

**SOCI580****Seminar in Community Development Leadership**

Topics include philosophical and spiritual foundations, profiles in leadership, strategic planning, grantsmanship, networking and interagency relations, managing volunteers, program evaluation. Offered over 3 quarters.

**SOCI585****Seminar in Community Service Programming**

Topics include support services for children, youth, families, single parents, elders, prisoners, refugees, AIDS victims. Offered over 3 quarters.

(2)

# BIOLOGY

Price Hall, Room 216  
(616) 471-3243  
biology@andrews.edu  
http://www.biol.andrews.edu

(2)

**Faculty**

John F. Stout, *Chair*  
Gordon J. Atkins  
Bill Chobotar  
H. Thomas Goodwin  
James L. Hayward  
Timothy G. Standish  
David A. Steen  
Dennis W. Woodland  
Robert E. Zdor

Academic Programs	Credits
BS: Biology	60
Biomedical	
Botany	
Molecular Biology	
Neurobiology	
Special	
Zoology	
Minor in Biology	30
MS: Biology	44
MAT in Biology	16

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

### Bachelor of Science

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

**Biology Core** **34**  
BIOL155, 156, 157, 348, 371, 372, 449, 461, 462, 463.

**Cognate Core** **36 or 39**  
CHEM121, 122, 123, 211, 212, 213;  
PHYS151, 152, 153 or 251, 252, 253 or 261, 262, 263.

**General Education Cognates**  
RELT340, RELP400, PSYC101.

### BS: Biology

Students must complete the *biology core*, the *cognate core*, and the requirements for one of the emphases listed below.

#### Biomedical Emphasis—24

Must include ZOOL315, 464, 465, BIOL475; PHTH 417 and 427. BCHM401,402 must be included in the *cognate core*.

#### Botany Emphasis—26

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 (ZOOL prefix) must be included.

#### Molecular Biology Emphasis—24-25

Must include BIOL418, 419, 445, 447, and **two** of the following courses: BIOL475; BIOL444, 446; ZOOL315; BOT470 or ZOOL464. BCHM401, 402 must be included in the *cognate core*.

#### Neurobiology Emphasis—26

Upper-division biology courses; must include a zoology course (ZOOL prefix) drawn from each of the environmental, morphological, and functional groups of courses listed below. In addition, ZOOL475 and either PSYC364, 365 or 449 must be taken. BCHM423 must be included in the *cognate core*.

#### Special Emphasis—26

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 26 are to be selected from courses in biology or other disciplines in consultation with a Biology Department adviser. Departmental approval must be received before the beginning of the winter quarter of the student's junior year.

#### Zoology Emphasis—26

Upper-division biology courses; must include a zoology course (ZOOL 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.

#### Minor in Biology—30

BIOL155, 156, 157, 449 and one course each from environmental, morphological, and functional biology electives.

#### SENIOR THESIS

A minimum of 4 credits of BIOL495 or HONS497. Biology majors may elect to complete a minimum of 4 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 study programs a summer of study at the Marine Biological Station at Rosario Beach, Puget Sound, Washington. During the 8-week summer session, students may earn 10 to 12 credits.

#### Master of Science

In addition to the general requirements for admission to and enrollment in graduate degree programs outlined in this bulletin on pp. 28-29, students must meet the following departmental requirements.

- A bachelor's degree with a major in biology or an approved, related discipline.
- 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 (36 credits). Mathematics through the calculus level is encouraged.

#### Degree Requirements

- The inclusion of BIOL550 or IDSC526, and BIOL691, 692, 693.
- A written comprehensive examination completed before the fifth quarter in residence.
- A thesis earning 8 credits.
- A final oral examination in defense of the thesis.
- A minimum of 44 credits of approved course work.

### Master of Arts in Teaching

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 16 (8 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. 169.

## Courses

See inside back cover for symbol code.

#### BIOL111,112,113 (Credits) \$ (5,5,2)

**Anatomy and Physiology I, II, III**  
BIOL111 and 112 include functional anatomy and control of each organ system of the human being. Weekly: 4 lectures and 1 lab. BIOL113 includes more detailed anatomy using human cadavers. Weekly: 1 lecture and 1 lab. BIOL111 is a prerequisite for BIOL112. BIOL112 or consent of the instructor is the prerequisite for BIOL113.

#### BIOL204, 205 \$ (4, 4)

**Principles of Environmental Science**  
Study of basic ecological principles, how organisms interact with their environment, and the application of ecological principles to human activities. Discussions deal with contemporary environmental issues. Labs include field trips, guest speakers, films, and debates. Applies toward certain certification requirements.

#### BIOL260 \$ (5)

**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: 5 lectures and two 1½ hr. labs. Does not apply on major or minor.

#### BIOL330

##### **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: 3 lectures and 1 lab. Does not apply to a major or minor.

### REQUIRED CORE

#### BIOL155,156,157 \$ (5,5,5)

##### **Foundations of Biology**

Provides a firm foundation for students majoring or minoring in the biological sciences. Weekly: 5 lectures and one 3-hour lab. Earns 15 credits when offered during the academic year; 12 credits when offered at the Marine Biological Station during the summer.

#### BIOL348 \$ (4)

##### **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: 3 lectures and 1 lab. Prerequisites: BIOL155, 156, 157, 204 or equivalent.

#### BIOL371 \$ (4)

##### **Genetics, Cellular and Molecular Biology I**

Mechanisms of heredity are considered in light of classical and molecular genetics. Labs feature experience in *Drosophila* genetics, chromosome analysis, statistical techniques, and recombinant DNA technology. Prerequisite: BIOL157, and completion of or simultaneous enrollment in General Chemistry.

#### BIOL372 \$ (4)

##### **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. Prerequisite: BIOL157; prerequisite or corequisite: CHEM121, 122, 123.

#### BIOL449 (4)

##### **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: 3 lectures and 1 lab. Prerequisite: BIOL156 or consent of instructor.

#### BIOL461,462,463 (1,1,1)

##### **Questions in Biology: Analysis, Evaluation and Answers**

Lectures, discussions, and individual work centered around asking and answering important questions in the life sciences. 461 Research in Biology; 462 Discussions on important issues in origins; 463 Discussions on major topics in Bioethics. Attendance at monthly research seminars required. Open to senior Biology majors.

### ELECTIVES

Elective courses offered at the Marine Biological

- (4) Station may be included under these electives.

### Group A: Environmental Biology

#### BIOL479 g (5)

##### **Marine Ecology**

A study of interspecific, intraspecific, and community relationships demonstrated by marine organisms. Offered only at the Marine Station.

#### BIOL487 \$ g (5)

##### **Biogeography**

The distribution of plants and animals in relation to their environment, including a consideration of the major biogeographic regions of the world and the role of distribution in adaptive change and diversification of life in the past and present. Weekly: 4 lectures and 1 conference period.

#### BOT468 g (5)

##### **Marine Botany**

A systematic study of marine plants found in Puget Sound, with a survey of marine plants from other areas. Offered only at the Marine Station.

#### BOT474 Alt g (5)

##### **Flora of the Great Lakes Region**

A taxonomic study of vascular plants emphasizing the plants found in the Great Lakes area. Field trips. Weekly: 4 lectures and 1 lab. Open to non-science majors.

#### ZOOL454S \$ g (4-5)

##### **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: 3 lectures and 1 or 2 labs.

#### ZOOL458 g (5)

##### **Marine Invertebrates**

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. Offered only at the Marine Station.

#### ZOOL459 \$ g (4-5)

##### **Entomology**

Study of the fundamental aspects of insect biology. Weekly: 3 lectures and 1 lab.

### Group B: Morphological Biology

#### BIOL428 \$ g (4)

##### **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: 3 lectures and 1 lab. Prerequisites: BIOL156 or permission of instructor.

#### BOT430 Alt \$ g (5)

##### **Plant Anatomy**

A study of cell and tissue structure and organ development in vascular plants. Weekly: 4 lectures and 1 lab.

#### BOT435 Alt \$ g (5)

##### **Morphology of Plants**

A comparative study of plant structure and

reproduction in algae, fungi, bryophytes, and vascular plants. Weekly: 4 lectures and 1 lab. Some field trips. Prerequisite: BIOL156.

**ZOOL315** \$ (4)  
**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: 3 lectures and 1 lab. Prerequisite: BIOL157.

**ZOOL316** \$ (1)  
**Human Embryology**  
Acquaints students with the process of human development and embryology. Pre/Corequisite: ZOOL315 recommended. Weekly: 1 lecture.

**ZOOL465** \$ g (5)  
**Histology**  
Microscopic anatomy, cytology, ultrastructure of tissues and organ systems are correlated with function. Emphasis on normal tissues of vertebrates. Weekly: 3 lectures and 2 labs.

### Group C: Functional Biology

**BIOL418** g (3)  
**Immunology**  
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: 3 lectures. Prerequisites: BIOL155, 156, 157. BCHM401,402 strongly recommended.

**BIOL419** \$ g (2)  
**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: 2 labs. Pre/Corequisite: BIOL418.

**BIOL445** \$ g (5)  
**Molecular Genetics**  
An advanced consideration of the structure, function, alteration, and manipulation of nucleic acids. Weekly: 3 lectures and 2 labs. Prerequisite: BIOL471.

**BOT470** Alt \$ g (5)  
**Plant Physiology**  
Study of plant functions including water relations, metabolic pathways, growth regulators, and photomorphogenesis. Weekly: 4 lectures and 1 lab. Prerequisites: BIOL156, 157 or equivalent; CHEM122, 123 or equivalent.

**ZOOL464** \$ g (5)  
**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: 4 lectures and 1 lab. Prerequisite: BIOL157, CHEM122, 123, or permission of instructor.

**ZOOL484** Alt \$ g (5)  
**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: 3 lectures and 2 labs. Prerequisite: BIOL157.

### Group D: Other Elective Courses

**BIOL444** \$ g (2)  
**Electron Microscopy in Biological Investigations**  
The theory, functions, and use of the transmission and scanning electron microscopes. Weekly: 2 lectures.

**BIOL446** \$ g (3)  
**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. Pre/Corequisite: BIOL444.

**BIOL447** \$ g (5)  
**Tissue Culture**  
Study of theory, application, and techniques useful for propagating tissues in the research lab. Topics include sterile techniques, nutrition, media preparation, establishment and maintenance of primary and secondary cultures, enumeration, and analysis. Weekly: 3 lectures and 2 labs. Prerequisite: BIOL157. Pre/Corequisite: Organic Chemistry.

**BIOL475** \$ g (5)  
**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: 3 lectures and 2 labs. Prerequisites: BIOL155, 156, 157 or equivalent; Organic Chemistry or Cell Physiology desirable.

**BOT450** g (4)  
**Medical Botany**  
Designed as an interface between botany, medicine, anthropology, and pharmacology to define the impact plants have with the remedial, harmful, or psychoactive properties on the health of humans. Prerequisite: BIOL112 or equivalent recommended.

**ZOOL425** \$ g (5)  
**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: 3 lectures and 2 labs. Prerequisites: BIOL155, 156, 157, or equivalent.

**ZOOL475** \$ g (5)  
**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, and either

independent research or functional human neuroanatomy. Prerequisite: BIOL157 (ZOOL464 suggested).

## GRADUATE COURSES

**BIOL516** (5)  
**Behavior of Marine Organisms**  
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. Offered only at Marine Station.

**BIOL550** (4)  
**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.

**BOT515** Alt \$ (5)  
**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: 3 lectures and 2 labs. Prerequisite: BOT470.

**BOT525** (4)  
**Molecular Laboratory Techniques**  
Acquaints students with modern lab techniques of molecular biology. The manipulation and study of nucleic acids and protein using model systems involving plant-microbe interactions.

**BOT530** Alt \$ (5)  
**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: 4 lectures and 1 lab. Prerequisite: BOT474.

**ZOOL500** Alt \$ (5)  
**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: 3 lectures and 2 labs. Prerequisite: ZOOL425.

**ZOOL520** Alt (3)  
**Molecular and Developmental Neurobiology**  
A seminar course that deals with current and relevant issues in the areas of molecular and developmental neurobiology. Offered with ZOOL484.

**ZOOL565** Alt \$ (5)  
**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: 4 lectures and 1 lab/problem session. To be alternated with

BIOL590.

**RESEARCH AND SPECIALIZED STUDIES****BIOL405***Topics in \_\_\_\_\_*

Investigates various specialties of biology. Repeatable in different areas.

**BIOL495***Independent Readings/Research*

Independent readings or research in biology under the direction of the instructor. Consent of instructor required.

**BIOL590***Topics in \_\_\_\_\_*

Investigates various specialties of biology. Repeatable in different areas.

**BIOL648***Workshop***BIOL691,692,693***Research Methods and Biology Seminar*

Use of biological literature and methods in current research. 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 3 quarters is required.

**BIOL697***Research in Biology*

Repeatable to 5 credits.

**BIOL699***Master's Thesis*

Repeatable to 8 credits.

(1-5)

(5)

(1-5)

(variable)

(1, 1, 1)

(1-5)

(4)

# CHEMISTRY AND BIOCHEMISTRY

Halenz Hall, Room 225  
(616) 471-3247 or 471-3248  
chemistry@andrews.edu  
http://www.andrews.edu/CHEM/**Faculty**G. William Mutch, *Chair*  
David E. Alonso  
Desmond H. Murray  
D. David Nowack  
Steven E. Warren  
Robert A. Wilkins  
Peter A. Wong

Academic Programs	Credits
BS: Chemistry	60
BS: Biochemistry	51
Minor in Chemistry	30

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 program 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 of up to three non-consecutive quarters in an industrial setting or research in an academic 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 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: CHEM435, 474, 475, and BCHM401.

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

## Undergraduate Programs

**BS: Chemistry—60****Major Requirements:** CHEM121, 122, 123, 200, 211, 212, 213, 320, 400, 401, 402, 403, 420, 421, 422, 430, 460.**Research/Cooperative Experience:** An on-campus or off-campus research or cooperative educational experience. The student may satisfy this requirement by matriculating in CHEM495, HONS497, 498 or GCAS380.**Cognate Courses:** COSC125; MATH171, 172, 173, 281, 282; PHYS251, 252, 253, 261, 262, 263.

Courses in economics and marketing are strongly recommended. A reading knowledge of German or French, although not required for professional undergraduate education in chemistry, is strongly recommended for students planning advanced study.

**BS: Biochemistry—51****Major Requirements:** BCHM401, 402, 412, 413, 423; CHEM121, 122, 123, 200, 211, 212, 213, 401, 402, 403, 421, 435 (422 may be substituted for 435).**Cognate Courses:** BIOL155, 156, 157; MATH171, 172, 173; PHYS151, 152, 153 (or PHYS251, 252, 253, 261, 262, 263); and two courses selected from BIOL371, 372; FDNT485; ZOOL315, 464, 465.

Students desiring a career in biochemistry might be better served by adding the biochemistry courses to the Bachelor of Science degree in chemistry, but the Bachelor of Science degree in biochemistry can be strengthened by the addition of CHEM320, 400, 420, 430, and 495.

**Minor in Chemistry—30**

CHEM121, 122, 123, 211, 212, 213, plus 6 elective credits.

## Graduate Program

The Department of Chemistry and Biochemistry collaborates in offering the Master of Science: Interdisciplinary Studies (Mathematics and Physical Sciences). See the Interdisciplinary Studies section, p. 85.

## Courses

(Credits)

See inside back cover for symbol code.

**BCHM115**

§ (4)

**Concepts in Biochemistry**

Survey of major concepts in biochemistry; structures of biologically relevant molecules, their functions, intermediary metabolism. Weekly: 3 lectures and 3 hours lab. Not applicable toward a major or minor in chemistry. Prerequisite: CHEM112.

**BCHM401**

(3)

**Biochemistry I**

Study of the fundamental principles of enzyme kinetics and mechanisms based on the structure and chemistry of biomolecules including amino acids and proteins, nucleotides, and nucleic acids, and on the structure and function of biological membranes. Weekly: 3 lectures and 1 recitation. Prerequisite: CHEM213.

**BCHM402**

(3)

**Biochemistry II**

Study of the chemistry and metabolism of carbohy-