BIOLOGY (BA OR BS)

Chairs: Lisa Morey, PhD (moreyl@canisius.edu) and Jon O'Brien, PhD

Introduction

The biology major offers broad training in the biological sciences and balances organismal with cellular/molecular biology. This background serves as a solid preparation for

1. future graduate level education in the biological sciences
2. future professional education in clinical and health-related sciences
3. employment at the bachelor's level
4. additional training in other disciplines that require a thorough understanding of biology, such as various areas of business, communications, engineering, law and social policy development

The biology program of study combines lectures and a hands-on learning experience in both its core and elective courses. The elective courses offered within the major cover a variety of biological fields, which allow students to sample many areas of biology or to investigate more thoroughly specific areas of special interest. In addition, the opportunity to perform independent research with a faculty member in the biology department helps develop additional skills not normally offered in undergraduate courses and provides additional opportunities to apply the knowledge acquired in coursework.

Additionally, Canisius has developed programs for students interested in Early Assurance Acceptance into the Lake Erie College of Osteopathic Medicine (College of Medicine, Schools of Dental Medicine, Podiatric Medicine, and Pharmacy) as well as Joint Degree Programs with the University at Buffalo (School of Pharmacy), Lake Erie College of Osteopathic Medicine (School of Pharmacy), D'Youville University (School of Pharmacy) and SUNY College of Optometry.

Qualifications

Students must maintain a 2.0 overall average to graduate with a degree in biology. Students must attain a D or greater in each of the introductory courses (BIO 111, BIO 112, and BIO 211) in order to progress into the next course in the biology sequence. Students must have a D or better in BIO 112 (or BIO 113) to take any 300-level Biology courses and a D or better in BIO 212 and successfully complete BIO 211L and BIO 212L to take any 400-level Biology courses.

Advisement

All students should have an advisor in the major and should contact the department directly to have an advisor assigned if they do not already have one. Meetings with academic advisors are required prior to students receiving their PIN for course registration each semester. All majors should work closely with their advisor in discussing career expectations, choosing their major electives, developing their entire academic program and planning their co-curricular or supplemental academic experiences.

In addition to academic advisement for the major, advisement relevant to career options in the biological sciences, including pre-clinical and research interests, is also provided.

Major Experiences

All faculty in the biology department are research-active and maintain their own research program at Canisius. Students interested in pursuing research opportunities with biology faculty are encouraged to speak with individual faculty members about their work and research opportunities in their respective laboratories.

Biology with Distinction

This degree option for the biology program is intended for biology majors who have a true interest in research and may have career interests in biological or biomedical research. Upon graduation they will receive certification of completing their major with distinction. Program requirements include writing of a formal research proposal to be submitted to their thesis committee, completion of the research project (600 research hours minimum), writing the final thesis paper, and presentation of a departmental seminar with verbal thesis defense in front of their committee. Interested students must apply to this program by January of their junior year. See the department chair for complete details including appropriate paperwork.

Double Majors

Students who wish to expand their educational opportunities may decide to declare a double major. This decision may be based on career goals, planned graduate studies, and/or other student interests. Before a student declares a double major, it is important to meet with the appropriate academic departments for advisement. In order to declare a double major, the student must complete the Major/Minor Declaration form. This form will be submitted electronically and reviewed and approved by each department chairperson as well as the appropriate associate dean.

Per university policy, each additional major requires a minimum of 15 credits that do not apply to the student's first or subsequent major. Some double major combinations can be completed within the minimum 120 credit hour degree requirement, but in other cases, additional coursework may be required. Please note that students will only receive **one** degree unless completing the dual degree (https://catalog.canisius.edu/undergraduate/academics/curricular-information/) requirement, including at least 150 undergraduate credit hours, regardless of the number of majors they complete. Both (all) majors appear on a student's transcript.

Minors in Other Disciplines

Minors provide students the opportunity to pursue additional interests but generally do not require as many courses as a major. Minors generally range from five to eight required courses. To receive a minor, the student must complete at least 9 credit hours of coursework distinct from their other credentials (i.e., majors, other minors). The complete list of minors is available on the Canisius website (https://www.canisius.edu/academics/programs/undergraduate/?type%5B%5D=17) and in the catalog (https://catalog.canisius.edu/undergraduate/minors/) and provides links to each minor. Some majors and minors can be completed within the minimum 120 credit hour degree requirement, but in some cases additional coursework may be required. Students must complete the appropriate minor request form.

Additional Course Considerations

It is particularly important that the biology major maintain the indicated required science course sequence to ensure prerequisite requirements are met for upper-level courses and to ensure that all basic requirements have been completed prior to taking standardized graduate/professional school entrance examinations (e.g. GRE, MCAT, DAT). These exams are normally taken late in spring semester of the junior year. Biology majors normally take BIO 111/BIO 112 and CHM 111/CHM 112 in the freshman year, and BIO 211/BIO 212 and CHM 227/CHM 228 in the sophomore year so that they stay on schedule for completing the major requirements. In

selecting courses for the major, students should consult carefully with their advisors each semester about the best selection of courses for the coming semesters. In addition, students will want to consult the on-line advisement guide, which is published each semester and contains valuable information about course offerings for the coming semester's offerings.

BS Curriculum

An Ignatian Foundation

All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/core-curriculum/) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/all-college-honors-program/). Many schools refer to their college-wide undergraduate requirements as "general education" requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

Free Electives

Students may graduate with a bachelor's degree with more but not less than 120 credit hours. Free electives are courses in addition to the Canisius Core Curriculum or All-College Honors Curriculum and major requirements sufficient to reach the minimum number of credits required for graduation. The number of credits required to complete a bachelor's degree may vary depending on the student's major(s) and minor(s).

Major Requirements

The Biology curriculum fulfills all requirements and prepares students well for graduate programs in the biological sciences, and for schools of allopathic (MD) and osteopathic (DO) medicine, dentistry, veterinary medicine, and several allied health programs including, but not limited to, chiropractic, optometry, physician's assistant, and podiatry.

Biology Major Course Requirements

Code	Title	Credits
BIO 111 & 111L	Introductory Biology I and Introductory Biology Laboratory I	4
BIO 112 & 112L	Introductory Biology II and Introductory Biology Laboratory II	4
or BIO 113 & BIO 112L	Introductory Biology II: Organismal Biology and Introductory Biology Laboratory II	
BIO 211 & 211L	Biochemistry and Cell Biology I and Biochemistry and Cell Biology Lab I	4
BIO 212 & 212L	Biochemistry and Cell Biology II and Biochemistry and Cell Biology Lab II	4
BIO 351	Biology Seminar I	1
BIO 353	Biology Seminar II	1
CHM 111 & 111L	General Chemistry I and General Chemistry I Laboratory	4
CHM 112 & 112L	General Chemistry II and General Chemistry II Laboratory	4
CHM 227 & 227L	Organic Chemistry I and Organic Chemistry I Laboratory	4
CHM 228 & 228L	Organic Chemistry II and Organic Chemistry II Laboratory	4
PHY 201 & 201L	College Physics I and College Physics I Laboratory	4
PHY 202 & 202L	College Physics II and College Physics II Laboratory	4
Select one of the following mathematics electives options:		8
Option 1:		
MAT 111	Calculus I	
MAT 141	Inferential Statistics and Computers for Science	
or PSY 201	Basic Statistics for Behavioral Sciences	
Option 2:		
MAT 111 & MAT 112	Calculus I and Calculus II	
Option 3:		
One year of statistics for sciences		
Biology Major Electives (6 courses as described below)		22
Total Credits		**72**

Major Electives

Code	Title	Credits
Select six 300- or 400-level lecture courses, four with associated laboratories		
Area 1 Elective and Lab		4
Area 2 Elective and Lab		4
Area 3 Elective and Lab		4
Biology Elective [1]		3
Biology Elective [1]		3
Biology Elective and Lab [2]		4
Total Credits		**22**

[1] The remaining three biology electives may come from within the three areas or from any other 300- or 400-level elective courses in biology listed below.

[2] At least one elective course must taken with a laboratory. A student enrolled in three semesters of BIO 301 Research Methods would fulfill this fourth laboratory requirement

ARea 1: Ecology and Evolution

Code	Title	Credits
BIO 305 & 305L	Medical Microbiology and its Ecological Basis and Medical Microbiology and its Ecological Basis Lab [1]	4
BIO 320 & 320L	Field Ecology and Field Ecology Lab	4
BIO 357 & 357L	Evolution and Evolution Laboratory	4
BIO 375 & 375L	Community Ecology and Community Ecology Laboratory	4
BIO 377 & 377L	Freshwater Biology and Freshwater Biology Laboratory	4
BIO 378 & 378L	Wetlands and Wetlands Laboratory	4
BIO 406 & 406L	Population and Conservation Genetics and Population and Conservation Genetics Laboratory	4
BIO 412 & 412L	Evolution & Development and Evolution & Development Lab	4

[1] If BIO 305 taken in Area 1, then BIO 307 cannot be taken for Area 2.

AREA 2: Organismal Biology

Code	Title	Credits
BIO 307 & 307L	Microbiology and Microbiology Laboratory	4
BIO 324 & 324L	Human Anatomy and Human Anatomy Lab	4
BIO 335 & 335L	Plant Biology and Plant Biology Lab	4
BIO 340 & 340L	Physiology and Physiology Laboratory	4
BIO 343 & 343L	Entomology and Entomology Lab	4
BIO 366 & 366L	Ornithology and Ornithology Laboratory	4

Area 3: molecular and cellular biology

Code	Title	Credits
BIO 404 & 404L	Genetics and Genetics Laboratory	4
BIO 419 & 419L	Cell Biology and Cell Biology Laboratory	4
BIO 425 & 425L	Cellular Neurobiology and Cellular Neurobiology Laboratory	4
BIO 426 & 426L	Immunochemistry and Immunochemistry Laboratory	4
BIO 430 & 430L	Advanced Cellular Biochemistry and Metabolism and Advanced Cellular Biochemistry and Metabolism Laboratory	4
BIO 432 & 432L	Developmental Biology and Developmental Biology Laboratory	4
BIO 435 & 435L	Developmental Neurobiology and Develop Neurobiology Laboratory	4
BIO 450 & 450L	Molecular Biology and Molecular Biology Laboratory	4

Biology Electives

Code	Title	Credits
BIO 312	Primatology	3
BIO 317	Sex, Evolution and Behavior	3
BIO 322	Conservation Biology	3
BIO 345	Functional Neuroanatomy	3
BIO 357	Evolution	3
BIO 360	Environmental Health	3
BIO 364	Zoology: Diversity of Animal Life	3
BIO 424	Epigenetics and Disease	3
BIO 441	Neurobiology of Nervous System Disorders	3
BIO 444	Cancer Biology	3

BS Roadmap

Recommended Semester Schedule for Major Course Requirements

Freshman	
Fall	**Spring**
BIO 111 & 111L	BIO 112 & 112L
CHM 111 & 111L[1]	CHM 112 & 112L[1]
MAT (Pre-calculus, Calculus or Statistics)	MAT (Pre-calculus, Calculus or Statistics)
Sophomore	
Fall	**Spring**
BIO 211 & 211L	BIO 212 & 212L
CHM 227 & 227L	CHM 228 & 228L
	BIO 351
Junior	
Fall	**Spring**
PHY 201 & 201L	PHY 202 & 202L
BIO Elective with lab	BIO Elective with lab
Senior	
Fall	**Spring**
BIO Elective with lab	BIO Elective with lab
BIO Elective	BIO Elective
BIO 353	

[1] **Note:** For students who do not begin the fall freshman semester in CHM 111, they may take this course in the spring semester. Students would then take CHM 112 & CHM 112L in the summer to complete general chemistry to take BIO 211 and 211L in the fall sophomore semester.

BA Curriculum

An Ignatian Foundation

All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/core-curriculum/) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/all-college-honors-program/). Many schools refer to their college-wide undergraduate requirements as "general education" requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

Free Electives

Students may graduate with a bachelor's degree with more but not less than 120 credit hours. Free electives are courses in addition to the Canisius Core Curriculum or All-College Honors Curriculum and major requirements sufficient to reach the minimum number of credits required for graduation. The number of credits required to complete a bachelor's degree may vary depending on the student's major(s) and minor(s).

Major Requirements

Code	Title	Credits
BIO 111 & 111L	Introductory Biology I and Introductory Biology Laboratory I	4
BIO 112 & 112L	Introductory Biology II and Introductory Biology Laboratory II	4
or BIO 113 & BIO 112L	Introductory Biology II: Organismal Biology and Introductory Biology Laboratory II	
BIO 211 & 211L	Biochemistry and Cell Biology I and Biochemistry and Cell Biology Lab I	4
BIO 212 & 212L	Biochemistry and Cell Biology II and Biochemistry and Cell Biology Lab II	4
CHM 111 & 111L	General Chemistry I and General Chemistry I Laboratory	4
CHM 112 & 112L	General Chemistry II and General Chemistry II Laboratory	4
CHM 227 & 227L	Organic Chemistry I and Organic Chemistry I Laboratory	4
or PHY 201 & 201L	College Physics I and College Physics I Laboratory	
Select three Biology 300- or 400-level Electives with associated Lab One course must be at the 400 level with its associated lab.		12
One Biology Elective at 300 or 400 Level		3
MAT 111	Calculus I	4
or MAT 141	Inferential Statistics and Computers for Science	
BIO 351	Biology Seminar I	1
BIO 353	Biology Seminar II	1
Total Credits		**49**

BA ROADMAP

Recommended Semester Schedule for Major Course Requirements

Freshman

Fall	Spring
BIO 111 & 111L	BIO 112 & 112L
CHM 111 & 111L[1]	CHM 112 & 112L[1]
MAT (Pre-calculus, Calculus or Statistics)	MAT (Pre-calculus, Calculus or Statistics)

Sophomore

Fall	Spring
BIO 211 & 211L	BIO 212 & 212L
select one of the following:	BIO 351
CHM 227 & 227L	
PHY 201 & 201L	

Junior

Fall	Spring
BIO Elective with lab	BIO Elective with lab

Senior

Fall	Spring
BIO Elective	BIO Elective with lab

1 **Note:** For students who do not begin the fall freshman semester in CHM 111, they may take this course in the spring semester. Students would then take CHM 112 & CHM 112L in the summer to complete general chemistry to take BIO 211 and 211L in the fall sophomore semester.

Learning Goals and Objectives

Student Learning Goal 1

Students will develop competency with respect to knowledge, having a working understanding of basic concepts in the biological sciences.

Students will:

- Objective A: Demonstrate detailed knowledge within at least two areas of biology to be selected among the following: from ecology/evolutionary biology; molecular biology/cellular biology/biochemistry; physiology/organism biology;
- Objective B: Connect previously learned material with current research in biology.

Student Learning Goal 2

Students will develop problem solving skills applicable to the biological sciences.

Students will:

- Objective A: Accurately interpret data;
- Objective B: Design an experiment to address a specific hypothesis;
- Objective C: Critically analyze an article from the original scientific literature or a professional report.

Student Learning Goal 3

Students will demonstrate mastery with respect to technical skills in the biological sciences.

Students will:

- Objective A: Effectively communicate scientific material in a written format;
- Objective B: Effectively communicate scientific material orally;
- Objective C: Draw graphs or design tables to accurately represent scientific information;
- Objective D: Describe or Explain instrumentation and technology appropriate to their course of study.

Minors

The Biology Department offers six minors: General Biology, Cell and Molecular Biology, Environmental Biology, Neuroscience, Animal Behavior, and Zoo Biology. Students interested in the Cell and Molecular Biology, Environmental Biology, Neuroscience, or Biology minors should consult with the coordinator of that minor and their departmental advisor to plan the proper course selections. Students interested in the Animal Behavior and Zoo Biology minors should consult with Dr. Sue Margulis, Chair of the Animal Behavior, Ecology and Conservation (ABEC) department. A description of the Animal Behavior and Zoo Biology minors can be located within the ABEC pages (http://catalog.canisius.edu/undergraduate/division-arts-education-sciences/school-natural-environmental-animal-sciences/animal-behavior-ecology-conservation/) of the college catalog. A description of the other minors are listed in the following text.

- General Biology Minor (for Non-Biology Majors) (http://catalog.canisius.edu/undergraduate/division-arts-education-sciences/school-natural-environmental-animal-sciences/biology/general-minor/)
- Cell and Molecular Biology Minor (http://catalog.canisius.edu/undergraduate/division-arts-education-sciences/school-natural-environmental-animal-sciences/biology/general-minor/)
- Environmental Science Minor (http://catalog.canisius.edu/undergraduate/division-arts-education-sciences/school-natural-environmental-animal-sciences/biology/environmental-minor/)
- Neuroscience Minor (http://catalog.canisius.edu/undergraduate/division-arts-education-sciences/school-natural-environmental-animal-sciences/biology/neuroscience-minor/)

Minors are an important part of the undergraduate curriculum. If students declare a minor by sophomore year, they can usually complete it in a timely manner. Students should work with their advisor to determine if it is possible that the minor can be completed by graduation.

To receive a minor, a student must complete at least 9 credit hours of coursework distinct from their major(s) and from other minors, and students must complete more than 50% of the coursework required for the minor at Canisius. Please note that "ancillary/supporting" courses required for a major may still count as distinct courses as long as the remaining coursework still meets the 30 credit-hours required for a major. For more information about minor policies, please see the Declaring Majors and Minors (http://catalog.canisius.edu/undergraduate/academics/student-records/declaring-majors-minors/) page in the catalog.

Combined Degree Programs

- 4+1 Biology BA/Adolescence 7-12, Teaching Students With Disabilities (All Grades) MSEd (http://catalog.canisius.edu/undergraduate/division-arts-education-sciences/school-natural-environmental-animal-sciences/biology/4-1-biology-ba-swd/)
- 4+1 Biology BS/Adolescence 7-12, Teaching Students With Disabilities (All Grades) MSEd (http://catalog.canisius.edu/undergraduate/division-arts-education-sciences/school-natural-environmental-animal-sciences/biology/4-1-biology-bs-adolescence-swd-msed/)

Courses

BIO 109 Nutrition **3 Credits**
How food intake influences us as individuals and as components of society, what food is, how we get and use food, processes regulating its use.
Fulfills College Core: Field 6 (Natural Sciences)

BIO 111 Introductory Biology I **3 Credits**
Introductory course for freshmen biology and other science majors. Course provides foundation of evolution, natural selection and heredity, and ecological principles as mechanisms of selection and evolution. Topics include the basis of evolutionary theory, concept of natural selection, evolution of living cells, basic inheritance, biological diversity, intra- and inter-specific interactions between organisms, and interactions between organisms and their environment. Three hours of lecture and a one and a half hour recitation per week.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: every fall.

BIO 111L Introductory Biology Laboratory I **1 Credit**
Laboratories in selection, heredity, diversity, population biology and ecology. Also includes introduction to scientific method and scientific writing. Three hours of lab per week.
Corequisite: BIO 111.
Offered: every fall.

BIO 112 Introductory Biology II **3 Credits**
Introductory course for freshmen biology and other science majors. Course focuses on homeostasis in multicellular organisms through exploring structure and function relationships in plants and animals. Topics include cell interactions in tissues and organs, anatomy and physiology of plants and animals, and the role of natural selection in shaping the anatomy and physiology of plants and animals. Three hours of lecture and a one and a half hour recitation per week.
Prerequisite: BIO 111.
Offered: every spring.

BIO 112L Introductory Biology Laboratory II **1 Credit**
Laboratories that provide an examination of the structure and function of living organisms (plants and animals). Three hours of lab per week.
Offered: every spring.

BIO 113 Introductory Biology II: Organismal Biology **3 Credits**
Introductory course for science majors not on a pre-health track. Course explores structure and function relationships in plants and animals. Topics include cell interactions in tissues and organs, anatomy and physiology of plants and animals through several organ systems, and how plants and animals respond to internal and external stimuli.
Prerequisite: BIO 111. **Corequisite:** BIO 112L.
Offered: every spring.

BIO 114 Introductory Human Anatomy and Physiology I **3 Credits**
An introductory course for students requiring an understanding of the structure and function of the human body. After a general overview of anatomy and physiology and some key principles related to homeostasis, biological control systems and feedback loop, the course proceeds to examine the chemical, cellular, tissue, organ, organ system, and organismal levels of organization. From there, the course examines multiple organ systems, including the integumentary, nervous, endocrine, cardiovascular, lymphatic, immune, and respiratory systems. This course examines the relationships among physiology, anatomy, metabolism, genetics, evolution, the physical environment, and exercise, and how they relate to diet, human health and disease, and also emphasizes the interrelationships between organ systems.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: fall & spring.

BIO 114L Introductory Human Anatomy and Physiology I Laboratory 1 Credit
One three-hour lab per week.
Corequisite: BIO 114.
Offered: fall & spring.

BIO 115 Introductory Human Anatomy and Physiology II **3 Credits**
Although the courses can be taken in any order, this course builds on BIO 114 Human Anatomy and Physiology I in providing an introduction to the structure and function of the human body. The course begins with a review of the chemical, cellular, tissue, organ, organ system, and organismal levels of organization. From there, the course examines multiple organ systems, including the anatomical, physiological, and biomechanical aspects of the skeletal and muscular systems, and how these systems interact with the digestive system and metabolism to fuel exercise and all other energy-requiring processes in the body. The urinary and reproductive systems will also be covered.
Corequisite: BIO 115L.
Offered: every spring.

BIO 115L Introductory Human Anatomy and Physiology II Laboratory **1 Credit**
One three-hour lab per week.
Corequisite: BIO 115.
Offered: fall & spring.

BIO 121 Human Reproduction **3 Credits**
This course will explore the following topics: the process of human sexual development, birth control and fertility, human reproductive anatomy, the reproductive process, body changes during pregnancy, human embryonic and fetal development and developmental disorders. Scientific literature will be consulted on important issues including abortion, in vitro fertilization, germ-line CRISPR-modifications, sexuality, and gender identity. There will be a focus on the variety of paths and outcomes possible at all life stages of sexual reproduction and development.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: occasionally.

BIO 132 Genes and People **3 Credits**
How human characteristics are transmitted and affect future generations. Ethical and legal ramifications of genetic advances.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: occasionally.

BIO 166 Biology of Birds **3 Credits**
An introduction to the diversity, behavior, anatomy, and physiology of birds. Students will learn how to identify common local birds. Topics include flight, songs and calls, finding mates, nesting behaviors, and migration. Three hours of lecture per week.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: occasionally.

BIO 211 Biochemistry and Cell Biology I **3 Credits**
Fundamentals of biochemistry (biological chemistry) and cell biology for students majoring in the biological sciences. Structure and biological activities of proteins and lipids. Integrates the cellular and biochemical relationships between systems within the cell, with an emphasis on membrane transport, signal transduction, and cell motility. Three hours of lecture and a one and a half hour recitation per week.
Prerequisite: Minimum grade of C- in BIO 112 or BIO 113 & CHM 111 or co-enrollment in CHM 112 with permission of Chair.
Offered: every fall.

BIO 211L Biochemistry and Cell Biology Lab I **1 Credit**
Investigative laboratory provides opportunity for students to learn how to isolate, measure, and characterize macromolecules present within a variety of cellular systems. Three hours of lab per week. Students must also register for BIO 211.
Offered: every fall.

BIO 212 Biochemistry and Cell Biology II **3 Credits**
Fundamentals of biochemistry (biological chemistry) and cell biology for students majoring in the biological sciences. Structure and biological activities of carbohydrates and nucleic acids. Integrates the cellular and biochemical relationships between systems within the cell with an emphasis on the role cell communication, respiration, photosynthesis, gene expression, and cell division. Three hours of lecture and a one and a half hour recitation per week.
Prerequisite: BIO 211 and minimum grade of C- in CHM 112.
Offered: every spring.

BIO 212L Biochemistry and Cell Biology Lab II **1 Credit**
Examination of experimental methodologies that relate the expression and action of various macromolecules to biological processes at the cellular/molecular level. The role of experimentation in the scientific process is emphasized. Three hours of lab per week.
Prerequisite: BIO 211 & minimum grade of D in BIO 211L. **Corequisite:** BIO 212.
Offered: spring.

BIO 251 Career Exploration in STEM **1 Credit**
Have you ever wondered what other career options a degree in Biology allows you to pursue besides a medical path? This seminar will explore career options and pathways through interviews with various professionals in the fields of biological research, public health, biotechnology, and education.
Offered: occasionally.

BIO 298 Pre-clinical Experience for Undergraduates **1 Credit**
Students undertake a substantial shadowing experience in a clinical setting. Must document and complete a minimum of 100 hours of voluntary work with the same clinician within the academic period. An academic component is also required. Student arranges contact with clinician. Application process is required.
Prerequisite: BIO 111, BIO 112, & approval of the department chair.
Offered: fall & spring.

BIO 300 Research Methods (non-credit) **0 Credits**
Training in experimental methods for the biological sciences under the direct supervision of a faculty member. Each section and research methodologies taught within the section unique to the instruction and research work of a specific faculty member. Requires approval of faculty member for enrollment into an individual section.
Offered: fall, spring, & summer.

BIO 301 Research Methods (credit) **1 Credit**
Training in experimental methods for the biological sciences under the direct supervision of a faculty member. Each section and research methodologies taught within the section unique to the instruction and research work of a specific faculty member. May be taken in multiple semesters for credit. Requires approval of faculty member for enrollment into an individual section.
Offered: fall, spring, & summer.

BIO 305 Medical Microbiology and its Ecological Basis **3 Credits**
Microbiology course that merges discussion of microbial interactions in the human environment (both beneficial and disease-causing) with discussion of microbial interactions in other natural environments. Topics include microbial & ecosystem diversity, the human microbiome compared to other microbial communities, human host-pathogen interaction compared to microbial competition in soil and water, and disease treatment compared to environmental bioremediation.
Prerequisite: minimum grade of C- in BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 305L Medical Microbiology and its Ecological Basis Lab **1 Credit**
Current and historical techniques for the isolation and measurement of microorganisms in the environment and for differentiation between medically important bacteria. Topics include microscopy, preparation of culture media and aseptic technique, staining of microorganisms, isolation and culture of specialized groups of bacteria from human, soil or aquatic environments, and determination of antibiotic resistance. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO112L. **Corequisite:** BIO 305.

BIO 307 Microbiology **3 Credits**
Cell structure, genetics, biochemistry and physiology of microorganisms, with emphasis on bacteria. Medical microbiology, epidemiology, and some immunology also are discussed.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 307L Microbiology Laboratory **1 Credit**
Microbiology laboratory is concerned primarily with the cell structure, growth, physiology and identification of bacteria. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO112L. **Corequisite:** BIO 307.

BIO 308 Parasitology **3 Credits**
Parasitism is the most common biological interaction on the planet, and virtually every organism can be infected by one or more parasites. This course will provide a comprehensive introduction to parasites, their hosts, and the co-evolutionary relationship between them. This class deals primarily with human and animal parasites of public health/ecological importance, including amoeba, malaria, trypanosomes, helminths, and other microparasites.
Prerequisite: BIO 111 and BIO 112 or BIO 113.
Offered: occasionally.

BIO 312 Primatology **3 Credits**
Primatology is the scientific study of primates. Topics include primate evolution, behavior, ecology, and conservation. Emphasis will be placed on reading and critiquing primary literature.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Fulfills College Core: Advanced Writing-Intensive
Offered: every fall.

BIO 317 Sex, Evolution and Behavior **3 Credits**
Reproductive behavior of diverse animal species, including humans, from an evolutionary perspective. Focus on how evolutionary accounts explain male-female differences in life style and behavior.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 320 Field Ecology **4 Credits**
Introduction to the flora, fauna and physical characteristics of regional terrestrial and aquatic ecosystems. Emphasis on field methods and implementation of scientific method from data collection, analysis, and data presentation. Introduction to Geographic Information System (GIS) and its applications in ecology. Lab required. Three hours of lecture and six hours of lab per week.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: fall of even-numbered years.

BIO 320L Field Ecology Lab **0 Credits**
BIO 320 Field Ecology lab.
Offered: fall of even-numbered years.

BIO 322 Conservation Biology **3 Credits**
Study of the plight of endangered species, the biological consequences of fragmented populations, and the scientific basis of habitat/species restoration.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: every spring.

BIO 324 Human Anatomy **4 Credits**
A structure/function approach based on what was learned in BIO112, this course will allow the student to increase their conceptual understanding of human anatomy. Lab required. Three hours of lecture and three hours of lab per week.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: every fall.

BIO 324L Human Anatomy Lab **0 Credits**
Required lab for BIO 324.
Corequisite: BIO 324.
Offered: every fall.

BIO 335 Plant Biology **3 Credits**
Critical examination of the structure, physiology and biochemistry of vascular plants. The interaction of plants with light, water and predators is included. The plants' ability to grow in the face of global climate change is discussed.
Prerequisites: BIO 111 & BIO 112 (or BIO 113).
Offered: occasionally.

BIO 335L Plant Biology Lab **1 Credit**
Investigative survey of plant structure and function. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO112L. **Corequisite:** BIO 335.

BIO 340 Physiology **3 Credits**
Examination of the biochemical, molecular and cellular regulatory mechanisms involved in maintaining stable internal environments required for normal cell, tissue and organ function. Course focuses on cell and organ function, integrated physiological control systems for various organ systems (including cardiovascular, respiratory, GI, renal, reproductive, and immune), and the maintenance of homeostasis. Three hours of lecture per week.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: every spring.

BIO 340L Physiology Laboratory **1 Credit**
Experimental study of physiological systems, using biochemical, cellular and hematological techniques and electronic instrumentation. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO112L. **Corequisite:** BIO 340.

BIO 343 Entomology **4 Credits**
Introduction to the diversity and natural history of insects. The structure, function, evolution and ecology of this group are emphasized. Laboratory focuses on anatomy, diversity and classification. Lab required. Three hours of lecture and three hours of lab per week.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 343L Entomology Lab **0 Credits**
BIO 343 Entomology Lab.
Offered: occasionally.

BIO 345 Functional Neuroanatomy **3 Credits**
Examination of human neuroanatomy, with emphasis on the relationship between neuronal circuits and nervous system function/dysfunction. Three hours of lecture per week.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 351 Biology Seminar I **1 Credit**
Designed to provide sophomore biology major students with the opportunity to learn various methods of preparing scientific/experimental information for oral presentation. Attendance at departmental seminars required. Meets for 1.5 hours per week.
Offered: every spring.

BIO 353 Biology Seminar II **1 Credit**
Provides opportunities for fourth-year Biology major students to present seminars on research of the primary biological literature. Attendance at departmental seminars required. Meets for 1.5 hours per week.
Prerequisite: BIO 351.
Fulfills College Core: Oral Communication
Offered: every fall.

BIO 357 Evolution **3 Credits**
An in-depth examination of the unifying principles of evolutionary biology. Pre-Darwin ideas about evolution, Darwinian evolution, the Modern Synthesis, and contemporary evolutionary biology. Specific concepts include, but are not limited to, population genetics, speciation, origin of life, phylogenetic analysis, with special emphasis on the evolution of sexual reproduction, virulence evolution, and human evolution. Three hours of lecture per week.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 357L Evolution Laboratory **1 Credit**
Examination of fundamental evolutionary processes through a combination of laboratory experiments, simulations, and analysis of experimental data sets. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO112L. **Corequisite:** BIO 357.
Offered: occasionally.

BIO 360 Environmental Health **3 Credits**
Environmental effects on human health, including biological, physical and chemical hazards in water soil, and air. Course focuses on public health and epidemiological study approaches. Emerging issues also discussed.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: Every other year.

BIO 364 Zoology: Diversity of Animal Life **3 Credits**
This course will explore differences in form, function, systematics and evolutionary relationships of the major groups of animal life on the planet. The course will focus on the evolution of major patterns in body plans and physiological adaptations of the major phyla within the animal kingdom.
Prerequisite: BIO 111 and BIO 112 or BIO 113.
Offered: occasionally.

BIO 366 Ornithology **4 Credits**
Diversity, relationships, ecology, natural history and the behavior of birds. Laboratory focuses on world-wide diversity, local species and field techniques. Lab required. Three hours of lecture and three hours of lab per week.
Prerequisite: BIO 111 & BIO 112 (or BIO 113). **Corequisite:** BIO 366L.
Offered: occasionally.

BIO 366L Ornithology Laboratory **0 Credits**
BIO 366 Ornithology lab.
Corequisite: BIO 366.
Offered: occasionally.

BIO 375 Community Ecology **3 Credits**
Examination of how processes in multi-species assemblages affect communities by altering species' abundances, distributions, composition and driving long-term evolutionary change. Both theoretical models and empirical studies are used to illustrate concepts. Three hours of lecture per week.
Prerequisites: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 375L Community Ecology Laboratory **1 Credit**
The laboratory reinforces ecological concepts discussed in lecture through computer simulations along with field- collected and experimental data. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO112L. **Corequisite:** BIO 375.

BIO 377 Freshwater Biology **4 Credits**
Explores the biology of lakes, rivers, and wetlands. Lectures cover the main concepts in freshwater ecology, including the major physical, biological, and biogeochemical characteristics of freshwater environments. Lab required. The laboratory component covers field techniques, laboratory analyses and identification of common aquatic organisms. Three hours of lecture and three hours of lab per week.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 377L Freshwater Biology Laboratory **0 Credits**
BIO 377 Freshwater Biology lab.
Offered: occasionally.

BIO 378 Wetlands **3 Credits**
Explores the plants, animals and environmental conditions that define wetland environments. The course covers the physical characteristics such as the soils and hydrology, the biological adaptations by plants and animals, and human interaction with these diverse and vibrant ecosystems.
Prerequisite: BIO 111 & BIO 112 or BIO 113.
Offered: occasionally.

BIO 378L Wetlands Laboratory **1 Credit**
Optional lab for Wetlands. Meets once a week for three hours.

BIO 400 Independent Study **1-3 Credits**
Independent study under the direction of a faculty member. Arrangements made prior to registration. Independent studies require an application and approval by the associate dean.
Prerequisite: permission of the instructor, department chair, & associate dean.

BIO 401 Independent Research **1-4 Credits**
Independent laboratory research in biology conducted under the supervision of a faculty member. Arrangements made prior to registration.
Prerequisite: written permission of faculty member & department chair.

BIO 404 Genetics **3 Credits**
Principles of Mendelian, molecular, population, human and quantitative genetics, with emphasis on inherited diseases. Three hours of lecture and a one and a half hour of recitation per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 404L Genetics Laboratory **1 Credit**
Principles of Mendelian and molecular genetics as demonstrated by experiments with Drosophila and other experimental organisms. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO212L. **Corequisite:** BIO 404.
Fulfills College Core: Advanced Writing-Intensive

BIO 406 Population and Conservation Genetics **3 Credits**
General introduction to the field of population genetics, the branch of evolutionary biology concerned with the genetic structure of populations and how it changes through time. We will examine the interaction of basic evolutionary processes (including mutation, natural selection, genetic drift, inbreeding, recombination, and gene flow), with special emphasis on their application to species conservation. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 406L Population and Conservation Genetics Laboratory **1 Credit**
Experimental studies designed to explore fundamental concepts in population genetics and their application in conservation. Laboratory is a combination of in vitro Drosophilaexperiments and in silico computer simulations/data analyses.
Prerequisite: minimum grade of D in BIO212L.

BIO 412 Evolution & Development **3 Credits**
This course will cover concepts, methods and paradigmatic examples in the field of evolutionary developmental biology ("evodevo"). Evo-devo is both a new and old field of biology focusing on how mechanisms controlling development have changed during evolution. The course will cover basic developmental mechanisms based on gene regulation, cell communication, differentiation, growth, etc.(the “genetic toolkit”). Other concepts include evolutionary novelty, evolution of patterning, the genetic basis of complexity, and evolution of the gene regulatory network controlling development.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 412L Evolution & Development Lab **1 Credit**
Optional lab for EvoDevo. The lab will explore the use of non-model organisms for EvoDevo research and illustrate examples from class.
Prerequisite: minimum grade of D in BIO 212L. **Corequisite:** BIO 412.
Offered: occasionally.

BIO 419 Cell Biology **3 Credits**
In depth examination of cellular processes, including metabolism, motility, gene expression, protein processing and sorting, signal transduction, cell cycle, cell death, cell renewal and differentiation are discussed. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 419L Cell Biology Laboratory **1 Credit**
Experimental laboratories examining different cellular processes, including cytoskeleton, protein localization, and gene expression. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO212L. **Corequisite:** BIO 419.

BIO 424 Epigenetics and Disease **3 Credits**
Epigenetic mechanisms alter how the genome is utilized and it is apparent that this changes between healthy and disease states and may start during development. This course focuses on the impact of environment influences on phenotype via epigenetic changes. Topics include cancer, metabolism and metabolic syndromes, autoimmune disorders and allergies. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 425 Cellular Neurobiology **3 Credits**
Cellular and molecular mechanisms underlying nervous system function. Topics include neuron/glia interactions, signaling within the nervous system, neuroplasticity, and neurodegeneration. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 425L Cellular Neurobiology Laboratory **1 Credit**
Experimental laboratories researching current topics in cell and molecular neurobiology. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO212L. **Corequisite:** BIO 425.

BIO 426 Immunochemistry **3 Credits**
Structural concept of antigenic determinants, immunoglobulin sequences and combining site specificity related to the diversity of the immune response and its control. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 426L Immunochemistry Laboratory **1 Credit**
Current methods in immunological research and diagnosis. Designed to present available methodology and insight into the underlying principles. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO212L. **Corequisite:** BIO 426.

BIO 430 Advanced Cellular Biochemistry and Metabolism **3 Credits**
This course focuses on the Biochemistry of human nutrition with emphasis on nutritional components and their metabolism in humans. The course will also discuss various disease treatments and their mechanisms of effect in disease systems. A mechanism-based approach will be utilized to elucidate functional biochemistry within human physiology and establish links to disease states. The function of metabolic pathways, vitamins and metals as essential players in cell survival and human disease is discussed.
Prerequisite: BIO 212 OR BCH 301, and a minimum grade of C- in CHM 228.
Offered: occasionally.

BIO 430L Advanced Cellular Biochemistry and Metabolism Laboratory **1 Credit**
This course focuses on the Biochemistry of pathways associated with higher plant and animal metabolism. A function / mechanism-based approach will be utilized to elucidate the biochemistry within protein and enzyme structure. The regulation of enzyme activity and functional conformation will be examined in several hands on, inquiry based research experiences.
Prerequisite: Minimum grade of C- in BIO 212 or BCH 301. **Corequisite:** BIO 430.
Offered: occasionally.

BIO 432 Developmental Biology **3 Credits**
A study of the basic principles that shape the development of a complex, multicellular organism from a single cell,with a particular emphasis being placed on the underlying cellular and molecular mechanisms. Relevant topics include fertilization, cell fate determination and differentiation, pattern formation, and organogenesis. Three hours of lecture per week.
Prerequisite: BIO 212.
Fulfills College Core: Advanced Writing-Intensive
Offered: occasionally.

BIO 432L Developmental Biology Laboratory **1 Credit**
Examination of the cellular and molecular aspects of animal development using classical model organisms. Three hours of lab per week.
Prerequisite: BIO 211L & BIO 212L.
Offered: occasionally.

BIO 435 Developmental Neurobiology **3 Credits**
Cellular and molecular mechanisms underlying development of the nervous system and neurodevelopmental disorders. Topics include: neural induction, neurogenesis, migration, axon guidance, synaptogenesis, and regeneration. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 435L Develop Neurobiology Laboratory **1 Credit**
Experimental studies of the development and regeneration of nervous tissue using neuronal tissue culture and digital microscopy. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO212L. **Corequisite:** BIO 435.

BIO 441 Neurobiology of Nervous System Disorders **3 Credits**
Cellular and molecular mechanisms under lying diseases of the nervous system, with an emphasis on emerging therapeutic approaches to treating diseases. Topics covered include: neurodegenerative diseases, neurodevelopmental disorders, infectious diseases, neuropsychiatric illnesses, stroke, and trauma. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 444 Cancer Biology **3 Credits**
The causes of cancer, progression of the disease, and therapeutic approaches will be discussed. Students learn the common features of cancers as well as the distinguishing characteristics of a few specific cancers. Throughout the course therapeutic targets will be identified and novel therapeutic approaches will be discussed. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 450 Molecular Biology **3 Credits**
This course focuses on genomes and nuclear organization and function. Topics include genome content and organization from an evolutionary perspective, epigenetic inheritance, chromatin structure and organization, somatic recombination, and organismal complexity. Three hours of lecture per week.
Prerequisite: BIO 212.
Offered: occasionally.

BIO 450L Molecular Biology Laboratory **1 Credit**
Experimental laboratories examining the regulation of gene expression and how regulation affects expression. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO212L. **Corequisite:** BIO 450.

BIO 477 Plants and Society **3 Credits**
Various ways in which plants affect human existence. Topics include food products, building (utilitarian) applications, medicinal and poisonous plants, propagation and improvement, roles in ecology. Open to students in any major. This course does not count for the biology major.
Fulfills College Core: Core Capstone

BIO 498 Biology With Distinction Thesis **3 Credits**
Requirement for any student seeking to complete the Biology with Distinction degree option. Must be taken by seniors in the fall or spring of their senior year.

BIO 499 Biology Internship **3 Credits**
Provides students with work experience in the biological sciences. Practical application of material taught in biology classes to the work environment. Requires an application and approval by the associate dean.
Prerequisite: permission of the department chair & associate dean.