BIOLOGY (BS)

Chairs: Andrew Stewart, PhD (stewar34@canisius.edu) and Lisa Morey, PhD (morey@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. For more information please view the department’s Biology website (https://www.canisius.edu/academics/programs/biology/).

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 appropriate double major request form and get the signature of each department chairperson and the appropriate associate dean.

Per college 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, regardless of the number of majors they complete.

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. The minors page (http://catalog.canisius.edu/undergraduate/minors/) provides a complete list of 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/core-curriculum/) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 111</td>
<td>Introductory Biology I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 111L</td>
<td>and Introductory Biology Laboratory I</td>
<td>4</td>
</tr>
<tr>
<td>BIO 112</td>
<td>Introductory Biology II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 112L</td>
<td>and Introductory Biology Laboratory II</td>
<td>4</td>
</tr>
<tr>
<td>BIO 211</td>
<td>Biochemistry and Cell Biology I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 211L</td>
<td>and Biochemistry and Cell Biology Lab I</td>
<td>4</td>
</tr>
<tr>
<td>BIO 212</td>
<td>Biochemistry and Cell Biology II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 212L</td>
<td>and Biochemistry and Cell Biology Lab II</td>
<td>4</td>
</tr>
<tr>
<td>BIO 351</td>
<td>Biology Seminar I</td>
<td>1</td>
</tr>
<tr>
<td>BIO 353</td>
<td>Biology Seminar II</td>
<td>1</td>
</tr>
<tr>
<td>Biology Electives (6 courses as described below) &amp; 22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHM 111</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 111L</td>
<td>and General Chemistry I Laboratory 1</td>
<td>4</td>
</tr>
<tr>
<td>CHM 112</td>
<td>General Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 112L</td>
<td>and General Chemistry II Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CHM 227</td>
<td>Organic Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 227L</td>
<td>and Organic Chemistry I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CHM 228</td>
<td>Organic Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 228L</td>
<td>and Organic Chemistry II Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 201</td>
<td>College Physics I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 201L</td>
<td>and College Physics I Laboratory</td>
<td>4</td>
</tr>
</tbody>
</table>

Select one of the following mathematics electives options:

**Option 1:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 111</td>
<td>Calculus I 1</td>
<td>4</td>
</tr>
<tr>
<td>MAT 141</td>
<td>Inferential Statistics and Computers for Science</td>
<td>4</td>
</tr>
<tr>
<td>or PSY 201</td>
<td>Basic Statistics for Behavioral Sciences</td>
<td>4</td>
</tr>
</tbody>
</table>

**Option 2:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 111</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MAT 112</td>
<td>Calculus II</td>
<td>4</td>
</tr>
</tbody>
</table>

**Option 3:**

One year of statistics for sciences

Total Credits: 72

1. Note: The combination of MAT 109 and MAT 110 can be taken in place of MAT 111; likewise, the combination of CHM 109 and CHM 110 can be taken in place of CHM 111.

Major Electives
Six 300- or 400-level lecture courses, four with associated laboratories.

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIO 305</td>
<td>Medical Microbiology and its Ecological Basis</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 305L</td>
<td>and Medical Microbiology and its Ecological Basis Lab 1</td>
<td>4</td>
</tr>
<tr>
<td>BIO 320</td>
<td>Field Ecology</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 320L</td>
<td>and Field Ecology Lab</td>
<td>4</td>
</tr>
<tr>
<td>BIO 357</td>
<td>Evolution</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 357L</td>
<td>and Evolution Labaratory</td>
<td>4</td>
</tr>
<tr>
<td>BIO 375</td>
<td>Community Ecology</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 375L</td>
<td>and Community Ecology Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>BIO 377</td>
<td>Freshwater Biology</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 377L</td>
<td>and Freshwater Biology Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>BIO 378</td>
<td>Wetlands</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 378L</td>
<td>and Wetlands Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>BIO 406</td>
<td>Population and Conservation Genetics</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 406L</td>
<td>and Population and Conservation Genetics Laboratory</td>
<td>4</td>
</tr>
</tbody>
</table>

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

**AREA 2: Organismal Biology**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIO 307</td>
<td>Microbiology</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 307L</td>
<td>and Microbiology Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>BIO 314</td>
<td>Comparative Anatomy of Vertebrates</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 314L</td>
<td>and Comparative Anatomy lab</td>
<td>4</td>
</tr>
</tbody>
</table>
BIO 316 & 316L  Social Organization of Mammals and Social Organization of Mammals Lab  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
BIO 370 & 370L  Plant Morphology and Plant Morphology Lab  4

Area 3: molecular and cellular biology
Code Title Credits
BIO 404 & 404L Genetics and Genetics Laboratory  4
BIO 408 & 408L Biotechnology, Theory in Practice and Biotechnology Lab  4
BIO 414 & 414L Enzymes and Proteins and Enzymes and Proteins Laboratory  4
BIO 418 & 418L Endocrinology and Endocrinology 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

Junior
Fall
PHY 201 & 201L BIO Elective with lab
Spring
PHY 202 & 202L BIO Elective with lab

Senior
Fall
BIO Elective with lab
Spring
BIO Elective with lab
BIO Elective

BIO 353

Note: For students who need additional math and or chemistry background, the combination of CHM 109 and CHM 110 can be taken in place of CHM 111. CHM 109 is taken in the fall of the freshman year, CHM 110 & CHM 111L are taken in the spring of the freshman year, and CHM 112 & CHM 112L are taken either in the summer or in the fall of the sophomore year concurrent with CHM 227 & CHM 227L.

Learning Goals & 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/)

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.
Corequisite: BIO 112.
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.

BIO 114L Human Biology: Introduction to Human Anatomy and Physiology Laboratory 1 Credit
One three-hour lab per week.
Corequisite: BIO 114.

BIO 115 Musculoskeletal Anatomy and Physiology 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.
Prerequisite: minimum grade of C in BIO 114.
Offered: fall & spring.

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

BIO 116 Disease: Myth and Reality 3 Credits
Exploration of causation, treatment and prevention of illness. Objective: to increase awareness and understanding of health and disease.
Fulfills College Core: Field 6 (Natural Sciences)

BIO 120 Biology in the News 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.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: fall.

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)

BIO 150 Animal Nutrition 3 Credits
Nutrition and dietary science focused on the maintenance of wildlife in captivity. Practical examples at our local zoo and aquariums are included.

BIO 150 Animal Nutrition 3 Credits
Nutrition and dietary science focused on the maintenance of wildlife in captivity. Practical examples at our local zoo and aquariums are included.

BIO 150L Animal Nutrition Laboratory 1 Credit
Laboratories provide an examination of the structure and function of living organisms (plants and animals). Three hours of lab per week.
Corequisite: BIO 150.
Offered: every fall & spring.

BIO 151 Animal Behavior Afternoon 3 Credits
Behavior and biology 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: every fall & spring.

BIO 151L Animal Behavior Afternoon Laboratory 1 Credit
One three-hour lab per week.
Corequisite: BIO 151.

BIO 152 Animal Behavior Evening 3 Credits
Behavior and biology 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: every fall & spring.

BIO 152L Animal Behavior Evening Laboratory 1 Credit
One three-hour lab per week.
Corequisite: BIO 152.

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 199 Science Scholars Transfer Student Seminar 1 Credit
Seminar course for first year BIO/ENVI/ABEC transfer students to aid in integration into respective major. During the semester, we will review skills necessary for success in the major(s), discuss topics identified as missing/lacking from transferred introductory biology courses, and how to get involved in departmental activities (i.e. research, clubs, etc.). Course meets once a week (75 minutes) and will be scheduled according to availability of participants, as possible. All Science Scholar Transfer students are required to take this course during the first year of their scholarship.
Restrictions: Canisius Science Scholar transfer scholarship recipient or permission of instructor.
Offered: every fall.

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 & CHM 112 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.
Corequisite: BIO 211.
Offered: 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: minimum grade of C- in BIO 211 & 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 221 Biology of Women 3 Credits
Biological principles applied to the human female. Structure, function, growth and development throughout the life cycle. Includes relevant social, psychological and medical information. Associated with Women's Studies Program.
Fulfills College Core: Field 6 (Natural Sciences)
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 302 Science Scholars Seminar I: Research, Presentations, & Publishing 1 Credit
Seminar course for students actively pursuing undergraduate research, or students planning on pursuing graduate research in the future. During the semester, we will discuss how to get involved in research lab, how to pursue independent research projects, how to seek research funding, how to present research (posters & oral presentations), and finally how to publish research results. 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.
Restrictions: Canisius College Science Scholar scholarship recipient or permission of instructor.
Offered: every spring.

BIO 303 Science Scholars Seminar II: Career Preparation, Applications, & Interviews 1 Credit
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.
Restrictions: Canisius Science Scholar scholarship recipient or permission of instructor.
Offered: every fall.

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.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>BIO 305L</td>
<td>Medical Microbiology and its Ecological Basis Lab</td>
<td>1</td>
<td>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.</td>
</tr>
<tr>
<td>BIO 307</td>
<td>Microbiology</td>
<td>3</td>
<td>Cell structure, genetics, biochemistry and physiology of microorganisms, with emphasis on bacteria. Medical microbiology, epidemiology, and some immunology also are discussed. Prerequisite: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
<tr>
<td>BIO 307L</td>
<td>Microbiology Laboratory</td>
<td>1</td>
<td>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.</td>
</tr>
<tr>
<td>BIO 310</td>
<td>Histology and Histophysiology</td>
<td>4</td>
<td>A systematic study of structure and function of cells and tissues as viewed by light microscopy. Lab employs tissue slides and digital images. Lab required. Three hours of lecture and one three-hour lab per week. Prerequisite: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
<tr>
<td>BIO 312</td>
<td>Primatology</td>
<td>3</td>
<td>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: minimum grade of C- in BIO 111 &amp; BIO 112. Fulfills College Core: Advanced Writing-Intensive Offered: every fall.</td>
</tr>
<tr>
<td>BIO 313</td>
<td>Embryology</td>
<td>4</td>
<td>Emphasis will be on early developmental stages as seen in the invertebrate sea urchin and in the chordate animals, including human embryology. Establishment of the basic vertebrate body plan will be shown by classic models such as the frog, chick and pig. Specific embryological and anatomical knowledge will be gained through macro- and microscopic investigations and dissections. Lab required. Three hours of lecture and three hours of lab per week. Prerequisite: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
<tr>
<td>BIO 314</td>
<td>Comparative Anatomy of Vertebrates</td>
<td>4</td>
<td>Evolution of chordates, with emphasis on comparative anatomic, functional, and developmental aspects of vertebrate organ systems. The laboratory portion will include dissection of vertebrate specimens including shark, amphibian, cat, and selected mammal organs. Lab required. Three hours of lecture and three hours of lab per week. Prerequisite: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
<tr>
<td>BIO 317</td>
<td>Sex, Evolution and Behavior</td>
<td>3</td>
<td>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: minimum grade of C- in BIO 111 &amp; BIO 112. Offered: spring 2017 and fall 2017.</td>
</tr>
<tr>
<td>BIO 320</td>
<td>Field Ecology</td>
<td>4</td>
<td>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: minimum grade of C- in BIO 111 &amp; BIO 112. Offered: fall of even-numbered years.</td>
</tr>
<tr>
<td>BIO 322</td>
<td>Conservation Biology</td>
<td>3</td>
<td>Study of the plight of endangered species, the biological consequences of fragmented populations, and the scientific basis of habitat/species restoration. Prerequisite: minimum grade of C- in BIO 111 &amp; BIO 112. Offered: every spring.</td>
</tr>
<tr>
<td>BIO 324</td>
<td>Human Anatomy</td>
<td>3</td>
<td>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: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
<tr>
<td>BIO 324L</td>
<td>Human Anatomy Lab</td>
<td>1</td>
<td>Required lab for BIO 324. Corequisite: BIO 324.</td>
</tr>
<tr>
<td>BIO 335</td>
<td>Plant Biology</td>
<td>3</td>
<td>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: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
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<tr>
<td>BIO 335L</td>
<td>Plant Biology Lab</td>
<td>1</td>
<td>Investigative survey of plant structure and function. Three hours of lab per week. Prerequisite: minimum grade of D in BIO112L. Corequisite: BIO 335.</td>
</tr>
<tr>
<td>BIO 340</td>
<td>Physiology</td>
<td>3</td>
<td>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: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
<tr>
<td>BIO 340L</td>
<td>Physiology Laboratory</td>
<td>1</td>
<td>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.</td>
</tr>
<tr>
<td>BIO 343</td>
<td>Entomology</td>
<td>4</td>
<td>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: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
<tr>
<td>BIO 345</td>
<td>Functional Neuroanatomy</td>
<td>3</td>
<td>Examination of human neuroanatomy, with emphasis on the relationship between neuronal circuits and nervous system function/dysfunction. Three hours of lecture per week. Prerequisite: minimum grade of C- in BIO 111 &amp; BIO 112.</td>
</tr>
</tbody>
</table>
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: minimum grade of C- in BIO 111 & BIO 112.

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: minimum grade of C- in BIO 111 & BIO 112.
Offered: Spring 2020.

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 112.
Offered: fall.

BIO 364L Zoology: Diversity of Animal Life Laboratory 1 Credit
This laboratory course will explore anatomical and physiological differences within and among taxonomic groups in the animal kingdom.
Corequisite: BIO 364.
Offered: fall.

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: minimum grade of C- in BIO 111 & BIO 112.
Offered: spring of odd-numbered years.
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: minimum grade of C- in BIO 212.

BIO 418 Cellular Neurobiology 3 Credits
In depth examination of current topics in endocrinology at the molecular, cellular and organismal levels. Three hours of lab per week.
Prerequisite: minimum grade of D in BIO212L. Corequisite: BIO 419.

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 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 420L Phylogenetics 4 Credits
Students will learn how to interpret what phylogenetic trees communicate about the evolution of a group of related species, how clues to the history of populations accumulate at the molecular level in DNA, and how statistical models based on this understanding allow us to build phylogenetic trees that reveal evolutionary history to us. Students will also understand how phylogenies allow us to test specific hypotheses concerning evolution. Three hours of lecture and three hours of lab per week.
Prerequisite: minimum grade of C- in BIO 212.

BIO 420L Phylogenetics Laboratory 1 Credit
Students will get firsthand experience generating genetic data, building phylogenies, and testing their own hypotheses. To accomplish this, students will work both at the lab bench and on the computer, using a number of programs to manipulate the data they generate. In short, this is a class where evolution, genetics, statistics, and computer science meet.
Prerequisite: minimum grade of D in BIO212L.

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: minimum grade of C- in BIO 212.

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: minimum grade of C- in BIO 212.

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 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 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: Minimum grade of C- in 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: 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. Corequisite: BIO 432.

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 440 Medical Biochemistry  
3 Credits
Biochemistry of disease. Includes examination of pathways and regulatory enzymes that lead to normal and disease states. Three hours of lecture per week.
Prerequisite: minimum grade of C- in BIO 212.

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.