

# Biology

## (Interdepartmental Undergraduate Program)

Iowa State University is a major center for research and education in the biological sciences. With over 200 faculty in the life sciences, students have the opportunity to learn from some of the nation's leaders in biological research and teaching and to participate in innovative, meaningful research projects that explore frontiers of biology. Few other universities have such a wealth of faculty expertise available to undergraduate students, making Iowa State's Biology Program the logical choice for those who want to participate in a thriving academic community.

The faculties of the Department of Ecology, Evolution and Organismal Biology and the Department of Genetics, Development and Cell Biology jointly offer the undergraduate biology major. This high quality academic program has the flexibility to accommodate a range of career goals while taking advantage of the university's strengths in science and technology. A bachelor's degree in biology provides excellent preparation for graduate study in biological disciplines ranging from the molecular to the ecological levels, and for entrance into various professional schools, such as human medicine, physical therapy, or veterinary medicine. The major is well suited for those who plan to teach biology, who wish to enter government or industrial employment in health or environmental professions, or who prefer educational breadth as an end in itself. By working with our professional and faculty advisers, it is possible to design a unique program of study that will meet student needs and objectives.

Students with special interests and aptitudes should consider combining biology with a minor or a second major in another subject, such as chemistry, environmental studies, journalism, mathematics, music, statistics, or many other subjects offered by the university.

## Customizing a degree

Biology encompasses an amazing diversity of disciplines and scales of study ranging from molecules to the biosphere. The Biology major offers a rich variety of coursework addressing most of the areas of biology. The major's curriculum requirements offer tremendous flexibility in creating an individualized program of study to facilitate achievement of a student's career goals, while simultaneously assuring some exposure to all areas of biology and providing complementary knowledge from supporting courses in chemistry, physics, and math/statistics.

While flexibility is the hallmark of the Biology major, the breadth of the field can also be challenging. Thus, in an effort to provide more guidance to students who desire such, the major also provides five advising tracks, or areas of specialization, for students who wish to focus on subfields of biology or who have specific career goals in mind. Course plans for each area of specialization are listed on the Biology web site. The areas are:

**Pre-medical and Human Health Professions**--This area emphasizes preparation for further study in medical school or allied human health professions such as dentistry, optometry, genetic counseling, physical therapy, occupational therapy, physician assistant, nursing, chiropractic, and others. It also will prepare students for a broad range of careers in the biological sciences. Students are urged to determine the specific entrance requirements for the professional schools where they might study and to plan a program of study accordingly, in addition to following the basic plan.

**Pre-veterinary**--An eventual degree in Veterinary Medicine can lead to a wide variety of careers, including private clinical practice in small animal medicine or agricultural animal production. But, pre-veterinary students can also prepare themselves for careers in animal research, public health, laboratory animal medicine, food safety, regulatory medicine, and education. Specific requirements for entrance to the Iowa State Veterinary College or other schools should be consulted as programs of study are planned, in addition to following the basic plan.

**Molecular and Cellular Biology**--Students specializing in this field will explore the structure, function, and interactions of the molecules and sub-cellular features that make up living cells. This area is particularly designed for those who plan to pursue a career in research in molecular or cell biology or in related areas such as biochemistry, genetics, microbiology, developmental biology, human medicine, or veterinary medicine. Many students in this area will choose to go on to graduate school.

**Ecology and Conservation Biology**--Ecologists examine the interactions and relationships that living organisms have with each other and their environment. Conservation biologists study the nature and status of Earth's biodiversity with the aim of protecting species, their habitats, and ecosystems from excessive rates of

extinction and loss. Students who choose this specialization may go on to work for a non-profit environmental group; an environmental consulting firm; a local, state, or federal agency; or other related organizations. Many students in this area will choose to go on to graduate school.

**Evolution and Biodiversity**--This area provides students with a sound understanding of evolutionary principles and the biological patterns that result from evolutionary change. Students have the opportunity to explore, in depth, the biodiversity found within a wide range of groups of organisms. Students who choose this specialization may go on to work for a non-profit environmental group; an environmental consulting firm; a local, state, or federal agency; or other related organizations. Many students in this area will choose to go on to graduate school.

## Other opportunities

**Teacher licensure**--Biology majors seeking licensure to teach biology in secondary schools must meet requirements of the Teacher Education Program as well as those of the Biology Program. In addition, they must apply formally for admission to the teacher education program. See the section on Teacher Education for a list of licensure areas, degree requirements, and other information about this program.

**Undergraduate research**--Students who have interests in biological research are encouraged to become involved in the research projects of faculty members on campus. Those doing so may receive credit for the experience in BIOL 490 Independent Study. Making the effort to find a suitable research mentor and engaging in research work can be one of the most valuable experiences of an undergraduate education. Internship experiences are often available at other universities, zoos, museums, governmental and non-governmental entities focused on environmental issues, and at industrial or government laboratories. Students participating in such projects may receive internship credit in BIOL 494 Biology Internship.

**Field trip courses** -- The Biology Program offers two field trip courses: BIOL 393 (North American Field Trips in Biology) and BIOL 394 (International Field Trips in Biology). In recent years field trip opportunities to the Boundary Waters area of Minnesota, Honduras, and Spain have been available. These courses involve a pre-trip seminar followed by one-week to one-month long field trip at a time when academic year classes are not in session. The classes are low enrollment and allow extensive interaction between instructors and students in locations of biological interest.

**International experience**--Because major discoveries in science often result from global efforts, biology majors are encouraged to include an international or study abroad component in their degree programs. This can be done by participating in international field trips originating from the ISU campus in BIOL 394 International Field Trips in Biology. In addition, many students choose to study abroad, attending a university in another country for up to a year as an exchange student. Minors in a foreign language can also add an international emphasis to a degree in biology.

## Courses offered at other locations

In addition to biological science courses taught on campus, students may take courses at various remote locations and arrange to have the credits count toward the advanced courses required in the biology major. Attending a summer field station adds an important component to an undergraduate program of study.

**Gulf Coast Research Laboratory**--The Gulf Coast Research Laboratory is affiliated with the University of Southern Mississippi. Iowa State students may register for marine biology courses and transfer credit to their degree programs under the number BIOL 480 Studies in Marine Biology. Written permission of the Biology Program Director is required for this arrangement. Courses that are available each summer are listed at [www.coms.usm.edu](http://www.coms.usm.edu).

**Summer Biological Field Stations**--Courses taken at summer field stations may be transferred to Iowa State University as credit in BIOL 481 Summer Field Studies. Such stations are found throughout the country and often offer courses that emphasize the adaptation of plants and animals to unique environments. See [www.biology.iastate.edu](http://www.biology.iastate.edu) for links to Iowa Lakeside Laboratory and other field stations in different biomes, e.g. marine/coastal, Great Lakes, taiga, deciduous forests, deserts, Rocky Mts., etc.

**Organization for Tropical Studies**--Iowa State students may register for courses in tropical biology taught in Costa Rica by the Organization for Tropical Studies. Credit is transferred to Iowa State as BIOL 482 Tropical Biology. For further information see [www.ots.duke.edu](http://www.ots.duke.edu) or contact the Biology Student Services Office in 103 Bessey Hall.

## General requirements

Students may earn the B.S. degree in Biology from either the College of Liberal Arts and Sciences or from the College of Agriculture and Life Sciences. Students in the College of Liberal Arts and Sciences must fulfill the foreign language and general education requirements for that college. Students in the College of Agriculture and Life Sciences must meet the general education requirements for that college. Contact the Student Services Office for details regarding differences in general education and course requirements that are specific to these colleges.

Supporting course requirements-- Understanding biology requires a basic understanding of the physical sciences and mathematics. Consequently, a minimum number of credits in general chemistry, organic chemistry, biochemistry, and physics is required. See the Biology Program Web Site for specific supporting science requirements.

The Math requirement is competency based. After demonstrating competency in algebra and trigonometry, biology majors must take two semesters of calculus; or two semesters of Statistics; or one semester of calculus and one semester of Statistics chosen from a list of approved courses available on the Biology Program Web Site and in the Biology Program Office.

Given the important role of writing in the modern sciences, biology majors must demonstrate communication competency by earning a minimum of C in both ENGL 150 Critical Thinking and Communication and ENGL 250 Written, Oral, Visual, and Electronic Composition or equivalent composition courses and in one advanced writing course numbered ENGL 302 through ENGL 316, or JL MC 347.

## Undergraduate Study

Biology majors start their studies in the biological sciences by taking a unified biology core curriculum consisting of six integrated courses, including four with labs. The first year provides a broad introduction to the nature of life.

BIOL 211	Principles of Biology I	3
BIOL 211L	Principles of Biology Laboratory I	1
BIOL 212	Principles of Biology II	3
BIOL 212L	Principles of Biology Laboratory II	1
Total Credits		8

During the first year, students also take BIOL 110 Introduction to Biology and BIOL 111 Opportunities in Biology, which are half semester courses designed to introduce the student to the discipline of biology and opportunities for careers in biology. Students transferring into the Biology major BIOL 112 in place of BIOL 110.

Students then explore concepts of ecology in BIOL 312; the principles of genetics in BIOL 313 and BIOL 313L; cell and molecular biology in BIOL 314; and evolutionary biology in BIOL 315. Biology majors must take an additional 21 credits of biological science at the 300 level, or above, from an approved list of courses. Of these, at least 9 credits must be taken as BIOL courses, and a minimum of two BIOL laboratory or field courses must also be included.

Biology majors should carefully consider their selection of upper-level courses to allow them to emphasize one, or more, of the sub-disciplines of Biology relevant to their post-baccalaureate objectives. Most biology courses numbered 300 or above can be used to satisfy the additional credit requirement. Some courses taught in other departments can also be applied to the biology major. Advanced students should consider including 500 level courses in their programs. The Biology Program's web site has a complete listing of acceptable upper-level life science courses.

Biology majors must demonstrate competency in their understanding of the biological sciences. Thus, grades of C- or better in all biological science courses applied to the major are required. Furthermore, in order to graduate, a student must have a cumulative average in the major of at least 2.00.

## Minor

A minor in Biology is offered by the Biology Program. The minor requires 15 credits in Biology and includes the completion of the specific courses listed below:

BIOL 211	Principles of Biology I	3
BIOL 211L	Principles of Biology Laboratory I	1
BIOL 212	Principles of Biology II	3
BIOL 212L	Principles of Biology Laboratory II	1
Total Credits		8

and 7 credits in biology courses numbered 300 or above. Nine (9) credits of the required courses must apply only to the minor. For more information, see the

Biology Program web site or contact the Student Services Office in 103 Bessey Hall.

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BIOL 211L	Principles of Biology Laboratory I	1
BIOL 212	Principles of Biology II	3
BIOL 212L	Principles of Biology Laboratory II	1

During the first year, students also take BIOL 110 Introduction to Biology and BIOL 111 Opportunities in Biology, which are half semester courses designed to introduce the student to the discipline of biology and opportunities for careers in biology. Students transferring into the Biology major BIOL 112 in place of BIOL 110.

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Biology majors must demonstrate competency in their understanding of the biological sciences. Thus, grades of C- or better in all biological science courses applied to the major are required. Furthermore, in order to graduate, a student must have a cumulative average in the major of at least 2.00.

## Graduate Study

Biology is an undergraduate major only. Persons interested in graduate study in the biological sciences should apply directly to one of the life science graduate programs at Iowa State University. Interdepartmental graduate offerings in Bioinformatics and Computational Biology; Ecology and Evolutionary Biology; Genetics; Molecular, Cellular and Developmental Biology; Neuroscience; Plant Biology; Toxicology; Immunobiology; and Environmental Science are also available. (See Index. )

A non-thesis master's degree in Interdisciplinary Graduate Studies (biological sciences) has been established particularly for those who wish to have a more diversified program of advanced study than that generally permitted by specific departments and programs.

## Curriculum in Biology

### *College of Liberal Arts and Sciences*

Administered by the Departments of Ecology, Evolution, and Organismal Biology; and Genetics, Development and Cell Biology. Students should consult the Biology Student Services Office, 103 Bessey (or biology@iastate.edu ) for the appropriate course selections for professional or graduate school preparation.

### **Total Degree Requirement: 120 cr.**

Only 65 cr. from a two-year institution may apply which may include up to 16 technical cr.; 9 P-NP cr. of free electives; 2.00 minimum GPA.

### **International Perspective: 3 cr.**

### **U.S. Diversity: 3 cr.**

### **Communications Proficiency (with a C or better)**

English composition	3
Speech fundamentals	3
Total Credits	6

**Communication/Library**

ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
LIB 160	Information Literacy	1
One of the following:		
SP CM 212	Fundamentals of Public Speaking	3
ENGL 312X Biological Communications (3 cr.)		

Total Credits		10
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**Humanities and Social Sciences**

Humanities course		12
Social Science course		9
Total Credits		21

**Mathematical Sciences 7 cr.**

MATH 160	Survey of Calculus	4
or MATH 181	Calculus and Mathematical Modeling for the Life Sciences I	
or		
MATH 165 & STAT 101	Calculus I and Principles of Statistics	3-8
or STAT 104	Introduction to Statistics	
MATH 165 & MATH 166	Calculus I and Calculus II	8
or		
MATH 181 & MATH 182	Calculus and Mathematical Modeling for the Life Sciences I and Calculus and Mathematical Modeling for the Life Sciences II	8
or		
STAT 101	Principles of Statistics	4
or		
STAT 104 & STAT 401	Introduction to Statistics and Statistical Methods for Research Workers	7

**Physical Sciences**

General chemistry 5 cr. minimum

CHEM 163 & 163L	College Chemistry and Laboratory in College Chemistry	5
or		
CHEM 177 & 177L	General Chemistry I and Laboratory in General Chemistry I	5
CHEM 178 & 178L	General Chemistry II and Laboratory in College Chemistry II	4
CHEM 231 or CHEM 331	Elementary Organic Chemistry or Organic Chemistry I	3
Organic chemistry: 4 cr. minimum		
CHEM 231 & 231L	Elementary Organic Chemistry and Laboratory in Elementary Organic Chemistry	4
or		
CHEM 331 & 331L	Organic Chemistry I and Laboratory in Organic Chemistry I	4
and		
CHEM 332 & 332L	Organic Chemistry II and Laboratory in Organic Chemistry II	4
Biochemistry: 3 cr.		
BBMB 316	Principles of Biochemistry	3
or		
BBMB 404	Biochemistry I	3
or		
BBMB 420	Physiological Chemistry	3
Physics: 4 cr. minimum		
PHYS 115X Physics for Life Sciences (5 cr.)		
or		
PHYS 111 & PHYS 112	General Physics and General Physics	10

**Biology: 24 cr.**

All graded courses minimum C-; 2.00 GPA average required.

BIOL 110	Introduction to Biology	1
BIOL 111	Opportunities in Biology	0.5
BIOL 211	Principles of Biology I	3
BIOL 211L	Principles of Biology Laboratory I	1
BIOL 212	Principles of Biology II	3
BIOL 212L	Principles of Biology Laboratory II	1
BIOL 312	Ecology	4
BIOL 313	Principles of Genetics	3
BIOL 313L	Genetics Laboratory	1
BIOL 314	Principles of Molecular Cell Biology	3
BIOL 315	Biological Evolution	3
Total Credits		23.5

**Advanced Biology: 21 cr.**

All graded courses minimum C-; 2.00 GPA average required. See the Biology Program web site for list of approved Advanced Biology courses, or consult an adviser in the Biology Student Services office, 103 Bessey Hall.

Two Advanced BIOL courses with lab or field components (from approved list)

Biology advanced courses (from approved list)	9
Additional approved biology advanced courses	12
Total Credits	21

**Courses primarily for undergraduates:****BIOL 101. Introductory Biology.**

(3-0) Cr. 3. F.S.SS.

Life considered at cellular, organism, and population levels. Function and diversity of the living world. Presentation of basic biological principles as well as topics and issues of current human interest. Intended primarily for nonmajors; available to biology majors for elective credit.

**BIOL 110. Introduction to Biology.**

Cr. 1. F.

Orientation to the scope of the biological sciences, and discussion of professional opportunities. Required of first year biology majors. Offered on a satisfactory-fail basis only.

**BIOL 111. Opportunities in Biology.**

(1-0) Cr. 0.5. S.

Introduction to biological science disciplines and professional opportunities through faculty presentations which examine a variety of current research topics. Offered on a satisfactory-fail basis only.

**BIOL 112. Transfer Student Orientation.**

Cr. R. F.S.

Orientation to opportunities in Biology. Review of degree requirements and other information needed by students that have not participated in the first year Biology orientation courses. Offered on a satisfactory-fail basis only.

**BIOL 155. Human Biology.**

(3-0) Cr. 3. F.S.

A survey course of human biology, including principal structures and functions of the body systems and the diseases and disorders associated with them. Designed to meet general education requirements in natural science. Not recommended for those seeking a career in the allied health professions or for students majoring in life science.

**BIOL 173. Environmental Biology.**

(Cross-listed with ENV S). (3-0) Cr. 3. F.S.

An introduction to the structure and function of natural systems at scales from the individual to the biosphere and the complex interactions between humans and their environment. Discussions of human population growth, biodiversity, sustainability, resource use, and pollution. Intended primarily for non-majors; available to biology majors for elective credit.

**BIOL 201. Introduction to Environmental Issues.**

(Cross-listed with ENV S, ENSCI). (2-0) Cr. 2. F.S.

Discussion of current and emerging environmental issues such as human population growth, energy use, loss of biodiversity, water resources, and climate change.

**BIOL 204. Biodiversity.**

(Cross-listed with ENV S). (4-0) Cr. 2. S. *Prereq: One course in life sciences*  
Survey of the major groups of organisms and biological systems. Definition, measurements, and patterns of distribution of organisms. Sources of information about biodiversity. Intended primarily for non-majors; available to biology majors for elective credit. Half semester course.

**BIOL 211. Principles of Biology I.**

(3-0) Cr. 3. F.S. *Prereq: High school biology*  
Introduction to the nature of life, including the diversity of microbial, plant, and animal life; the nature of heredity; evolution; and principles of ecology. Intended for life science majors.

**BIOL 211L. Principles of Biology Laboratory I.**

(0-3) Cr. 1. F.S. *Prereq: Credit or enrollment in BIOL 211*  
Laboratory to accompany 211.

**BIOL 212. Principles of Biology II.**

(3-0) Cr. 3. F.S. *Prereq: High School Biology; high school chemistry or credit or enrollment in CHEM 163 or CHEM 177*  
Introduction to the chemical, molecular, and cellular basis of life; form and function of microbial, plant, and animal life. Intended for life science majors.

**BIOL 212L. Principles of Biology Laboratory II.**

(0-3) Cr. 1. F.S. *Prereq: credit or enrollment in BIOL 212*  
Laboratory to accompany 212.

**BIOL 255. Fundamentals of Human Anatomy.**

(3-0) Cr. 3. F. *Prereq: High School Biology and Chemistry, or BIOL 101*  
An introduction to human anatomy, beginning with cells and tissues, surveying all body systems, relating form to function. Systems covered include: integumentary, bones and joints, muscles, nervous, sensory, endocrine, circulatory, lymphatic, respiratory, digestive, urinary, and reproductive. Pre-Medical students should consider Biol 351 for their anatomy background. Not intended for major credit in biology.

**BIOL 255L. Fundamentals of Human Anatomy Laboratory.**

(0-3) Cr. 1. F. *Prereq: Credit or enrollment in BIOL 255*  
Investigation of human anatomy using models and dissections of preserved organs and model mammals. Pre-Medical students should consider 351 for their anatomy background. Not intended for major credit in biology.

**BIOL 256. Fundamentals of Human Physiology.**

(3-0) Cr. 3. S. *Prereq: High School Biology and Chemistry, or BIOL 101, or BIOL 255 (recommended)*  
An introduction to human physiology, studying the function of all body systems. Systems covered include: integumentary, bones and joints, muscles, nervous, sensory, endocrine, circulatory, lymphatic and immune, respiratory, digestive, urinary, and reproductive. Pre-Medical students should consider 335 for their physiology background. Not intended for major credit in biology.

**BIOL 256L. Fundamentals of Human Physiology Laboratory.**

(0-3) Cr. 1. S. *Prereq: Credit or enrollment in BIOL 256*  
Student-conducted experiments investigating concepts of human physiology with computer data acquisition and analysis. Interpretation of experimental results and preparation of lab reports. Pre-Medical students should consider 335 for their anatomy and physiology background. Not intended for major credit in biology.

**BIOL 258. Human Reproduction.**

(Cross-listed with W S). (3-0) Cr. 3. F. *Prereq: BIOL 101, or BIOL 155, or BIOL 211*  
Anatomy and physiology of human reproductive systems, including fertility, pregnancy, and delivery.

**BIOL 306. Metabolic Physiology of Mammals.**

Cr. 3. *Prereq: BIOL 211, BIOL 212*  
Introduction to physiology of metabolic function in mammals and other animals. Metabolic processes and their interactions with various subsystems, approached from an organismal perspective. Integration of cellular, gastrointestinal, cardiovascular, respiratory, and renal processes, relevant to their control and integration at the nervous and endocrine system levels. Functional aspects of organismal physiology; energy and water balances, physiology of rest exercise, and environmental stress. Students cannot receive credit for both Biol 306 and Biol 335.

**BIOL 307. Women in Science and Engineering.**

(Cross-listed with W S). (3-0) Cr. 3. F. *Prereq: a 200 level course in science, engineering or women's studies; ENGL 250*  
The interrelationships of women and science and engineering examined from historical, sociological, philosophical, and biological perspectives. Factors contributing to underrepresentation; feminist critiques of science; examination of successful strategies.  
Meets U.S. Diversity Requirement

**BIOL 312. Ecology.**

(Cross-listed with A ECL, ENSCI). (3-3) Cr. 4. F.S.S. *Prereq: BIOL 211L and BIOL 212L*  
Fundamental concepts and principles of ecology dealing with organisms, populations, communities and ecosystems. Laboratory and field exercises examine ecological principles and methods as well as illustrate habitats.

**BIOL 313. Principles of Genetics.**

(Cross-listed with GEN). (3-0) Cr. 3. F.S.S.S. *Prereq: BIOL 211, BIOL 211L, BIOL 212, and BIOL 212L*  
Introduction to the principles of transmission and molecular genetics of plants, animals, and bacteria. Recombination, structure and replication of DNA, gene expression, cloning, quantitative and population genetics. Students may receive graduation credit for no more than one of the following: Gen 260, Gen 313 and 313L, Gen 320, Biol 313 and 313L, and Agron 320.

**BIOL 313L. Genetics Laboratory.**

(Cross-listed with GEN). (0-3) Cr. 1. F.S. *Prereq: Credit or enrollment in BIOL 313*  
Laboratory to accompany 313. Students may receive graduation credit for no more than one of the following: Biol 313 and 313L, Gen 260, Gen 313, Gen 320, and Agron 320.

**BIOL 314. Principles of Molecular Cell Biology.**

(3-0) Cr. 3. F.S. *Prereq: BIOL 211, 211L, 212, 212L.*  
Integration of elementary principles of metabolism, bioenergetics, cell structure and function to develop a molecular view of how the cell works.

**BIOL 315. Biological Evolution.**

(3-0) Cr. 3. F.S. *Prereq: BIOL 211, BIOL 211L, BIOL 212, BIOL 212L. Biol 313 recommended.*  
The mechanisms of evolution. Topics in microevolution: population genetics, natural selection, genetic variation, and adaptation. Macroevolution: speciation, extinction, phylogeny, and major evolutionary patterns.

**BIOL 328. Molecular and Cellular Biology of Human Diseases.**

Cr. 3. *Prereq: BIOL 212*  
Survey of molecular, genetic and cellular aspects of human diseases. Fundamental concepts of cell biology and how they are linked to the pathologies of different classes of human diseases. Recent scientific advances with an emphasis on new methods of diagnosis and treatment.

**BIOL 330. Principles of Plant Physiology.**

(3-0) Cr. 3. *Prereq: BIOL 313 or GEN 320; BIOL 314 or BBMB 301; CHEM 231 or CHEM 332; PHYS 106 or PHYS 111*  
An overview of classical and current concepts, principles and approaches regarding the basic mechanisms of plant function underlying growth, development and survival of plants. Topics covered include environmental and developmental signals, plant hormone action, signal transduction, mineral nutrition, water relations, metabolism and photosynthesis. Nonmajor graduate credit.

**BIOL 330L. Principles of Plant Physiology Laboratory.**

(0-3) Cr. 1. *Prereq: Credit or enrollment in BIOL 330*  
Laboratory to accompany Biol 330. Experiments and explorations illustrating fundamental principles of plant physiology. Nonmajor graduate credit.

**BIOL 335. Principles of Human and Other Animal Physiology.**

(3-3) Cr. 4. F.S. *Prereq: BIOL 314*  
Introduction to systemic functions with emphasis on mammals. Nonmajor graduate credit.

**BIOL 336. Ecological and Evolutionary Animal Physiology.**

Cr. 3. *Prereq: BIOL 211, BIOL 212*  
Study of mechanisms by which animals perform life-sustaining functions; the evolution and adaptive significance of physiology traits, the diversity of physiological mechanisms, and how physiology and ecology interact.

**BIOL 350. Comprehensive Human Anatomy.**

(3-0) Cr. 3. F. *Prereq: Credit in BIOL 211 and BIOL 212*  
Comprehensive survey of human anatomy, emphasizing structural and functional relationships of major organ systems. Compartmental study of normal anatomy; practical clinical application of anatomical regions.

**BIOL 351. Comparative Chordate Anatomy.**(3-4) Cr. 5. S. *Prereq: BIOL 212, junior classification*

The evolution of chordates as reflected in the anatomy of extinct and living forms. Lecture topics include the history and diversity of chordates; comparisons of anatomic structures among major groups, the adaptive significance of anatomic structures. Laboratory involves dissection of representative species.

**BIOL 352. Vertebrate Histology.**(3-3) Cr. 4. S. *Prereq: BIOL 212*

Microscopic structure of vertebrate tissues and organs, with an introduction to histological techniques.

**BIOL 353. Introductory Parasitology.**(Cross-listed with V PTH, MICRO). (3-0) Cr. 3. S. *Prereq: BIOL 212*

Biology and host-parasite relationships of major groups of animal parasites, and techniques of diagnosing and studying parasites.

**BIOL 354. Animal Behavior.**(3-0) Cr. 3. F. *Prereq: BIOL 212*

Ethological and sociobiological approaches to animal behavior. Genetic and developmental aspects of behavior, biological rhythms, orientation (including navigation, migration), communication, and social behavior (mating, aggression, parental care).

**BIOL 354L. Laboratory in Animal Behavior.**(0-3) Cr. 1. F. *Prereq: Credit or enrollment in BIOL 354*

Laboratory techniques for observation, description and analysis of animal activities; independent projects.

**BIOL 355. Plants and People.**(3-0) Cr. 3. S. *Prereq: Credit in BIOL 211 and BIOL 211L*

Uses of plants and fungi by humans and the importance of plants in the past, present and future. Discussion of fruits, vegetables, grains, herbs, spices, beverages, oils, fibers, wood, medicines, and drugs, in the context of their agricultural, cultural, and economic roles in modern societies. Emphasis on origins and worldwide diversity of culturally important plants, their characteristics, and uses.

**BIOL 356. Dendrology.**(Cross-listed with FOR). (2-4) Cr. 4. F. *Prereq: BIOL 211*

Identification and ecology of North American woody plant species. Importance of woody plants in timber production and wildlife habitat. Natural disturbances, human impacts, management and restoration concerns for major North American forest regions will be addressed. Nonmajor graduate credit.

**BIOL 364. Invertebrate Biology.**Cr. 3-4. F. *Prereq: BIOL 212*

Emphasis on diversity, development, physiology and behavior of invertebrate organisms- the "spineless wonders" of the world. Laboratory involves hands-on study and investigation of living invertebrates.

**BIOL 365. Vertebrate Biology.**(Cross-listed with A ECL). (3-2) Cr. 4. F. *Prereq: BIOL 212, BIOL 212L*

Evolution, biology, and classification of fish, amphibians, reptiles, birds, and mammals. Emphasis on a comparative analysis of the structure and function of organ systems. Laboratory exercises concentrate on morphology and identification of orders of vertebrates.

**BIOL 366. Plant Systematics.**(2-4) Cr. 4. S. *Prereq: BIOL 211*

Introduction to plant phylogenetic systematics, plant classification, survey of flowering plant families, identification and field study of local plants.

**BIOL 371. Ecological Methods.**(Cross-listed with A ECL). (2-3) Cr. 3. F. *Prereq: A ECL 312; STAT 101 or STAT 104*

Quantitative techniques used in management of natural resources with emphasis on inventory and manipulation of habitat and animal populations. Nonmajor graduate credit.

**BIOL 381. Environmental Systems I: Introduction to Environmental Systems.**

(Dual-listed with EEOB 581). (Cross-listed with ENSCI, ENV S, MICRO). Cr. 3-4.

F. *Prereq: 12 credits of natural science including biology and chemistry*

Introduction to the structure and function of natural environmental systems. Emphasis on the analysis of material and energy flows in natural environmental systems and the primary environmental factors controlling these systems. Nonmajor graduate credit.

**BIOL 382. Environmental Systems II: Analysis of Environmental Systems.**(Dual-listed with EEOB 582). (Cross-listed with ENSCI). (2-2) Cr. 3. S. *Prereq: ENSCI 381*

Continuation of EnSci 381. Systems approach to the analysis of material and energy flows in natural environmental systems and the primary environmental factors controlling these systems. Nonmajor graduate credit.

**BIOL 393. North American Field Trips in Biology.**Cr. 1-4. Repeatable. *Prereq: Two courses in the biological sciences and by approval of application*

Extended field trips, usually during break periods, to North American locations of interest to biologists. Inquire in the Biology Program Office, 103 Bessey Hall, for trip schedule.

**BIOL 393A. North American Field Trips in Biology: Pre-trip Seminar.**(1-0) Cr. 1. Repeatable. *Prereq: Two courses in the biological sciences and by approval of application*

Discussion of relevant biological and cultural topics during semester preceding extended field trips to North American locations of interest to biologists.

**BIOL 393B. North American Field Trips in Biology: North American Field trip.**Cr. 1-3. Repeatable. *Prereq: Two courses in the biological sciences and by approval of application*

Extended field trip to North American location under supervision of faculty member, usually during break periods, to North American locations of interest to biologists. Inquire in the Biology Program Office, 103 Bessey Hall, for trip schedule. Report required.

**BIOL 394. International Field Trips in Biology.**Cr. 1-4. Repeatable. *Prereq: Two courses in the biological sciences and by approval of application*

Extended field trips, usually during break periods, to international locations of interest to biologists. Inquire in the Biology Program Office, 103 Bessey Hall, for trip schedule.

Meets International Perspectives Requirement.

**BIOL 394A. International Field Trips in Biology: Pre-trip Seminar.**(1-0) Cr. 1. Repeatable. *Prereq: Two courses in the biological sciences and by approval of application*

Discussion of relevant biological and cultural topics during semester preceding extended field trip to international locations of interest to biologists.

**BIOL 394B. International Field Trips in Biology: Field Trip to International Location.**Cr. 1-3. Repeatable. *Prereq: Two courses in the biological sciences and by approval of application*

Extended field trips, under supervision of faculty member, usually during break periods, to international locations of interest to biologists. Inquire in the Biology Program Office, 103 Bessey Hall, for trip schedule. Offered on a satisfactory-fail basis only.

**BIOL 423. Developmental Biology.**(3-0) Cr. 3. S. *Prereq: BIOL 313*

Principles of embryogenesis and animal development. Establishment of body axes, organ and limb development, and specification of cell fates. Emphasis on cell signaling and the control of gene expression within the context of a developing organism. Medically relevant subjects will be discussed, including stem cells, cancer biology, fertilization, and cloning.

**BIOL 423L. Developmental Biology Laboratory.**(0-3) Cr. 1. S. *Prereq: Credit or enrollment in BIOL 423*

Experiments and explorations illustrating fundamental principles of multicellular development.

**BIOL 428. Topics in Cell Biology.**(3-0) Cr. 3. S. *Prereq: BIOL 314*

Selected topics on biological organization and function at the cellular level. Emphasis on biomembranes. Nonmajor graduate credit.

**BIOL 434. Endocrinology.**(3-0) Cr. 3. S. *Prereq: BIOL 211, BIOL 212*

Dual-listed with EEOB 534. Chemical integration of vertebrate organisms. The structure, development, and evolution of the endocrine glands and the function and structure of their hormones. Nonmajor graduate credit.

**BIOL 436. Neurobiology.**(3-0) Cr. 3. F. *Prereq: BIOL 212*

Basic principles of brain function and development. Signaling of nerve cells, synaptic transmission, structure/function of ion channels and receptors, memory and synaptic plasticity, movement and central control, sensation and sensory processing, construction of neural circuits, early brain development, complex brain functions in health and disease. Nonmajor graduate credit.

**BIOL 439. Environmental Physiology.**Cr. 3-4. Alt. S., offered 2012. *Prereq: BIOL 335; physics recommended*

Dual-listed with EEOB 539. Physiological adaptations to the environment with an emphasis on vertebrates. Nonmajor graduate credit.

**BIOL 444. Introduction to Bioinformatics.**(Cross-listed with BCB, BCBIO, COM S, CPR E, GEN). (4-0) Cr. 4. F. *Prereq: MATH 165 or STAT 401 or equivalent*

Broad overview of bioinformatics with a significant problem-solving component, including hands-on practice using computational tools to solve a variety of biological problems. Topics include: database searching, sequence alignment, gene prediction, RNA and protein structure prediction, construction of phylogenetic trees, comparative and functional genomics, systems biology. Nonmajor graduate credit.

**BIOL 451. Plant Evolution and Phylogeny.**(Dual-listed with BIOL 551). (Cross-listed with EEOB). (3-3) Cr. 4. F. *Prereq: BIOL 315 or equivalent*

Survey of land plant evolution; phylogenetic comparison of anatomical, reproductive, and life history specializations. Relationships among bryophytes, lycophytes, pteridophytes, gymnosperms, and angiosperms emphasizing significant evolutionary changes documented by paleobotanical, morphological, and molecular studies.

**BIOL 454. Plant Anatomy.**(3-3) Cr. 4. F. *Prereq: BIOL 212L; BIOL 366 recommended*

Characteristics of cell and tissue types in vascular plants. Anatomy of developing and mature stems, roots, and leaves, including secondary (woody) growth. Introduction to the special anatomy of flowers and seeds. Nonmajor graduate credit.

**BIOL 455. Bryophyte and Lichen Biodiversity.**(Dual-listed with BIOL 555). Cr. 3. *Prereq: BIOL 211, BIOL 211L*

(Dual-listed with EEOB) Introduction to the biology and ecology of mosses, liverworts, and lichens. Emphasis on identification and diversity of local representatives of these three groups of organisms. Required field trips and service-learning. Nonmajor graduate credit.

**BIOL 456. Principles of Mycology.**(Cross-listed with MICRO). (2-3) Cr. 3. F. *Prereq: 10 credits in biological sciences* Morphology, diversity, and ecology of fungi; their relation to agriculture, industry, and human health. Nonmajor graduate credit.**BIOL 457. Herpetology.**(Dual-listed with BIOL 557). (Cross-listed with A ECL). (2-3) Cr. 3. F. *Prereq: BIOL 351 or BIOL 365*

Dual listed with EEOB 557. Biology, ecology, and evolution of amphibians (salamanders, frogs, caecilians) and reptiles (lizards, snakes, tuatara, turtles, crocodylians). Emphasis on structure, physiological adaptation to different environments, behavior, reproduction, roles of amphibians and reptiles in ecosystems, and conservation. Laboratory focus on survey methods, identification, relationships, distribution, habits, and habitats of amphibians and reptiles.

**BIOL 458. Ornithology.**(Dual-listed with EEOB 558). (Cross-listed with A ECL). (2-3) Cr. 3. S. *Prereq: A ECL 365 or BIOL 351*

Biology, evolution, ecology and taxonomy of birds. Emphasis on structure, physiology, behavior, communication, navigation, reproduction, and conservation. Laboratory exercises complement lecture topics, emphasize identification and distribution of Midwest birds, and include field trips.

**BIOL 459. Mammalogy.**(Dual-listed with EEOB 559). (Cross-listed with A ECL). (2-3) Cr. 3. S. *Prereq: BIOL 351 or A ECL 365*

Biology, ecology, and evolution of mammals. Emphasis on structure, physiological adaptation to different environments, behavior, reproduction, roles of mammals in ecosystems, and conservation. Laboratory focus on identification, distribution, habits, and habitats of mammals.

**BIOL 462. Evolutionary Genetics.**(Cross-listed with GEN). (3-0) Cr. 3. S. *Prereq: BIOL 315*

The genetic basis of evolutionary processes in higher organisms. The role of genetic variation in adaptation, natural selection, adaptive processes, and the influence of random processes on evolutionary change. Nonmajor graduate credit.

**BIOL 465. Morphometric Analysis.**(3-2) Cr. 4. Alt. S., offered 2012. *Prereq: STAT 401*

Dual-listed with EEOB 565. A comprehensive overview of the theory and methods for the analysis of biological shape with emphasis on data acquisition, standardization, statistical analysis, and visualization of results. Methods for both landmark and outline data will be discussed. Nonmajor graduate credit.

**BIOL 471. Introductory Conservation Biology.**Cr. 3. *Prereq: BIOL 312*

Examination of conservation issues from a population and community perspective. The role of genetics, demography, and environment in determining population viability, habitat fragmentation, reserve design, biodiversity assessment, and restoration ecology.

**BIOL 472. Community Ecology.**(2-2) Cr. 3. S. *Prereq: BIOL 312*

The effect of interspecific interactions on the structure and dynamics of natural and managed communities; including concepts of guild structure and trophic web dynamics and their importance to the productivity, diversity, stability, and sustainability of communities. The implications of interspecific interactions in the management of wild species will be emphasized with illustrative case histories of interactions between plants, invertebrates, and vertebrates. Nonmajor graduate credit.

**BIOL 474. Plant Ecology.**(3-0) Cr. 3. S. *Prereq: BIOL 312*

Principles of plant population and community ecology. Nonmajor graduate credit.

**BIOL 476. Functional Ecology.**(3-0) Cr. 3. Alt. S., offered 2013. *Prereq: BIOL 312*

Dual-listed with EEOB 576. The nature of adaptations to physical and biotic environments. Biophysical, biomechanical, and physiological bases of the structure, form, growth, distribution, and abundance of organisms.

**BIOL 480. Studies in Marine Biology.**

Cr. 1-8. Repeatable.

Courses taken at Gulf Coast Research Laboratory and other marine biological stations are transferred to Iowa State University under this number.

**BIOL 481. Summer Field Studies.**

Cr. 1-8. Repeatable.

Courses taken at summer biological field stations are transferred to Iowa State University under this number. See [www.biology.iastate.edu](http://www.biology.iastate.edu) for links to field stations located in different biomes: coastal, Great Lakes, taiga, deciduous forests, deserts, Rocky Mountains.

**BIOL 482. Tropical Biology.**Cr. 1-4. Repeatable, maximum of 8 credits. *Prereq: One year of college biology; knowledge of Spanish desirable but not required*

Students registering for courses taught by the Organization for Tropical Studies will receive credit for this ISU course when requesting a transfer of credits.

**BIOL 484. Ecosystem Ecology.**(Cross-listed with ENSCI). (3-0) Cr. 3. S. *Prereq: Combined 12 credits in biology and chemistry*

Introduction of the study of ecosystems and the factors that influence their properties and dynamics. Conceptual foundations for ecosystem studies. Quantitative analyses of accumulations, transformations, and fluxes of nutrients, water, and energy within and among ecosystems.

**BIOL 486. Aquatic Ecology.**(Dual-listed with BIOL 586). (Cross-listed with ENSCI). (3-0) Cr. 3. F. *Prereq: Biol 312 or EnSci 381 or EnSci 402 or NREM 301*

Dual-listed with EEOB 586. Structure and function of aquatic ecosystems with application to fishery and pollution problems. Emphasis on lacustrine, riverine, and wetland ecology. Nonmajor graduate credit.

**BIOL 486L. Aquatic Ecology Laboratory.**(Cross-listed with ENSCI, A ECL). (0-3) Cr. 1. F. *Prereq: Concurrent enrollment in BIOL 486*

Dual-listed with EEOB 586L. Field trips and laboratory exercises to accompany 486. Hands-on experience with aquatic research and monitoring techniques and concepts. Nonmajor graduate credit.

**BIOL 487. Microbial Ecology.**

(Dual-listed with BIOL 587). (Cross-listed with ENSCI, MICRO). (3-0) Cr. 3. F.

*Prereq: Six credits in biology and 6 credits in chemistry*

Dual-listed with EEOB 587. Introduction to major functional groups of autotrophic and heterotrophic microorganisms and their roles in natural systems. Nonmajor graduate credit.

**BIOL 488. Identification of Aquatic Organisms.**

(0-3) Cr. 1. F.S.

On line taxonomic and identification exercises to accompany 486. Instruction and practice in the identification of algae, aquatic macrophytes, zooplankton, and benthos. Nonmajor graduate credit.

**BIOL 489. Population Ecology.**

(2-2) Cr. 3. F. *Prereq: BIOL 312, STAT 101 or STAT 104, a course in calculus, or graduate standing*

Dual-listed with EEOB 589. Concepts and theories of population dynamics with emphasis on models of growth, predation, competition, and regulation.

**BIOL 490. Independent Study.**

Cr. 1-6. Repeatable, maximum of 9 credits. F.S.SS. *Prereq: Permission of instructor.*

Independent study opportunities for undergraduate students in the biological sciences. No more than 9 credits in Biol 490 may be counted toward graduation and of those, only 6 credits may be applied to the major.

**BIOL 490I. Iowa Lakeside Laboratory.**

(Cross-listed with IA LL, ANTHR, NREM). Cr. 1-6. Repeatable, maximum of 9 credits. *Prereq: 8 credits in biology and permission of instructor*

Research opportunities for undergraduate students in the biological sciences. No more than 9 credits in Biol 490 may be counted toward graduation and of those, only 6 credits may be applied to the major.

**BIOL 491. Undergraduate Teaching Experience.**

Cr. 1-2. Repeatable. *Prereq: Permission of supervising staff*

For students registering to be undergraduate teaching assistants. Satisfactory-Fail grading only. Offered on a satisfactory-fail basis only.

**BIOL 492. Preparing for Graduate School in the Biological Sciences.**

(1-0) Cr. 1. F. *Prereq: For life science majors; Minimum requirement: sophomore standing.*

For students considering pursuing a graduate degree in the biological sciences. Professional development topics including the defining of academic and career areas of interest, finding and evaluating appropriate programs of graduate study, the graduate school application process, and developing a curriculum vita. Exploration of learning opportunities at field stations, research internships, and independent research activities.

**BIOL 494. Biology Internship.**

Cr. 1-3. Repeatable. *Prereq: 8 credits in biology and permission of instructor*

Intended to provide credit for significant professional experiences in biological sciences. A written proposal is required prior to registration. Intended for Biology majors.

**BIOL 495. Undergraduate Seminar.**

Cr. 1-3. Repeatable. F.S. *Prereq: Permission of instructor*

Content varies from year to year and may include detailed discussion of special topics in biology, current issues in biology, or careers in biology.

**BIOL 498. Cooperative Education.**

Cr. R. Repeatable. F.S.SS. *Prereq: Permission of the Biology Program cooperative education coordinator*

Required of all cooperative education students. Students must register for this course prior to commencing each work period.

**BIOL 499. Undergraduate Research Experience.**

Cr. 1-6. Repeatable, maximum of 9 credits. F.S.SS. *Prereq: Permission of instructor.*

Research opportunities for undergraduate students in the biological sciences. No more than 9 credits in Biol 499 may be counted toward graduation and of those, only 6 credits may be applied to the major.