic of various species. Weekly: 2 lectures and 1 lab. Prerequisite: BIOL166. *Spring* (odd years)

Group D: Other Electives**BIOL444** ◆ (1)**Electron Microscopy in Biological Investigations**

The theory, functions, and use of the transmission and scanning electron microscopes. Weekly: 1 lecture. *Spring* (odd years)

BIOL446 ◆ § (2)***Electron Microscopy Laboratory***

Lab preparation of tissues for transmission and scanning electron microscopy with hands-on experience with the ultramicrotome and both T.E.M. and S.E.M. instruments. Acceptable photographs with interpretations required with lab reports on appropriate research projects. Weekly: 2 labs. Prerequisite: Prior or concurrent registration in BIOL444. *Spring* (odd years)

BIOL447 ◆ § (3)***Tissue Culture***

Study of theory, application, and techniques useful for propagating tissues in the research laboratory. Topics include sterile techniques, nutrition, media preparation, establishment and maintenance of primary and secondary cultures, enumeration, and analysis. Weekly: 2 lectures and 1 lab. Prerequisite: BIOL166. Pre- or corequisite: CHEM231. *Spring* (even years)

BIOL450 ◆ § (3)***Neuropsychopharmacology***

A study of the mechanisms of actions of psychotropic agents and how they affect human perception and behavior. Emphasis is placed on the organization and function of the nervous system and the molecular and biochemical basis of drugs used to treat behavioral and clinical disorders. Weekly: 2 lectures and one 3-hour lab. Prerequisites: PSYC101 or 180; BIOL111,112 or BIOL165, 166.

BIOL475 ◆ § (3)***Biology of Bacteria***

Study of the properties of bacteria that illustrate their function and relationship to other living systems. Topics include structure and function, classification, and interaction with the environment. Weekly: 2 lectures and 1 lab. Prerequisites: BIOL166. Organic Chemistry background recommended. *Fall*

ZOOL425 ◆ § (3)***Parasitology***

Emphasis on better known parasites of humans and animals. Attention given to ecological factors concerned with host-parasite contact, pathogenicity and pathology, and treatment and effect on parasitized populations. Weekly: 2 lectures and 1 lab. Prerequisites: BIOL166. *Fall*

ZOOL475 ◆ § (3)***Neurobiology***

The neural basis of behavior, with some emphasis on the human nervous system, including cellular and molecular approaches to neuron function, development of neurons and circuits, and neuroendocrine mechanisms. Labs develop skills in electrophysiology and neuroanatomy. Weekly: 2 lectures and 1 lab. Prerequisite: BIOL166. *Fall*

RESEARCH AND SPECIALIZED STUDIES**BIOL405** (1-4)***Topics in _____***

Investigates various specialties of biology. Repeatable in different areas. *Fall, Spring, Summer*

BIOL495 (1-4)***Independent Readings/Research***

Independent readings or research in biology under the direction of the instructor. Consent of instructor required. *Fall, Spring, Summer*

GRADUATE**BIOL516** (4)***Behavior of Marine Organisms***
(offered only at Marine Station)

Study of inter- and intra-specific behavior of marine animals and their behavioral response to the physical environment. Involves lab experience, field observation, and a research project. Instructor's permission required. *Summer*

BIOL550 (3)***Issues in Origins and Speciation***

A comparative survey of the assumptions, attitudes, methods, and conclusions of science and religion in the handling of data. Attention is given to current scientific data and their relationship to an understanding of earth history and the present diversity of life. Weekly: 2 lectures. *Spring*

BOT515 § (3)***Plant Cell Biology***

Functional activities of plant tissues provide the basis for this study of the ultrastructure of a variety of plant cell types. Attention is given to the cytoskeleton and other organelles involved in plant cell morphogenesis. Weekly: 2 lectures and 1 lab. Prerequisite: BOT470. *As scheduled*

BOT525 § (3)***Molecular Laboratory Techniques***

Acquaints students with modern lab techniques of molecular biology. The manipulation and study of nucleic acids and proteins using model systems involving plant-microbe interactions. Weekly: 2 labs. *Fall* (even years)

BOT530 § (3)***Advanced Systematic Botany***

Literature and philosophy of plant classification, processes of speciation in higher plants, sources and interpretation of data, biosystematic methods, and plant nomenclature. Weekly: 2 lectures and 1 lab. Prerequisite: BOT475. *As scheduled*

ZOOL500 § (3)***Protozoology***

Protozoa, including morphology, physiology, systematics, ecology, reproduction, and host-parasite relationships; emphasis on the parasitic protozoa, but free-living forms also considered; current problems encountered in protozoan research and methods of studying protozoa. Weekly: 2 lectures and 1 lab. Prerequisite: ZOOL425. *As scheduled*

ZOOL520 (2)***Molecular and Developmental Neurobiology***

A seminar course that deals in depth with current and relevant issues in the areas of molecular and developmental neurobiology. Offered alternate years. Weekly: 2 lectures. *As scheduled*

ZOOL565 § (3)***Environmental Physiology***

Study of the physiological responses of animals to their environments. Topics include environmental periodicities and biological clocks, thermal budgets, water balances, and adaptations to extreme environments. Weekly: 2 lectures and 1 lab/problem session. *As scheduled*

BIOL590 (1–4)**Topics in _____**

Investigates various specialties of biology. Repeatable in different areas. *As scheduled*

BIOL648 (1–4)**Workshop****BIOL681, 682** (1, 1)**Research Methods and Biology Seminar**

An introduction to graduate studies in biology, the nature and methods of science, and principles of research ethics. During second semester reports are made by each student to the group on topics from current literature and on specific problems in biology. Participation once per week for 2 semesters is required. BIOL681: *Fall*; BIOL682: *Spring*

BIOL697 (1–4)**Research in Biology**

Repeatable to 4 credits. *Arranged*

BIOL699 (3)**Master's Thesis**

Repeatable to 6 credits. *Arranged*

CHEMISTRY AND BIOCHEMISTRY

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Faculty

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Academic Programs	Credits
BS: Chemistry	38
BS: Chemistry (Approved by the American Chemical Society (ACS) Committee on Professional Training)	44
BS: Biochemistry	34
Minor in Chemistry	20

Students who plan to major in chemistry or biochemistry are expected to have entrance credit in the preparatory subjects of chemistry and mathematics (including algebra and trigonometry); a background in physics is desirable. Those who do not have entrance credit or equivalent training in these subjects, particularly mathematics, may not fulfill the department graduation requirements in four years.

Students are encouraged to plan early for an on-campus or off-campus research experience required of all students in the Bachelor of Science degree programs in chemistry and strongly recommended for those in the Bachelor of Science degree program in biochemistry. This experience may take the form of a cooperative educational-research experience or research in an academic, industrial, or governmental laboratory setting. Interested students should consult the department chair.

AMERICAN CHEMICAL SOCIETY CERTIFICATION

Students desiring American Chemical Society certification must

- Complete the required courses for the (ACS) Bachelor of Science degree in chemistry as spelled out in this bulletin
- Achieve a minimum GPA of 3.00 in all chemistry courses taken at Andrews University
- Satisfactorily complete a research or cooperative educational experience in chemistry
- Pass at least one advanced course selected from the following: CHEM470, 474 or 475.

A complete statement of certification requirements is available from the department chair.