

# BIOLOGY (BS)

**Chairs:** Andrew Stewart, PhD ([stewar34@canisius.edu](mailto:stewar34@canisius.edu)) and Lisa Morey, PhD ([moreyl@canisius.edu](mailto:moreyl@canisius.edu))

## 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. Please see the website (<https://www.canisius.edu/academics/programs/biology/>) for a more detailed description of the program, faculty, facilities, academic and co-curricular opportunities. Canisius has developed programs for students interested in Early Assurance Acceptance into the SUNY Upstate (College of Medicine) and Lake Erie College of Osteopathic Medicine (College of Medicine, School of Dental Medicine and School of Pharmacy); Joint Degree Programs with the University at Buffalo (School of Dental Medicine and School of Pharmacy), Lake Erie College of Osteopathic Medicine (College of Medicine, School of Dental Medicine and School of Pharmacy), and SUNY College of Optometry. Canisius also has a Memorandum of Understanding with the Ontario Veterinary College, University of Guelph. In addition, a series of specialized courses have been developed for the non-science major that relate biological concepts and scientific methodologies to societal issues facing humankind as a result of technological advances.

## Qualifications

Students must maintain a 2.0 overall average to graduate with a degree in biology. Students must attain a C- 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 C- 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 course work may be required. Please note that students will receive only 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.

## 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
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 <sup>1</sup>	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 or PSY 201	Inferential Statistics and Computers for Science or 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
<b>Total Credits</b>		<b>72</b>

<sup>1</sup> **Note:** The combination of CHM 109 and CHM 110 can be taken in place of CHM 111.

### Major Electives

Code	Title	Credits
<b>Select six 300- or 400-level lecture courses, four with associated laboratories</b>		
Area 1 Elective and Lab		4
Area 2 Elective and Lab		4
Area 3 Elective and Lab		4
Biology Elective <sup>1</sup>		3
Biology Elective <sup>1</sup>		3
Biology Elective and Lab <sup>2</sup>		4
<b>Total Credits</b>		<b>22</b>

<sup>1</sup> 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.

<sup>2</sup> 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 <sup>1</sup>	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

<sup>1</sup> 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

## Roadmap

### Recommended Semester Schedule for Major Course Requirements

#### Freshman

Fall	Spring
BIO 111 & 111L	BIO 112 & 112L
CHM 111 & 111L <sup>1</sup>	CHM 112 & 112L <sup>1</sup>
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	

<sup>1</sup> **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/college-arts-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/college-arts-sciences/biology/general-minor/>)
- Cell and Molecular Biology Minor (<http://catalog.canisius.edu/undergraduate/college-arts-sciences/biology/cell-molecular-minor/>)
- Environmental Biology Minor (<http://catalog.canisius.edu/undergraduate/college-arts-sciences/biology/environmental-minor/>)
- Neuroscience Minor (<http://catalog.canisius.edu/undergraduate/college-arts-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/](http://catalog.canisius.edu/undergraduate/academics/student-records/declaring-majors-minors/)) page in the catalog.

## 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:** minimum grade of C- in 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:** C- in BIO 111. **Corequisite:** BIO 112L.

**Offered:** every spring.

### BIO 114 Human Biology: Introduction to Human Anatomy and Physiology 3 Credits

Introductory course for those students requiring an understanding of the structure and function of the human body. 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. Three hours of lecture and one three-hour lab per week.

**Fulfills College Core:** Field 6 (Natural Sciences)

**Offered:** fall & spring.

<b>BIO 114L Human Biology: Introduction to Human Anatomy and Physiology Laboratory</b> 1 Credit One three-hour lab per week. <b>Corequisite:</b> BIO 114. <b>Offered:</b> fall & spring.	<b>BIO 211 Biochemistry and Cell Biology I</b> 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. <b>Prerequisite:</b> Minimum grade of C- in BIO 112 & CHM 111 or co-enrollment in CHM 112 with permission of Chair. <b>Offered:</b> every fall.
<b>BIO 115 Musculoskeletal Anatomy and Physiology</b> 3 Credits Examination of the anatomy, physiology and biomechanical characteristics of the musculoskeletal components, and associated neural and vascular structures, of the human body. Three hours of lecture and one three-hour lab per week. <b>Corequisite:</b> BIO 115L. <b>Offered:</b> every spring.	<b>BIO 211L Biochemistry and Cell Biology Lab I</b> 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. <b>Offered:</b> every fall.
<b>BIO 115L Musculoskeletal Anatomy and Physiology Laboratory</b> 1 Credit One three-hour lab per week. <b>Corequisite:</b> BIO 115. <b>Offered:</b> fall & spring.	<b>BIO 212 Biochemistry and Cell Biology II</b> 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. <b>Prerequisite:</b> minimum grade of C- in BIO 211 & CHM 112. <b>Offered:</b> every spring.
<b>BIO 116 Disease: Myth and Reality</b> 3 Credits Exploration of causation, treatment and prevention of illness. Objective: to increase awareness and understanding of health and disease. <b>Fulfills College Core:</b> Field 6 (Natural Sciences) <b>BIO 120 Biology in the News</b> 3 Credits The biological concepts underlying science articles appearing in the current news media, examining these concepts in the context of relevant economic, social and cultural issues. Topics will vary. <b>Fulfills College Core:</b> Field 6 (Natural Sciences) <b>Offered:</b> fall.	<b>BIO 212L Biochemistry and Cell Biology Lab II</b> 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. <b>Prerequisite:</b> BIO 211 & minimum grade of D in BIO 211L. <b>Corequisite:</b> BIO 212. <b>Offered:</b> spring.
<b>BIO 121 Human Reproduction</b> 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. <b>Fulfills College Core:</b> Field 6 (Natural Sciences) <b>Offered:</b> occasionally.	<b>BIO 251 Career Exploration in STEM</b> 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. <b>Offered:</b> occasionally.
<b>BIO 132 Genes and People</b> 3 Credits How human characteristics are transmitted and affect future generations. Ethical and legal ramifications of genetic advances. <b>Fulfills College Core:</b> Field 6 (Natural Sciences) <b>Offered:</b> occasionally.	<b>BIO 298 Pre-clinical Experience for Undergraduates</b> 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. <b>Prerequisite:</b> BIO 111, BIO 112, & approval of the department chair. <b>Offered:</b> fall & spring.
<b>BIO 150 Animal Nutrition</b> 3 Credits Nutrition and dietary science focused on the maintenance of wildlife in captivity. Practical examples at our local zoo and aquariums are included. <b>BIO 166 Biology of Birds</b> 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. <b>Fulfills College Core:</b> Field 6 (Natural Sciences) <b>Offered:</b> occasionally.	<b>BIO 300 Research Methods (non-credit)</b> 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. <b>Offered:</b> fall, spring, & summer.



<b>BIO 301 Research Methods (credit)</b> <b>1 Credit</b> 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. <b>Offered:</b> fall, spring, & summer.	<b>BIO 312 Primatology</b> <b>3 Credits</b> 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. <b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112. <b>Fulfills College Core:</b> Advanced Writing-Intensive <b>Offered:</b> every fall.
<b>BIO 303 Science Scholars Seminar II: Career Preparation, Applications, &amp; Interviews</b> <b>1 Credit</b> Seminar course for students actively pursuing, or planning on pursuing graduate school or post-graduate employment in biology-related fields. During the semester, we will discuss how to identify potential graduate schools/employers, how to prepare application materials, and how to prepare for in-person interviews. Course meets once a week (75 minutes) and will be scheduled around availability of participants, as possible. All Science Scholars are required to take this course once during the three years of their scholarship. <b>Restrictions:</b> Canisius Science Scholar scholarship recipient or permission of instructor. <b>Offered:</b> every fall.	<b>BIO 317 Sex, Evolution and Behavior</b> <b>3 Credits</b> 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. <b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112. <b>Offered:</b> spring 2017 and fall 2017.
<b>BIO 305 Medical Microbiology and its Ecological Basis</b> <b>3 Credits</b> 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. <b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.	<b>BIO 320 Field Ecology</b> <b>4 Credits</b> 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. <b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112. <b>Offered:</b> fall of even-numbered years.
<b>BIO 305L Medical Microbiology and its Ecological Basis Lab</b> <b>1 Credit</b> 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. <b>Prerequisite:</b> minimum grade of D in BIO112L. <b>Corequisite:</b> BIO 305.	<b>BIO 320L Field Ecology Lab</b> <b>0 Credits</b> BIO 320 Field Ecology lab. <b>Offered:</b> fall of even-numbered years.
<b>BIO 307 Microbiology</b> <b>3 Credits</b> Cell structure, genetics, biochemistry and physiology of microorganisms, with emphasis on bacteria. Medical microbiology, epidemiology, and some immunology also are discussed. <b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.	<b>BIO 322 Conservation Biology</b> <b>3 Credits</b> Study of the plight of endangered species, the biological consequences of fragmented populations, and the scientific basis of habitat/species restoration. <b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112. <b>Offered:</b> every spring.
<b>BIO 307L Microbiology Laboratory</b> <b>1 Credit</b> Microbiology laboratory is concerned primarily with the cell structure, growth, physiology and identification of bacteria. Three hours of lab per week. <b>Prerequisite:</b> minimum grade of D in BIO112L. <b>Corequisite:</b> BIO 307.	<b>BIO 324 Human Anatomy</b> <b>4 Credits</b> 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. <b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112. <b>Offered:</b> every fall.
<b>BIO 308 Parasitology</b> <b>3 Credits</b> 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. <b>Prerequisite:</b> C- in BIO 111 and BIO 112. <b>Offered:</b> occasionally.	<b>BIO 324L Human Anatomy Lab</b> <b>0 Credits</b> Required lab for BIO 324. <b>Corequisite:</b> BIO 324. <b>Offered:</b> every fall.
	<b>BIO 335 Plant Biology</b> <b>3 Credits</b> 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. <b>Prerequisites:</b> minimum grade of C- in BIO 111 & BIO 112.
	<b>BIO 335L Plant Biology Lab</b> <b>1 Credit</b> Investigative survey of plant structure and function. Three hours of lab per week. <b>Prerequisite:</b> minimum grade of D in BIO112L. <b>Corequisite:</b> BIO 335.

<b>BIO 340 Physiology</b>	<b>3 Credits</b>	<b>BIO 360 Environmental Health</b>	<b>3 Credits</b>
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.		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.	
<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.		<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.	
<b>BIO 340L Physiology Laboratory</b>	<b>1 Credit</b>	<b>BIO 364 Zoology: Diversity of Animal Life</b>	<b>3 Credits</b>
Experimental study of physiological systems, using biochemical, cellular and hematological techniques and electronic instrumentation. Three hours of lab per week.		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.	
<b>Prerequisite:</b> minimum grade of D in BIO112L. <b>Corequisite:</b> BIO 340.		<b>Prerequisite:</b> C- in BIO 111 and BIO 112.	
<b>BIO 343 Entomology</b>	<b>4 Credits</b>	<b>BIO 366 Ornithology</b>	<b>4 Credits</b>
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.		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.	
<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.		<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112. <b>Corequisite:</b> BIO 366L.	
<b>BIO 343L Entomology Lab</b>	<b>0 Credits</b>	<b>Offered:</b> occasionally.	
BIO 343 Entomology Lab.		<b>BIO 366L Ornithology Laboratory</b>	<b>0 Credits</b>
<b>Offered:</b> occasionally.		BIO 366 Ornithology lab.	
<b>BIO 345 Functional Neuroanatomy</b>	<b>3 Credits</b>	<b>Corequisite:</b> BIO 366.	
Examination of human neuroanatomy, with emphasis on the relationship between neuronal circuits and nervous system function/dysfunction. Three hours of lecture per week.		<b>Offered:</b> occasionally.	
<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.		<b>BIO 375 Community Ecology</b>	<b>3 Credits</b>
<b>BIO 351 Biology Seminar I</b>	<b>1 Credit</b>	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.	
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.		<b>Prerequisites:</b> minimum grade of C- in BIO 111 & BIO 112.	
<b>Offered:</b> every spring.		<b>Offered:</b> occasionally.	
<b>BIO 353 Biology Seminar II</b>	<b>1 Credit</b>	<b>BIO 375L Community Ecology Laboratory</b>	<b>1 Credit</b>
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.		The laboratory reinforces ecological concepts discussed in lecture through computer simulations along with field- collected and experimental data. Three hours of lab per week.	
<b>Prerequisite:</b> BIO 351.		<b>Prerequisite:</b> minimum grade of D in BIO112L. <b>Corequisite:</b> BIO 375.	
<b>Fulfills College Core:</b> Oral Communication		<b>BIO 377 Freshwater Biology</b>	<b>4 Credits</b>
<b>Offered:</b> every fall.		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.	
<b>BIO 357 Evolution</b>	<b>3 Credits</b>	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.	
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.		<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.	
<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.		<b>BIO 377L Freshwater Biology Laboratory</b>	<b>0 Credits</b>
<b>BIO 357L Evolution Laboratory</b>	<b>1 Credit</b>	BIO 377 Freshwater Biology lab.	
Examination of fundamental evolutionary processes through a combination of laboratory experiments, simulations, and analysis of experimental data sets. Three hours of lab per week.		<b>Offered:</b> occasionally.	
<b>Prerequisite:</b> minimum grade of D in BIO112L. <b>Corequisite:</b> BIO 357.		<b>BIO 378 Wetlands</b>	<b>3 Credits</b>
<b>Offered:</b> occasionally.		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.	
		<b>Prerequisite:</b> minimum grade of C- in BIO 111 & BIO 112.	
		<b>BIO 378L Wetlands Laboratory</b>	<b>1 Credit</b>
		Optional lab for Wetlands. Meets once a week for three hours.	

<b>BIO 400 Independent Study</b>	<b>1-3 Credits</b>	<b>BIO 419L Cell Biology Laboratory</b>	<b>1 Credit</b>
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.		Experimental laboratories examining different cellular processes, including cytoskeleton, protein localization, and gene expression. Three hours of lab per week.	
<b>Prerequisite:</b> permission of the instructor, department chair, & associate dean.		<b>Prerequisite:</b> minimum grade of D in BIO212L. <b>Corequisite:</b> BIO 419.	
<b>BIO 401 Independent Research</b>	<b>1-4 Credits</b>	<b>BIO 424 Epigenetics and Disease</b>	<b>3 Credits</b>
Independent laboratory research in biology conducted under the supervision of a faculty member. Arrangements made prior to registration.		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.	
<b>Prerequisite:</b> written permission of faculty member & department chair.		<b>Prerequisite:</b> minimum grade of C- in BIO 212.	
<b>BIO 404 Genetics</b>	<b>3 Credits</b>	<b>BIO 425 Cellular Neurobiology</b>	<b>3 Credits</b>
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.		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.	
<b>Prerequisite:</b> minimum grade of C- in BIO 212.		<b>Prerequisite:</b> minimum grade of C- in BIO 212.	
<b>BIO 404L Genetics Laboratory</b>	<b>1 Credit</b>	<b>BIO 425L Cellular Neurobiology Laboratory</b>	<b>1 Credit</b>
Principles of Mendelian and molecular genetics as demonstrated by experiments with <i>Drosophila</i> and other experimental organisms. Three hours of lab per week.		Experimental laboratories researching current topics in cell and molecular neurobiology. Three hours of lab per week.	
<b>Prerequisite:</b> minimum grade of D in BIO212L. <b>Corequisite:</b> BIO 404.		<b>Prerequisite:</b> minimum grade of D in BIO212L. <b>Corequisite:</b> BIO 425.	
<b>Fulfills College Core:</b> Advanced Writing-Intensive		<b>BIO 426 Immunochemistry</b>	<b>3 Credits</b>
<b>BIO 406 Population and Conservation Genetics</b>	<b>3 Credits</b>	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.	
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.		<b>Prerequisite:</b> minimum grade of C- in BIO 212.	
<b>Prerequisite:</b> minimum grade of C- in BIO 212.		<b>BIO 426L Immunochemistry Laboratory</b>	<b>1 Credit</b>
<b>BIO 406L Population and Conservation Genetics Laboratory</b>	<b>1 Credit</b>	Current methods in immunological research and diagnosis. Designed to present available methodology and insight into the underlying principles. Three hours of lab per week.	
Experimental studies designed to explore fundamental concepts in population genetics and their application in conservation. Laboratory is a combination of in vitro <i>Drosophila</i> experiments and in silico computer simulations/data analyses.		<b>Prerequisite:</b> minimum grade of D in BIO212L. <b>Corequisite:</b> BIO 426.	
<b>Prerequisite:</b> minimum grade of D in BIO212L.		<b>BIO 430 Advanced Cellular Biochemistry and Metabolism</b>	<b>3 Credits</b>
<b>BIO 412 Evolution &amp; Development</b>	<b>3 Credits</b>	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.	
This course will cover concepts, methods and paradigmatic examples in the field of evolutionary developmental biology ("evo devo"). 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.		<b>Prerequisite:</b> Minimum grade of C- in BIO 212 OR BCH 301, and a minimum grade of C- in CHM 228.	
<b>Prerequisite:</b> minimum grade of C- in BIO 212.		<b>Offered:</b> occasionally.	
<b>Offered:</b> occasionally.		<b>BIO 430L Advanced Cellular Biochemistry and Metabolism Laboratory</b>	<b>1 Credit</b>
<b>BIO 412L Evolution &amp; Development Lab</b>	<b>1 Credit</b>	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.	
Optional lab for EvoDevo. The lab will explore the use of non-model organisms for EvoDevo research and illustrate examples from class.		<b>Prerequisite:</b> Minimum grade of C- in BIO 212 or BCH 301. <b>Corequisite:</b> BIO 430.	
<b>Prerequisite:</b> minimum grade of D in BIO 212L. <b>Corequisite:</b> BIO 412.		<b>Offered:</b> occasionally.	
<b>Offered:</b> occasionally.			
<b>BIO 419 Cell Biology</b>	<b>3 Credits</b>		
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.			
<b>Prerequisite:</b> minimum grade of C- in BIO 212.			



**BIO 431 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:** minimum grade of C- in BIO 212.

**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:** minimum grade of C- in 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:** minimum grade of C- in BIO 212.

**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 underlying 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:** minimum grade of C- in BIO 212.

**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:** minimum grade of C- in BIO 212.

**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:** minimum grade of C- in BIO 212.

**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.

## Biology BS/MSEd 4+1 Curriculum

The 4+1 (<http://catalog.canisius.edu/graduate/school-education-human-services/educator-preparation/dual-degree-content-and-msed-swd/#curriculumtext>) Program (<http://catalog.canisius.edu/graduate/school-education-human-services/educator-preparation/dual-degree-content-and-msed-swd/#curriculumtext>) offers a BS in Biology as well as a MSEd in Teaching Students with Disabilities All Grades. This program leads to Initial Adolescence Certification in Biology as well as Initial Certification in SWD (All Grades: PreK-Grade 12). Since it leads to two teaching certificates, candidates must meet the content requirements for both over the course of their curriculum. In most cases, the content area major covers those requirements. In some instances New York State has additional requirements. Please note, this 4+1 program can be completed in as little as 5 years if one summer is included.

## 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 Undergraduate Courses

Code	Title	Credits
<b>Biology Major Courses</b>		
BIO 111 & 111L	Introductory Biology I and Introductory Biology Laboratory I	4
BIO 112 & 112L	Introductory Biology II and Introductory Biology Laboratory II	4

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
<b>Biology Electives</b>		
Select one course with its associated laboratory from each of the Areas listed below		12
Biology Lecture Courses (3) from Areas or any 300- or 400- BIO Courses and Lab (1) <sup>1</sup>		10
<b>Chemistry &amp; Physics Courses</b>		
CHM 111 & 111L	General Chemistry I and General Chemistry I Laboratory <sup>1</sup>	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
<b>Mathematics Courses</b>		
Select one of the following mathematics electives options:		8
Option 1: Caculus I & Inferential Stats		
MAT 111	Calculus I	
MAT 141 or PSY 201	Inferential Statistics and Computers for Science or Basic Statistics for Behavioral Sciences	
Option 2: Calculus I & II		
MAT 111 & MAT 112	Calculus I and Calculus II	
Option 3: Statistics for Sciences		
One year of statistics for sciences		
<b>Education Courses</b>		
EDS 101	Human Growth and Social Development: Adolescence	3
EDS 223	Foundations of Adolescent Literacy	3
EDS 360	Evaluation and Teaching Strategies	3
EDS 405	Methods of Teaching Science: Adolescence	3
EDU 250	Foundations of Education	3
EDU 356	Assessment for Diverse Learners	3
SPE 341	Inclusive Strategies	3
<b>Total Credits</b>		<b>93</b>

<sup>1</sup> The remaining three biology elective lectures may come from within these areas, or from any other 300- or 400-level elective courses in biology, and at least one must include a laboratory. A student enrolled in three semesters of BIO 301 Research Methods would fulfill this fourth laboratory requirement

<sup>2</sup> The combination of CHM 109 and CHM 110 can be taken in place of CHM 111.

## 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 <sup>1</sup>	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

<sup>1</sup> 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 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

Please note, 6 credits of math, 6 credits of science, 6 credits of English, and 6 credits of social studies (including history) are needed for SWD certification.

## Graduate Courses

The education curriculum is provided below for the graduate MEd portion of the 4+1 degree program. Several foundation courses are taken at the undergraduate level listed above with the requirements for the Biology major. The graduate courses begin at the 500 level and continue until completion. These courses can be taken during a student's senior year. Refer to the roadmap for further details.

Code	Title	Credits
EDU 595	Child Abuse Workshop	0
EDU 596	Prevention of School Violence Workshop	0
EDU 597	Dignity for All Students Workshop	0
EDU 615	Research Methods	3
SPE 580	Classroom Management	3
SPE 631	Reading and Writing Process for Students with Learning and Behavioral Disorders	3
SPE 640	Learning and Behavioral Disabilities (LBD); Etiology and Research Based Interventions	3
SPE 644	Collaborative Practices on a Transdisciplinary Team	3
SPE 649	Transition for Adolescents with Disabilities	3
SPE 650	Intellectual Disabilities and Autism Spectrum Disorders: Etiology & Educational Needs	3
SPE 652	Functional Curriculum for Students with Severe Disabilities and ASD	3
SPE 693	Student Teaching	9
SPE 698	Seminar in Teaching and Assessment	3
SPE 697	Student Teaching Seminar	0
Total Credits		36

## Biology BS/MSEd 4+1 Roadmap

### Freshman

Fall	Spring
BIO 111 & 111L	BIO 112 & 112L
CHM 111 & 111L <sup>1</sup>	CHM 112 & 112L <sup>1</sup>
MAT (Calculus or Statistics)	MAT (Calculus or Statistics)
	HIS Course

### Sophomore

Fall	Spring
BIO 211 & 211L	BIO 212 & 212L
CHM 227 & 227L	BIO 351
EDS 101	CHM 228 & 228L
EDU 250	BIO Elective SPE 341

### Junior

Fall	Spring
BIO 307 or 307L	BIO Elective
PHY 201 & 201L	BIO Elective with lab
EDS 223	PHY 202 & 202L

EDS 360	EDS 405
	HIS Course
<b>Senior</b>	
<b>Fall</b>	<b>Spring</b>
BIO Elective with lab	BIO Elective with lab
BIO Elective with lab	EDU 615
BIO 353	SPE 649
EDU 356	Core Capstone
SPE 311	
SPE 644	
<b>Fifth Year</b>	
<b>Fall</b>	<b>Spring</b>
SPE 580	EDU 595
SPE 631	EDU 596
SPE 640	EDU 597
SPE 698	SPE 693
	SPE 697