

Biology

Biology spans a continuum of organization from molecules and cells to individuals and ecosystems. The programs are designed to give students a broad base, while allowing a measure of sub-field specialization. All Biology majors are required to take a two-semester series of "Introduction to Biology" classes, plus separate courses in Genetics, Cell Biology, and Ecology, followed by three (for the B.A. degree) or six (for the B.S. degree) biology electives. There are special programs in Biochemistry, Biology with Teaching, Biophysics, Environmental Science, Natural Science, and Neuroscience that the Biology department offers in conjunction with others.

The Bachelor of Science degree in Biology program provides a strong preparation for those wishing to attend professional or graduate school in biology or related disciplines such as cell or molecular biology, ecology, bioinformatics, biochemistry, biophysics, medicine, pharmacy, dentistry, and allied health fields. It is recommended for those who intend to enter the scientific workforce upon completion of a bachelor's degree.

The Bachelor of Arts degree in Biology program, which also provides the essential background for professional schools, is appropriate for those who are planning for careers in fields where a science background with additional breadth is advantageous.

The Bachelor of Science degree in Neuroscience - Cellular & Molecular is designed to provide rigorous preparation in scientific knowledge at the molecular and cellular level to those students interested in pursuing advanced studies and professional development in neuroscience, medicine or a related field in life sciences. In addition to neuroscience, graduates in the major will be well prepared for graduate or professional studies in cell or molecular biology, biochemistry, biophysics, biomedical sciences, medicine, pharmacy, dentistry, and many allied health fields. Neuroscience graduates who do not pursue graduate studies will be prepared to accept technical positions in industry (pharmaceutical, biotech) or government and university laboratories. Graduates will be ready to conduct research on a range of neuroscience and related topics at the level of cells or molecules, including nervous system function, development, disease or injury.

The Bachelor of Science degree in Biochemistry prepares students for excellence in graduate or medical school, and employment in the chemical, biotechnological, or pharmaceutical industries. Students learn a wide array of topics in Biology, Chemistry, Mathematics, and Physics. In upper division studies, Biochemistry majors learn to apply biochemical principles to real-life situations via problem-based approaches in their courses. Laboratory courses give students the tools they will need as biochemists to pursue research. Accomplished majors are encouraged to pursue independent research with a professor, and to present their work internally and at national meetings.

The Bachelor of Science degree in Biophysics fulfills all medical and pharmacy school requirements. Biophysics students interested in research careers can pursue a graduate degree in biophysics, biology, molecular biology or neuroscience, as well as the combined MD/PhD degree in medical physics, health physics or nuclear medicine.

The Bachelor of Arts degree in Natural Sciences provides students more breadth than traditional science programs. Many exciting areas of scientific inquiry, such as the neurosciences, environmental sciences, and biophysical sciences, require general science backgrounds that encompass multiple science disciplines. Students planning graduate study or technical careers in one of these interdisciplinary areas, as well as students preparing for careers in health sciences, legal professions, science education, science-related business, or social service might be well served by the B.A. in the Natural Sciences. However, this program of study will not prepare students for graduate study in a traditional science discipline nor will it prepare students for technical employment in a traditional science discipline.

The Bachelor of Science degree in Natural Sciences provides students more breadth than traditional science programs. Many exciting areas of scientific inquiry, such as the neurosciences, environmental sciences, and biophysical sciences, require general science backgrounds that encompass multiple science disciplines. This major provides necessary coursework for pre-health programs, entry level science positions, and a variety of graduate programs both disciplinary and interdisciplinary. In particular, this is an excellent background for students wishing to enter graduate programs in education, forensic science, scientific writing or editing, or science technology areas. In the bachelor of science degree, there is greater emphasis on depth of science content knowledge and application of knowledge compared with the Bachelor of Arts in Natural Sciences. The B.S. degree requires additional science coursework and offers more advanced study in natural sciences. This option provides more flexibility for students declaring the B.S. in Natural Sciences later in their undergraduate course of study as they can apply more disciplinary science courses to meet the additional science requirements of this degree.

The Bachelor of Science degree in Biology with Teaching and Bachelor of Science degree in General Science with Teaching are part of Temple's innovative "TUteach" secondary education teacher-training program. The programs prepare students for a career in secondary school teaching with the full content knowledge of their corresponding majors without teaching. The education courses in the B.S. with Teaching include supervised teaching in school district classrooms and emphasize inquiry-based approaches to learning. Students in the B.S. with Teaching degree program become eligible for a Pennsylvania teacher certification when they complete all the requirements for the degree that include theoretical and practical courses in education specifically designed for science and mathematics majors.

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Programs

- Biochemistry, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/chemistry/biochemistry-bs/#biology>)
- Biology, B.A. (<http://bulletin.temple.edu/undergraduate/science-technology/biology/biology-ba>)
- Biology, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/biology/biology-bs>)
- Biology with Teaching, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/tu-teach-programs/tu-teach-biology-bs/#biology>)
- Biology, B.A./M.Ed. (<http://bulletin.temple.edu/undergraduate/science-technology/accelerated-programs/biology-ba-med/#biology>)
- Biology, B.S./M.Ed. (<http://bulletin.temple.edu/undergraduate/science-technology/accelerated-programs/biology-bs-med/#biology>)
- Biology, Minor (<http://bulletin.temple.edu/undergraduate/science-technology/biology/biology-minor>)
- Biophysics, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/physics/biophysics-bs/#biology>)
- Environmental Science, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/earth-environmental-science/environmental-science-bs/#biology>)
- General Science with Teaching, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/tu-teach-programs/tu-teach-general-science-bs/#biology>)
- Genome Medicine, Certificate (<http://bulletin.temple.edu/undergraduate/science-technology/biology/genome-medicine-certificate>)
- Natural Sciences, B.A. (<http://bulletin.temple.edu/undergraduate/science-technology/biology/natural-sciences-ba>)
- Natural Sciences, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/biology/natural-sciences-bs>)
- Neuroscience: Cellular & Molecular, B.S. (<http://bulletin.temple.edu/undergraduate/science-technology/biology/neuroscience-cellular-molecular-bs>)

Courses

BIOL 0848. DNA: Friend or Foe. 3 Credit Hours.

This course is typically offered in Fall.

Through the study of basic biological concepts, think critically about modern biotechnology. Consider questions like: What are the ethical and legal implications involving the gathering and analysis of DNA samples for forensic analysis and DNA fingerprinting? Are there potential discriminatory implications that might result from the human genome project? What are embryonic stem cells, and why has this topic become an important social and political issue? Will advances in medicine allow humans to live considerably longer, and how will a longer human life span affect life on earth? We will learn through lectures, lecture demonstrations, problem solving in small groups and classroom discussion, and make vivid use of technology, including short videos from internet sources such as YouTube, electronic quizzes, imaging and video microscopy. NOTE: This course fulfills a Science & Technology (GS) requirement for students under GenEd and the Science & Technology Second Level (SB) requirement for students under Core. Students cannot receive credit for this course if they have successfully completed Biology 0948.

Course Attributes: GS

Repeatability: This course may not be repeated for additional credits.

BIOL 0948. Honors DNA: Friend or Foe. 3 Credit Hours.

This course is not offered every year.

Through the study of basic biological concepts, think critically about modern biotechnology. Consider questions like: What are the ethical and legal implications involving the gathering and analysis of DNA samples for forensic analysis and DNA fingerprinting? Are there potential discriminatory implications that might result from the human genome project? What are embryonic stem cells, and why has this topic become an important social and political issue? Will advances in medicine allow humans to live considerably longer, and how will a longer human life span affect life on earth? We will learn through lectures, lecture demonstrations, problem solving in small groups and classroom discussion, and make vivid use of technology, including short videos from internet sources such as YouTube, electronic quizzes, imaging and video microscopy. (This is an Honors course.) NOTE: This course fulfills a Science & Technology (GS) requirement for students under GenEd and the Science & Technology Second Level (SB) requirement for students under Core. Students cannot receive credit for this course if they have successfully completed Biology 0848.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: GS, HO

Repeatability: This course may not be repeated for additional credits.

BIOL 1001. Human Biology. 4 Credit Hours.

This course is typically offered in Fall, Spring, and Summer I.

An introduction to the principles of biology using the human as a model organism. The course covers biomolecules; the heredity, development, structure and function of the human body; and the relationship of humans to their environment. NOTE: (1) Laboratory requires dissection. Not available for Biology major credit; no credit if Biology 1011 (C083) is previously taken. (2) This course can be used to satisfy the university Core Science & Technology First Level (SA) requirement.

Course Attributes: SA

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
 OR MATH 0800 to 4999| Required Courses:1|Minimum Grade of C-|May be taken concurrently
 OR MC3 Y|May not be taken concurrently
 OR MC4 Y|May not be taken concurrently
 OR MC5 Y|May not be taken concurrently
 OR MC6 Y|May not be taken concurrently
 OR MC3A Y|May not be taken concurrently
 OR MC6A Y|May not be taken concurrently
 OR STAT 1001|Minimum Grade of C-|May not be taken concurrently
 OR STT2 Y|May not be taken concurrently
 OR STAT 1102|Minimum Grade of C-|May not be taken concurrently
 OR STAT 1902|Minimum Grade of C-|May not be taken concurrently.

BIOL 1009. Biological Reasoning. 3 Credit Hours.

This course is typically offered in Fall.

This course is a transition semester of biology to be taken before Introductory Biology 1111 for students who have not had advanced biology in high school or who wish to increase their reasoning skills before taking the Introductory Biology sequence. The course will focus on the analysis of biological data as well as understanding how these data support or contradict foundational concepts including biological evolution, structure and function, information exchange, energy transformation and flow and systems. The course format will involve group exercises designed to increase diagrammatic and quantitative reasoning in biology using examples from introductory textbooks. Understanding and developing concept maps will provide students with an effective approach for studying biology. The course will prepare students for the content and pace required to be successful in the Introductory Biology sequence.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

CHEM 1031|Minimum Grade of C|May be taken concurrently
 OR CHEM 1041|Minimum Grade of C|May be taken concurrently
 OR CHEM 1951|Minimum Grade of C|May be taken concurrently
 OR CHM1 Y|May not be taken concurrently.

BIOL 1011. General Biology I. 4 Credit Hours.

This course is typically offered in Fall and Summer I.

General introductory biology for non-biology majors. Topics include cell physiology (introduction), origins of life, taxonomy, principles of evolution, animal evolution, and a survey of physiology. NOTE: (1) Laboratory required. (2) This course can be used to satisfy the university Core Science & Technology First Level (SA) requirement. To determine if this course in combination with another course can satisfy the GenEd Science & Technology requirement, see your advisor.

Course Attributes: SA

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 4999| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May not be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May not be taken concurrently
OR STAT 1902|Minimum Grade of C-|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.

BIOL 1012. General Biology II. 4 Credit Hours.

This course is typically offered in Spring and Summer II.

General introductory biology for non-biology majors. Topics include biological molecules, biochemistry, molecular biology, and genetics. NOTE: (1) Laboratory required. (2) This course can be used to satisfy the university Core Science & Technology Second Level (SB) requirement. To determine if this course in combination with another course can satisfy the GenEd Science & Technology requirement, see your advisor.

Course Attributes: SB

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 4999| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May not be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May not be taken concurrently
OR STAT 1902|Minimum Grade of C-|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.

BIOL 1111. Introduction to Organismal Biology. 0 or 4 Credit Hours.

This course is typically offered in Fall and Spring.

This course, with Biology 2112, makes up the introductory series for Biology majors. Both courses must be completed with a grade of C or better before students will be allowed to take the second level of required courses in the Biology curriculum, Biology 2296 and 3096. Biology 1111 is designed to be taken during the students' freshman year. This semester covers evolutionary principles, an introduction to ecology, and anatomy and physiology of plants and animals with an emphasis on vertebrate systems. Concepts and facts discussed in lecture will be closely integrated with laboratory observation and experimentation. NOTE: This is part of the introductory series for Biology majors. There are weekly laboratories that emphasize hands-on experience with living material. Students must pass this course with a C or better to take upper level Biology courses.

Two sections are required for this course. This course requires registration for a 0.0 credit Recitation section in addition to the 4.0 credit Lecture & Laboratory section. The Recitation sections corresponding to a course are listed under the same course number as the Lecture & Laboratory sections, but have unique section numbers.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(CHEM 1031|Minimum Grade of C|May be taken concurrently
 OR CHEM 1951|Minimum Grade of C|May be taken concurrently
 OR CHEM 1032|Minimum Grade of C|May be taken concurrently
 OR CHEM 1952|Minimum Grade of C|May be taken concurrently
 OR CHM1 Y|May not be taken concurrently)
 AND (MATH 1041|Minimum Grade of C|May be taken concurrently
 OR MATH 1941|Minimum Grade of C|May be taken concurrently)

BIOL 1211. Basic Core Introduction to Biology for Pre-Medical Post-Baccalaureates II. 4 Credit Hours.

This course is typically offered in Spring.

Biology 1211 begins with a survey of the cell theory, basic microbiology, and embryogenesis, the process whereby cells are organized into the tissues that make up the major organ systems. The structure, function, and coordination of each of the major organ systems are examined. The course concludes with a study of evolutionary biology topics including natural selection, genetic drift, and speciation.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

CHEM 1052|Minimum Grade of C|May not be taken concurrently.

BIOL 1911. Honors Introduction to Organismal Biology. 4 Credit Hours.

This course is typically offered in Spring.

This course, with Biology 2912 (H102) or 2112 (0102), makes up the introductory series for Biology majors. The series must be completed with a grade of C or better before students will be allowed to take the second level of required courses in the Biology curriculum, Biology 2296 (2203, 0203) and 3096 (W204). Biology 1911 (H101) is designed to be taken in the students' freshman year. This semester covers evolutionary principles, an introduction to ecology, and anatomy and physiology of plants and animals with an emphasis on vertebrate systems. Concepts and facts discussed in lecture will be closely integrated with laboratory observation and experimentation. NOTE: (1) This course can substitute for Biology 1111 as part of the introductory series for Biology majors. (2) This course can be used to satisfy the university Core Science & Technology First Level (SA) requirement. To determine if this course in combination with another course can satisfy the GenEd Science & Technology requirement, see your advisor.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO, SA

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(CHEM 1031|Minimum Grade of C|May be taken concurrently
 OR CHEM 1951|Minimum Grade of C|May be taken concurrently
 OR CHEM 1032|Minimum Grade of C|May be taken concurrently
 OR CHEM 1952|Minimum Grade of C|May be taken concurrently
 OR CHM1 Y|May not be taken concurrently)
 AND (MATH 1041|Minimum Grade of C|May be taken concurrently
 OR MATH 1941|Minimum Grade of C|May be taken concurrently)

BIOL 2001. Clinical Microbiology. 4 Credit Hours.

This course is typically offered in Fall.

This course is an introduction to the microorganisms that cause infectious diseases around the world. The nonspecific and specific host defense mechanisms are discussed. Methods for diagnosis, including culturing and immunological procedures, are covered. Other topics include disinfection, sterilization, standard precautions, antimicrobials, disease prevention and control. Laboratory related learning experiences, involving the testing of scientific principles related to lecture/discussion content, are integrated to support concepts introduced during lectures. NOTE: Not available for Biology major credit.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(CHEM 1021|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 1031|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 1041|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 1951|Minimum Grade of C-|May not be taken concurrently)
 AND (BIOL 1012|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 2112|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C-|May not be taken concurrently)
 AND (KINS 1224|Minimum Grade of C-|May not be taken concurrently)

BIOL 2003. Introductory Laboratory for Transfer Students. 1 Credit Hour.

This course is typically offered in Fall and Spring.

For transfer students only. Instruction to satisfy the laboratory component of either Biology 1111 or Biology 2112 for students that transfer courses from other institutions that are similar in topic to those offered by the Biology Department, but lack a laboratory. This course allows such students to register solely for the laboratory component of the relevant course. This course does not serve as a Biology elective.

Repeatability: This course may not be repeated for additional credits.

BIOL 2005. Laboratory for Transfer Students. 1 Credit Hour.

This course is typically offered in Fall and Spring.

For transfer students only. Instruction to satisfy the laboratory component of either Biology 2296 or Biology 3096 for students that transfer courses from other institutions that are similar in topic to those offered by the Biology Department, but lack a laboratory. This course allows such students to register solely for the laboratory component of the relevant course. This course does not serve as a Biology elective.

Repeatability: This course may not be repeated for additional credits.

BIOL 2082. Independent Research I. 1 to 4 Credit Hour.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Research under the direction of a faculty member in the Department of Biology or under joint supervision of an approved outside preceptor and a member of the Biology department. The Temple Biology faculty member oversees their work and acts as a liaison between an outside institution and the Biology Honors Committee. All students must obtain the approval of the Biology Undergraduate Committee. Students must have completed Biology 1111 OR Biology 2112. NOTE: Not available for major credit. This course is not repeatable.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently
 OR BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently.

BIOL 2112. Introduction to Cellular and Molecular Biology. 4 Credit Hours.

This course is typically offered in Fall and Spring.

This course, with Biology 1111 (0101), makes up the introductory series for Biology majors. Both courses must be completed with a grade of C or better before students will be allowed to take the second level of required courses in the Biology curriculum, Biology 2296 (2203, 0203) and 3096 (W204), without the instructors' permission. Biology 2112 (0102) is designed to be taken in the fall of the sophomore year. This course provides an introduction to the fundamental concepts of biochemistry, cell biology, molecular biology and genetics. Topics covered include the structure of important biological macromolecules, enzyme kinetics, metabolic pathways, photosynthesis, cell changes during mitosis and meiosis, DNA replication, transcription, translation and genetic analysis. NOTE: This is part of the introductory series for Biology majors. There are weekly laboratories that emphasize hands-on experience with living material. Students must pass this course with a C or better to take upper level Biology courses.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(CHEM 1031|Minimum Grade of C|May not be taken concurrently

OR CHEM 1041|Minimum Grade of C|May not be taken concurrently

OR CHEM 1951|Minimum Grade of C|May not be taken concurrently

OR CHM1 Y|May not be taken concurrently)

AND (CHEM 1032|Minimum Grade of C|May not be taken concurrently

OR CHEM 1042|Minimum Grade of C|May not be taken concurrently

OR CHEM 1952|Minimum Grade of C|May not be taken concurrently

OR CHM2 Y|May not be taken concurrently)

AND (CHEM 2201|Minimum Grade of C-|May be taken concurrently

OR CHEM 2211|Minimum Grade of C-|May be taken concurrently

OR CHEM 2921|Minimum Grade of C-|May be taken concurrently)

AND (MATH 1022|Minimum Grade of C|May not be taken concurrently

OR MATH 1038 to 4999| Required Courses:1|Minimum Grade of C-|May be taken concurrently

OR MC6 Y|May not be taken concurrently

OR MA04 Y|May not be taken concurrently

OR MC6A Y|May not be taken concurrently)

BIOL 2133. Human Anatomy. 3 Credit Hours.

The fundamentals of human anatomical structure are examined. A primary goal will be the development of a comprehensive vocabulary, including the learning of Latin and Greek root words underlying medical terminology. Students will progress from a review of the history of anatomy; to the study of anatomy at the microscopic level of cells, organelles and tissues; and finally to the organ systems level. Muscular, skeletal, nervous, endocrine, cardiovascular, gastrointestinal and respiratory systems will be covered.

Repeatability: This course may not be repeated for additional credits.

BIOL 2212. Basic Core Introduction to Biology for Pre-Medical Post-Baccalaureates I. 4 Credit Hours.

This course is typically offered in Fall.

Biology 2212 examines living systems at the most fundamental levels. Topics include chemical bonds, the unique properties of water, carbon chemistry, the structures and functions of macromolecules, as well as the thermodynamic and kinetic properties of enzymes. At the cellular level, we will study the components of cell-to-cell communication, cellular signaling, the regulation of the cell cycle, and cell motility. An examination of the processes of gene expression and DNA replication lead into studies on chromosome behavior during meiosis and the field of genetics. This course finishes with a survey of viruses, biotechnology, and two compelling biological processes: cancer and aging.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(CHEM 1052|Minimum Grade of C|May not be taken concurrently)

AND (CHEM 2251|Minimum Grade of C-|May be taken concurrently)

BIOL 2227. Principles of Ecology. 3 Credit Hours.

This course is typically offered in Spring.

This course provides an overview of ecology from the level of the individual organism to populations, communities and ecosystems. It examines the physical, chemical, and biological components of ecological interactions, and includes a comparative treatment of terrestrial and aquatic ecosystems.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 1111|Minimum Grade of C|May not be taken concurrently

OR BIOL 1911|Minimum Grade of C|May not be taken concurrently

OR BIO3 Y|May not be taken concurrently.

BIOL 2233. Mammalian Anatomy. 4 Credit Hours.

This course is typically offered in Fall.

A study of the development and gross anatomy of the human. In the laboratory, the dissection of the cat, together with pertinent illustrations from humans and other animals, provides a comparative survey of the anatomical structure of mammals.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
OR BIO3 Y|May not be taken concurrently)
AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
OR BIO4 Y|May not be taken concurrently)

BIOL 2234. Dinosaur Paleobiology. 3 Credit Hours.

Examines "non-avian dinosaurs" as objects of valid scientific inquiry and where appropriate, evaluates media hype surrounding them. Among topics examined in detail are: evolutionary relationships (including phylogeny, together with relationships to modern birds), ecology (including survey of other Mesozoic vertebrate groups, important invertebrates, plant life, biogeography), anatomy (hard and soft tissues), physiology (particularly but not limited to understanding dinosaur temperature regulatory physiology, paleoneurology, molecular traces, growth), behavior (locomotion, posture, reproduction, etc.), and how these animals are reconstructed and restored as living animals (including what is actually known from fossil evidence). This course highlights how applying basic biological principles is used to gain significant insights about what can actually be known about long extinct animals.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 1111|Minimum Grade of C|May not be taken concurrently
OR BIOL 1911|Minimum Grade of C|May not be taken concurrently.

BIOL 2235. General Histology. 4 Credit Hours.

This course is typically offered in Spring.

A study of the fundamental techniques used in preparing tissues for microscopic examinations, followed by a detailed study of the various types of normal tissues and organs in mammals with emphasis on correlations between structure and function.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 1111|Minimum Grade of C|May not be taken concurrently
OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
OR BIO3 Y|May not be taken concurrently.

BIOL 2241. Invertebrate Biology. 4 Credit Hours.

This course is typically offered in Spring.

An introduction to the biology of the invertebrate phyla including insects. Demonstrations of the patterns of invertebrate evolution by consideration of morphology, behavior, development, physiology, and ecology of representative organisms.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 1111|Minimum Grade of C|May not be taken concurrently
OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
OR BIO3 Y|May not be taken concurrently.

BIOL 2296. Genetics. 4 Credit Hours.

This course is typically offered in Spring.

Examines the basic principles and problems of classical, biochemical, and molecular genetics. NOTE: Required for majors in Biology. There are weekly laboratories that emphasize hands-on experience with living material.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (CHEM 2201|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 2921|Minimum Grade of C-|May not be taken concurrently)
 AND (CHEM 2202|Minimum Grade of C-|May be taken concurrently
 OR CHEM 2922|Minimum Grade of C-|May be taken concurrently)

BIOL 2812. Principles of Medical Genetics. 3 Credit Hours.

Understanding of genetics is central for many biological disciplines, including medicine. This course examines the basic principles and problems of classical, biochemical, and molecular genetics to enable the student to apply them in solving medical problems.

Repeatability: This course may not be repeated for additional credits.

BIOL 2912. Honors Introduction to Cellular and Molecular Biology. 4 Credit Hours.

This course is typically offered in Fall.

This course, with Biology 1911 (H101) or Biology 1111 (0101), makes up the introductory series for Biology majors. Both courses in the series must be completed with a grade of C or better before students will be allowed to take the second level of required courses in the Biology curriculum, Biology 2296 (2203, 0203) and 3096 (W204). Biology 2912 (H102) is designed to be taken in the fall of the sophomore year. This course provides an introduction to the fundamental concepts of biochemistry, cell biology, molecular biology and genetics. Topics covered include the structure of important biological macromolecules, enzyme kinetics, metabolic pathways, photosynthesis, cell changes during mitosis and meiosis, DNA replication, transcription, translation and genetic analysis. NOTE: (1) This course can substitute for Biology 2112 as part of the introductory series for Biology majors. There are weekly laboratories. (2) This course can be used to satisfy the university Core Science & Technology Second Level (SB) requirement. To determine if this course in combination with another course can satisfy the GenEd Science & Technology requirement, see your advisor.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO, SB

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(CHEM 1031|Minimum Grade of C|May not be taken concurrently
 OR CHEM 1041|Minimum Grade of C|May not be taken concurrently
 OR CHEM 1951|Minimum Grade of C|May not be taken concurrently
 OR CHM1 Y|May not be taken concurrently)
 AND (CHEM 1032|Minimum Grade of C|May not be taken concurrently
 OR CHEM 1042|Minimum Grade of C|May not be taken concurrently
 OR CHEM 1952|Minimum Grade of C|May not be taken concurrently
 OR CHM2 Y|May not be taken concurrently)
 AND (CHEM 2201|Minimum Grade of C-|May be taken concurrently
 OR CHEM 2211|Minimum Grade of C-|May be taken concurrently
 OR CHEM 2921|Minimum Grade of C-|May be taken concurrently)
 AND (MATH 1022|Minimum Grade of C|May not be taken concurrently
 OR MATH 1038 to 4999| Required Courses:1|Minimum Grade of C-|May be taken concurrently
 OR MC6 Y|May not be taken concurrently
 OR MA04 Y|May not be taken concurrently
 OR MC6A Y|May not be taken concurrently)

BIOL 3082. Independent Research II. 1 to 4 Credit Hour.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Research under the direction of a faculty member in the Department of Biology or under joint supervision of an approved outside preceptor and a member of the Biology department. The Temple Biology faculty member oversees their work and acts as a liaison between an outside institution and the Biology Honors Committee. All students must obtain the approval of the Biology Undergraduate Committee. Students must have completed Biology 1111 and Biology 2112; as well as be enrolled in or have completed one of Biology 2227, 2296 or 3096. NOTE: Not available for major credit. This course is repeatable.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May be taken concurrently
 OR BIOL 2296|Minimum Grade of C-|May be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May be taken concurrently)

BIOL 3083. Directed Readings. 3 Credit Hours.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Prerequisites: Junior standing and a GPA of 3.2 or better with recommendation of a faculty sponsor and approval of the Biology Honors Committee.

This course is repeatable. A tutorial opportunity for a student to work with a faculty member to investigate areas of study not covered by courses in the department. Available as an elective for Biology major credit by petition to the Biology Honors Committee prior to registration. The student must make a written agreement with a Biology faculty member detailing the course of study to be followed and the mechanism of evaluation. NOTE: Agreement must be submitted to the Biology Undergraduate Advisor and the Biology Honors Committee for approval. This course can be taken a maximum of two times; only one of these can count toward Biology elective requirements as well as GPA requirements.

Class Restrictions: Must be enrolled in one of the following Classes: Junior 60 to 89 Credits, Senior 90 to 119 Credits, Senior/Fifth Year 120+ Credits.

Repeatability: This course may be repeated for additional credit.

BIOL 3091. Research Methods. 3 Credit Hours.

This course is typically offered in Spring.

Research Methods is required for all of the TUteach with Teaching majors. It is one of several content courses specially designed to meet the needs of future teachers. Sections meet two hours per week for non-traditional, interactive lectures and two hours per week for lab. The course is cross-listed in Biology, Chemistry, Earth and Environmental Science, and Physics. The goals of the course are (1) to provide students with the tools that scientists use to solve scientific problems; (2) to give students the opportunity to use these tools in a laboratory setting; (3) to make students aware of how scientists communicate with each other through peer-reviewed scientific literature; and (4) to enable students to understand how scientists develop new knowledge and insights, the most important of which are eventually presented in textbooks and taught in conventional science classes. Students design and carry out four independent inquiries, which they write up and present in the manner that is common in the scientific community. The inquiries incorporate mathematics and the various science disciplines, thus the team of instructors teaching this course have expertise in different disciplines and are available to supervise all students as they work on their inquiries in the lab. The combination of Research Methods and the TUteach course "Perspectives on Science and Mathematics" (Philosophy 2196) provides prospective science and mathematics teachers with an in-depth understanding of how the scientific enterprise works. NOTE: Biology 3091 is only available for major credit in the Biology with Teaching BS program.

College Restrictions: Must be enrolled in one of the following Colleges: Science & Technology.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

SCTC 1289|Minimum Grade of C-|May not be taken concurrently
 OR SCTC 1389|Minimum Grade of C-|May not be taken concurrently.

BIOL 3096. Cell Structure and Function. 4 Credit Hours.

This course is typically offered in Fall.

The chemistry and biological functions of important small molecules and macromolecules of the cell. Concept: the functions of cells are rooted in structures, and the structures themselves derive their characteristics from their chemical components. NOTE: Required for majors in Biology. There are weekly laboratories that emphasize hands-on experience with living material.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (CHEM 2202|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 2212|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 2922|Minimum Grade of C-|May not be taken concurrently)
 AND (PHYS 1021|Minimum Grade of C-|May be taken concurrently
 OR PHYS 1061|Minimum Grade of C-|May be taken concurrently
 OR PHYS 1961|Minimum Grade of C-|May be taken concurrently
 OR PHYS 2021|Minimum Grade of C-|May be taken concurrently
 OR PHYS 2921|Minimum Grade of C-|May be taken concurrently)

BIOL 3101. Evolution. 3 Credit Hours.

This course is typically offered in Fall.

Topics covered include Darwinism and neo-Darwinian theory, including adaptation, natural selection, sexual selection, speciation, and techniques used to understand evolution of living and extinct organisms.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)

BIOL 3111. Genomics in Medicine. 3 Credit Hours.

This course is typically offered in Fall.

The completion of the Human Genome Project in 2003 began a revolution in the treatment of human disease. More than 10 years later, the promise of personalized genome-guided medical treatment is becoming reality. This course will explore how genomic information has enhanced our understanding of human genetic variation and disease susceptibility. Students will develop familiarity with main areas in genomic medicine through lectures from intra- and extramural experts, and they will be involved in classroom discussions.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2112|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C-|May not be taken concurrently.

BIOL 3112. Fundamentals of Genomic Evolutionary Medicine. 3 Credit Hours.

This course is typically offered in Spring.

Modern evolutionary theory offers a conceptual framework for understanding human health and disease. In this course we will examine human disease in evolutionary contexts with a focus on modern techniques and genome-scale datasets. We ask: What can evolution teach us about human populations? How can we understand disease from molecular evolutionary perspectives? What are the relative roles of negative and positive selection in disease? How do we apply evolutionary principles in diagnosing diseases and developing better treatments? Students will conduct case studies of a variety of diseases and phenotypes in a group setting.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2112|Minimum Grade of C|May not be taken concurrently
OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
OR BIO4 Y|May not be taken concurrently.

BIOL 3114. Evolutionary Ecology. 3 Credit Hours.

This course is typically offered in Fall.

The field of evolutionary ecology deals broadly with understanding how organisms adapt to their abiotic and biotic environments. What is the adaptive significance and evolutionary potential of phenotypic variation in natural populations? How do ecological interactions and genetic constraints shape the course of evolution? The class will cover fundamental ecological and evolutionary theories and approaches used to address questions in evolutionary ecology, including molecular tools, modeling, manipulative field studies, and laboratory- or field-based common garden studies. Topics covered include adaptation and constraint, phenotypic plasticity, life history evolution, ecological speciation, and evolutionary conservation biology. Lectures, assignments, and discussions will explore theoretical and recent empirical advances in the field.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2227|Minimum Grade of C-|May not be taken concurrently.

BIOL 3128. Genomics and Infectious Disease Dynamics. 3 Credit Hours.

This course is typically offered in Fall.

Events such as the emergence of avian flu have increased public awareness about the need for incorporating ecology and evolution in decision-making processes that involve infectious diseases. It is evident for the public health community that molecular information, together with concepts from ecology and evolutionary biology, allows for testing of hypotheses and exploration of scenarios that otherwise could not be investigated by traditional epidemiological approaches. Understanding the ecological and evolutionary dynamics of infectious diseases requires the integration of information across organizational levels at various temporal and/or spatial scales. This requirement, together with novel molecular evolution, genomics, and mathematical modeling approaches, has positioned research on Genomics and Infectious Diseases Dynamics at the forefront of Public Health Genomics. The goal of this class is to discuss some of the biological processes leading to the emergence and re-emergence of infectious diseases stressing on evolutionary concepts within an epidemiological context. Basic concepts will be provided by the instructor as part of formal lectures. Our general objective (integrating evolutionary biology into epidemiology) will be fulfilled by discussing research articles. Such discussions will take place during the second half of the semester. "Emerging" perspectives such as One Health and Public Health Genomics will be integrated into the lectures and discussions.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2112|Minimum Grade of C|May not be taken concurrently)
AND (BIOL 2227|Minimum Grade of C|May not be taken concurrently)

BIOL 3181. Cooperative Research in Biochemistry. 3 Credit Hours.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Independent research carried out in an off-campus laboratory. A Biochemistry faculty member and the research director of the off-campus laboratory will jointly supervise research. Written permission must be obtained in advance from the supervising faculty member and one of the co-administrators. Student must present a seminar on campus describing the scientific aims of the project, the experimental design, and the conclusions drawn from the experiments. NOTE: Restricted to Biochemistry majors enrolled in the Cooperative Program.

Field of Study Restrictions: Must be enrolled in one of the following Fields of study: Biochemistry.

Repeatability: This course may be repeated for additional credit.

BIOL 3201. Human Genetics. 3 Credit Hours.

This course is typically offered in Fall.

The class provides an extensive overview of various Human genetics topics, including classical Mendelian genetics, molecular genetics and population genetics. We will delve into questions such as: what does human genome look like? What are the individual differences and how do they translate into phenotypic traits that affect our lives? How do we inherit and transmit this information? How do researchers study our genetic material and how do they find genes responsible for various diseases? What are the dynamic forces that shape genetic composition of human populations and why is it important to understand it? What have we learned about the past of human populations? Finally, is the ability to decipher the genome is the ultimate tool to tell the future and are there any ramifications we should be cautious of? The class will integrate lectures and in-class discussion of scientific literature. This course will build upon the basic genetic knowledge acquired in Biology 2296 (Genetics).

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C|May not be taken concurrently.

BIOL 3211. Human Evolution. 3 Credit Hours.

Since we last shared a common ancestor with chimpanzees, over 6 million years ago, the human species experienced a series of unusual adaptations so that today humans dominate planet earth and are masters of arts and letters, science and technology. Humans are both highly intelligent and highly social, so that when we work together extraordinary and unpredictable things can happen. This course will cover the evolutionary history of humans, with an emphasis on the genetic aspects of the process.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C|May not be taken concurrently

OR BIO6 Y|May not be taken concurrently.

BIOL 3212. Introduction to Bioinformatics and Computational Biology. 3 Credit Hours.

Introduction to Bioinformatics and Computational Biology presents students without a computational background with an initial presentation of the biological questions that can be addressed computationally using mostly online tools. Beginning with an introduction to the scientific hypothesis testing and computational biology, students will subsequently be introduced to searching the scientific literature and biological datasets and databases, concepts in the organization of genes and genomes, sequence searching (BLAST), pairwise and multiple sequence alignment, phylogenetic tree reconstruction, protein structure and homology modeling, and finally modeling function in metabolic pathways. This course is designed as an applied course and as a prerequisite for more advanced conceptual and technological courses in the department.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2112|Minimum Grade of C|May not be taken concurrently

OR BIOL 2912|Minimum Grade of C|May not be taken concurrently

OR BIO4 Y|May not be taken concurrently.

BIOL 3214. Theoretical Population Genetics. 3 Credit Hours.

This course explores the causes and consequences of genetic variation within and between populations. We can now obtain large-scale genetic variation data from a variety of species, and this data can be used to make inferences about demographic history, natural selection, gene flow, and a variety of other evolutionary processes. This course focuses on developing the theoretical machinery necessary to understand the factors that shaped the observed genetic variation, and examines how patterns of genetic variation inform our understanding of those forces. By developing probabilistic models of evolution based on coalescent theory and diffusion theory, students in the course will learn to apply statistical methods such as maximum likelihood and Bayesian inference to genetic data. Students will also gain familiarity with commonly used population genetics software.

Class Restrictions: Must be enrolled in one of the following Classes: Junior 60 to 89 Credits, Senior 90 to 119 Credits, Senior/Fifth Year 120+ Credits.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

MATH 1042|Minimum Grade of C|May not be taken concurrently

OR MATH 1942|Minimum Grade of C|May not be taken concurrently

OR MATH 1044|Minimum Grade of C|May not be taken concurrently.

BIOL 3225. Evolutionary Genetics. 3 Credit Hours.

This course is typically offered in Spring.

This class covers fundamental principles of population and comparative genetics with special attention given to recent advances in genomics. The scope of the class ranges from understanding variation at the population level to addressing species-level questions. Topics covered include classical population genetics, quantitative genetics, comparative genomics, phylogenomics and speciation. Lectures, assignments and discussions will explore theoretical and recent empirical advances.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C|May not be taken concurrently

OR BIO6 Y|May not be taken concurrently)

AND (MATH 1042|Minimum Grade of C|May not be taken concurrently

OR MATH 1044|Minimum Grade of C|May not be taken concurrently

OR MATH 1942|Minimum Grade of C|May not be taken concurrently

OR MATH 1951|Minimum Grade of C|May not be taken concurrently

OR MATH 2043 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently

OR MA07 Y|May not be taken concurrently)

BIOL 3232. Behavioral Genetics. 3 Credit Hours.

This course is typically offered in Fall.

This course is an introduction to the interdisciplinary field - behavioral genetics - that combines behavioral sciences and genetics and unifies the long-standing debate on what underlies complex human behavior: "nurture" or "nature." This course will discuss the genetic approaches used to dissect out the genetic determinant of complex human traits. For example, students will learn about genes that influence learning and memory, intelligence (IQ), cognitive disabilities, personality disorders, psychopathology, antisocial behavior, substance abuse, and sexual orientation. In addition, the interplay of environment and genetic factors that create individual differences in behavior will be explored. Because this field represents the intersection between what is known and what might be known in the future about complex and potentially controversial behaviors and characteristics, students will be encouraged to discuss contemporary ethical issues regarding human behavior in realm of the scientific evidence presented.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C|May not be taken concurrently.

BIOL 3241. Genomics and Evolutionary Biology of Parasites and Other Dependent Species. 3 Credit Hours.

This course is typically offered in Spring.

All known multicellular organisms harbor diverse assemblages of dependent species, many of which are considered parasites or pathogens. Yet, in spite of a growing awareness of the importance of dependent species in biodiversity and medicine, many studies are limited to assessing the consequences to their hosts. The goal of this seminar is to discuss some of the biological processes leading to the diversity of dependent species and their functional/evolutionary relationships with their hosts. This general objective will be fulfilled by discussing research articles on the genomics and evolution of dependent species, many of them considered parasites or pathogens. Students are also expected to gain proficiency in writing scientific review papers.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2112|Minimum Grade of C|May not be taken concurrently

OR BIOL 2912|Minimum Grade of C|May not be taken concurrently

OR BIO4 Y|May not be taken concurrently)

AND (BIOL 2227|Minimum Grade of C|May not be taken concurrently)

BIOL 3243. Parasitology. 4 Credit Hours.

This course is not offered every year.

This course will introduce students to the basic concepts of parasitology, including types of animal associations, adaptations to parasitic mode of life, and evolution of parasitism. Parasite life cycles (infection, transmission, pathology, symptoms, diagnosis, treatment) and control of medically and economically important parasites are the main emphasis of this course. Includes a laboratory.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 3096|Minimum Grade of C-|May not be taken concurrently)

AND (BIOL 2296|Minimum Grade of C-|May be taken concurrently)

BIOL 3244. Experimental Marine Biology. 4 Credit Hours.

This course is typically offered in summer.

Experimental Marine Biology is an upper level Biology course focused on the types of experiments that are used to further the science of Marine Biology. The course will be structured around three themes: Oceanography, Physiology, and Ecology. The Oceanography section will examine the marine environment in terms of the physics of current flow and the chemical properties of seawater. The Physiology section will examine how different organisms respond to these abiotic factors. In the Ecology section, we will discuss how organisms interact with each other as individuals and populations, and how communities and ecosystems are structured.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
OR BIO3 Y|May not be taken concurrently)
AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
OR BIO4 Y|May not be taken concurrently)

BIOL 3245. Marine Ecology. 4 Credit Hours.

This course is occasionally offered in Fall.

A survey of the concepts of aquatic ecology in estuarine and marine ecosystems, emphasizing the organization and maintenance of the major aquatic communities in response to the physical, chemical, and biological characteristics of the environment, modes of energy transfer, physiological adaptation, life history characteristics, and functional morphology. Laboratory exercises stress comparative measurement of biological diversity in the marine environment. NOTE: One or more field trips required.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2227|Minimum Grade of C-|May not be taken concurrently.

BIOL 3254. Animal Behavior. 3 Credit Hours.

This course is typically offered in Spring.

This course will examine how animals behave, and investigate the proximate (neurological and developmental) and ultimate (functional and evolutionary) explanations for these behaviors. The ecological and evolutionary processes that shape animal behavior will be examined through the study of classic theories and major principles of animal behavior, including a weighing of the experimental and observational evidence for each idea. Concepts will be illustrated with examples from a wide range of taxonomic groups of animals in diverse ecosystems, and emerging theories in animal behavior will be discussed. We will conclude with applications of animal behavior for conservation.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2227|Minimum Grade of C|May not be taken concurrently
OR BIO5 Y|May not be taken concurrently.

BIOL 3255. Critical Thinking in Biology. 3 Credit Hours.

The course is designed to improve students' critical thinking in broad areas of biology. Introductory lectures outline the elements and criteria that compose critical thinking, followed by student presentations and discussions based on the primary literature to promote development of this type of thinking in each student. For each session of class, one student will lead the discussion. Discussions will range in content from evolution to ecology and from molecular biology to the pathogenesis of human and animal diseases. Student presentations (one per student), twice weekly homework assignments (20 total), and oral participation in the scientific presentations throughout the semester will be used for grading.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Biology.

Field of Study Restrictions: Must be enrolled in one of the following Majors: Biology.

Class Restrictions: May not be enrolled in one of the following Classes: Freshman 0 to 29 Credits, Sophomore 30 to 59 Credits.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently)
 AND (CHEM 2201|Minimum Grade of C|May not be taken concurrently
 OR CHEM 2211|Minimum Grade of C|May not be taken concurrently
 OR CHEM 2921|Minimum Grade of C|May not be taken concurrently
 OR CHEM 2202|Minimum Grade of C|May be taken concurrently
 OR CHEM 2212|Minimum Grade of C|May be taken concurrently
 OR CHEM 2922|Minimum Grade of C|May be taken concurrently)

BIOL 3265. Developmental Biology. 3 Credit Hours.

This course is typically offered in Fall.

This course provides an introduction to invertebrate and vertebrate development. It combines the description of classical examples of experimental embryology with the current study of the mechanisms of development, differentiation, and growth in animals at the molecular, cellular, and genetic levels. Topics covered include embryonic patterning, cell-cell interactions, growth factors and signal transduction, transcriptional control mechanisms and regulatory network, evolutionary mechanisms as well as the discussion of relevant diseases.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C-|May not be taken concurrently.

BIOL 3268. Fundamentals of Cell and Cancer Biology. 3 Credit Hours.

This course examines cellular structures and biochemical pathways including those that, while mutated, lead to cellular transformation and formation of cancer.

Repeatability: This course may not be repeated for additional credits.

BIOL 3275. Ecology of Invasive Species. 3 Credit Hours.

This course is typically offered in Fall.

Species that are transported by humans from their native range and successfully establish and spread in a new environment are called invasive species. Invasive species can cause significant ecological and economic impacts and are a growing threat to native species and ecosystems across the globe. Recognition of this problem has led to a recent surge in research on invasive species and a better understanding of the ecology of invasions and approaches for improved prevention and control. Yet many challenges still hinder scientific and applied advancements in this emerging field. In this course we will investigate these challenges and the science of invasive species using interactive activities and student-driven projects.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2227|Minimum Grade of C|May not be taken concurrently
 OR BIO5 Y|May not be taken concurrently.

BIOL 3281. Cooperative Research in Biochemistry. 3 Credit Hours.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Independent research carried out in an off-campus laboratory. A Biochemistry faculty member and the research director of the off-campus laboratory will jointly supervise research. Written permission must be obtained in advance from the supervising faculty member and one of the co-administrators. Student must present a seminar on campus describing the scientific aims of the project, the experimental design, and the conclusions drawn from the experiments. NOTE: Restricted to Biochemistry majors enrolled in the Cooperative Program.

Field of Study Restrictions: Must be enrolled in one of the following Fields of study: Biochemistry.

Repeatability: This course may be repeated for additional credit.

BIOL 3301. Advanced Cell Biology. 3 Credit Hours.

This course is typically offered in Fall.

Fundamental knowledge in cell biology will be discussed. Topics include DNAs, RNAs, proteins, cell structure, cell motility, bio-membrane, endocytosis, nucleocytoplasmic transport, vesicular transport, cancers, visualizing macromolecular trafficking in cells with advanced microscopy imaging techniques, and stories of Nobel Prize Winners. Current journal articles reporting up-to-date developments in molecular cell biology will be covered as well. (Prior to Fall 2016, this course was titled "Cell Biology.")

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3307. Conservation Biology. 3 Credit Hours.

This course is typically offered in Fall.

The Earth harbors an incredible diversity of species and communities, most still poorly understood by science. This biodiversity is essential to the functioning of natural ecosystems and provides a wide array of priceless services to people today and a treasure of benefits for the future. Yet human threats to biodiversity have led us to the brink of the sixth major extinction event in Earth's history. Which populations, species, communities, and ecoregions are most diverse? Which are most threatened, and by which human activities? What is the contribution of biodiversity to human livelihoods? What does the science suggest is needed to conserve biodiversity? How might this best be done given social, economic, and political realities? These questions and more will be examined in this course, focusing on the key principles of conservation biology and the application of those principles to local, national, and international examples.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2227|Minimum Grade of C-|May not be taken concurrently.

BIOL 3311. Herpetology. 4 Credit Hours.

This course is typically offered in Spring.

Reptiles and amphibians comprise nearly 7,400 species and can be found on every major and minor landmass in the world except Antarctica. This course will provide a broad, evolutionary survey of the major groups of reptiles and amphibians ("herps"). We will cover topics about their basic biology, including anatomy, physiology, ecology, behavior, and conservation. The laboratory will emphasize taxonomic characters and identification of living and preserved specimens, with emphasis on species found in North America. Additionally several field trips (conducted during lab hours and spring break) will reinforce course material through hands-on experience.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
OR BIO3 Y|May not be taken concurrently)
AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
OR BIO4 Y|May not be taken concurrently)

BIOL 3312. Biostatistics. 3 Credit Hours.

This course is typically offered in Fall.

Students will learn the basic tools of statistical analysis for raw data and learn how to apply and interpret the analysis for the type of experiments they will encounter in biology. They will have opportunities to work with raw data using available computer tools such as EXCEL and SPSS.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(MATH 1042|Minimum Grade of C-|May not be taken concurrently
OR MATH 1044|Minimum Grade of C-|May not be taken concurrently
OR MATH 1942|Minimum Grade of C-|May not be taken concurrently
OR MATH 1951|Minimum Grade of C-|May not be taken concurrently
OR MATH 2043 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently)
AND (BIOL 1111|Minimum Grade of C|May not be taken concurrently
OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
OR BIO3 Y|May not be taken concurrently)
AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
OR BIO4 Y|May not be taken concurrently)

BIOL 3316. Tropical Marine Biology. 4 Credit Hours.

This course is typically offered in Fall of odd years.

A survey of marine biology focusing on coral reefs of the Atlantic Ocean. Course lectures given at Temple University include regular meetings during the fall semester plus some meetings between semesters during December and January. The course work at Temple is supplemented by a required week of lectures, field trips and field projects on Ambergris Caye in Belize (Central America). Lecture topics include coral biology, reef geology and ecology, coral reef biota, food webs and nutrient transfer in coral reefs, reef community organization, the biology of reef fishes, commensal and symbiotic interactions of reef organisms, and other appropriate topics. Group projects and presentations are required. Additional requirements include a current passport and snorkeling equipment. NOTE: Requires fall plus inter-session attendance, including air travel to a foreign country between fall and spring semesters. Room, board, and boat use in Belize are covered by the course fee; air transportation to Belize is not included. The course web site survey or an application available from the instructor must be completed prior to registration.

Repeatability: This course may not be repeated for additional credits.

BIOL 3317. General Microbiology. 4 Credit Hours.

This course is typically offered in Spring.

A general survey of bacteria and archaea. Topics include: classification; physiology, growth, and environmental impact; genetics and gene recombination; evolutionary relationships. Laboratory topics include pure culture, identification, growth characteristics, and genetics.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3321. Plant Community Ecology. 3 Credit Hours.

This course is typically offered in Fall.

This class focuses on fundamental principles in community ecology as they relate to plant systems. The scope of the class ranges from plant-environment interactions and species interactions, to the relationship among communities at larger spatial scales. Lectures and small group discussions will also highlight theoretical and empirical advances made in ecology through classic and contemporary studies of plant communities.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2227|Minimum Grade of C|May not be taken concurrently.

BIOL 3322. Biology of Plants. 3 Credit Hours.

This course is typically offered in Fall.

Plant Biology examines the current cellular, molecular and developmental aspects of higher plants, with an emphasis on Arabidopsis and maize. Topics include plant reproduction, embryonic pattern formation in plants, self-incompatibility, sex chromosomes in plants, polyploidy, chemical signaling in plants including PIN efflux carriers, phytochromes and cryptochromes, chloroplast structure and function, the light reaction of photosynthesis, stem cell populations in plants, leaf morphogenesis, flower development, DNA and histone methylation and epigenetics, RNA silencing in plants, plant genomics, plant viruses, and genetic engineering of monocot and dicot plants.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2112|Minimum Grade of C|May not be taken concurrently.

BIOL 3324. Molecular Biology. 3 Credit Hours.

This course is typically offered in Fall.

A comprehensive introduction to molecular genetics and the biochemistry of DNA, RNA, and proteins. The structure and expression of genes in both prokaryotes and eukaryotes will be discussed with special emphasis on DNA replication, transcription, and translation. Current journal articles covering recent developments in modern molecular biology and genetic engineering will be covered.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C-|May not be taken concurrently)

AND (CHEM 2202|Minimum Grade of C-|May not be taken concurrently)

OR CHEM 2212|Minimum Grade of C-|May not be taken concurrently

OR CHEM 2922|Minimum Grade of C-|May not be taken concurrently)

BIOL 3325. Research Techniques in Molecular Biology. 3 Credit Hours.

This course is typically offered in Spring.

Instruction in the techniques used in modern molecular biology and molecular genetics. This course takes a problem-oriented approach toward teaching the methods of DNA and RNA analysis that are used in determining the structure and function of genes. Practical experience in the preparation of DNA, modern cloning methods, restriction enzyme mapping, hybridization analysis, DNA sequencing, and PCR techniques will be provided. Students will carry out a research project during the course. NOTE: Biology 3324 is highly recommended, but not required.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C|May not be taken concurrently

OR BIO6 Y|May not be taken concurrently.

BIOL 3327. Immunology. 3 Credit Hours.

This course is typically offered in Spring.

The purpose of the Immunology course is to provide a comprehensive overview of the immune system that in its normal function protects each of us from the harmful effects of microbial invaders. The lectures will describe the general properties and development of immunity, the condition of being protected from infection by microorganisms or the effects of foreign molecules. They will provide systemic coverage of immune responses to viruses, bacteria, protozoa and roundworms as well as the practical aspects of vaccine development. Additional lectures will include a description of various types of primary immunodeficiencies, most prevalent autoimmune disease and cancer.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C-|May not be taken concurrently

OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3328. Virology. 3 Credit Hours.

This course is typically offered in Fall.

The role of viruses in human diseases, and their potential as tools for research and clinical interventions. The course will focus on virus-induced diseases in man including polio, rabies, hepatitis, herpes, and influenza; recently discovered viruses such as HIV and HTLV-1 will also be studied. Virus-host interactions and the mechanisms involved in disease progression, therapeutic strategies, and vaccines, strategies for viral entry, evasion of the immune system, transmission, and the subversion of host-cell machinery will be emphasized. Potential uses of viruses as vector for gene therapy of genetic disorders, cancers, and infectious diseases will also be discussed.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C-|May not be taken concurrently
AND BIOL 3096|Minimum Grade of C-|May not be taken concurrently)

BIOL 3329. Developmental Genetics. 3 Credit Hours.

This course is not offered every year.

The role of genes during the periods of determination and differentiation in eukaryote development. Emphasis on the regulation of gene function and the relationship between gene function and the molecular and developmental interactions that culminate in the adult phenotype.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C-|May not be taken concurrently
AND BIOL 3096|Minimum Grade of C-|May not be taken concurrently)

BIOL 3333. Advanced Techniques in Microscopy. 4 Credit Hours.

This course is typically offered in Spring.

A survey of modern techniques in microscopy. Students will acquire a thorough grounding in general principles of optics and their application to the microscope. We will cover the theory of many methods current in Biology and Medicine, including: phase, interference contrast, and fluorescence microscopy, confocal microscopy, video microscopy, and digital image processing and analysis. This course includes extensive laboratory experience.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3334. Mammalian Physiology. 4 Credit Hours.

This course is typically offered in Spring.

Emphasis on the physiology of normal animals; consideration of disease states as counter-illustrations. Certain comparative aspects of physiology are introduced. Discussions of function extend to the physical and biochemical level. NOTE: Credit is not permitted for both Biology 0234 (under the old numbering system) and Biology 3334 (0334).

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently
 OR BIOE 3725|Minimum Grade of C|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently
 OR BIOE 3725|Minimum Grade of C|May not be taken concurrently)
 AND (CHEM 1032|Minimum Grade of C|May not be taken concurrently
 OR CHEM 1042|Minimum Grade of C|May not be taken concurrently
 OR CHEM 1952|Minimum Grade of C|May not be taken concurrently
 OR CHM2 Y|May not be taken concurrently)
 AND (MATH 1042|Minimum Grade of C-|May not be taken concurrently
 OR MATH 1044|Minimum Grade of C-|May not be taken concurrently
 OR MATH 1942|Minimum Grade of C-|May not be taken concurrently
 OR MATH 1951|Minimum Grade of C-|May not be taken concurrently
 OR MATH 2043 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently)
 AND (PHYS 1062|Minimum Grade of C-|May be taken concurrently
 OR PHYS 2022|Minimum Grade of C-|May be taken concurrently
 OR PHYS 2922|Minimum Grade of C-|May be taken concurrently)

BIOL 3335. Life at the Extremes - Polar Biology. 3 Credit Hours.

"Life at the Extremes - Polar Biology" is an introduction to polar environments and the biology of aquatic and terrestrial organisms adapted to live in the Arctic and Antarctic. Similarities and differences between the poles as well as anthropogenic impacts on these remote environments will be addressed. Comparisons to other extreme environments will be included.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May be taken concurrently)

BIOL 3336. Freshwater Ecology. 4 Credit Hours.

This course is typically offered in Fall of even years.

The interrelationships between biological, chemical, and physical factors in freshwater environments. Lectures and laboratories address general ecological principles (population dynamics, community structure, energy flow, and nutrient cycling) as they apply to plants and animals in lakes, ponds, streams and wetlands. NOTE: Students are required to participate in up to two field trips, one of which includes weekend travel.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2227|Minimum Grade of C-|May not be taken concurrently.

BIOL 3337. Comparative Biomechanics. 3 Credit Hours.

This course is typically offered in Fall.

An overview of biomechanics with emphasis on locomotion. Students gain a working knowledge of the breadth of biomechanical study ranging across organismal and environmental scales.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (MATH 1042|Minimum Grade of C|May not be taken concurrently
 OR MATH 1044|Minimum Grade of C|May not be taken concurrently
 OR MATH 1942|Minimum Grade of C|May not be taken concurrently
 OR MATH 1951|Minimum Grade of C|May not be taken concurrently
 OR MA07 Y|May not be taken concurrently)
 AND (PHYS 2021|Minimum Grade of C-|May not be taken concurrently
 OR PHYS 1061|Minimum Grade of C-|May not be taken concurrently
 OR PHYS 2921|Minimum Grade of C-|May not be taken concurrently)

BIOL 3352. Systems Neuroscience. 3 Credit Hours.

This course is typically offered in Fall and Spring.

Study of the structure and function of the central nervous system (CNS) with a focus on the functional brain at a systems level. Systems level questions include how circuits are formed and used anatomically and physiologically to produce physiological functions, such as reflexes, sensory integration, motor coordination, emotional responses, learning and memory.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
 AND (CHEM 2201|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 2211|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 2921|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
 AND (MATH 1042|Minimum Grade of C|May not be taken concurrently
 OR MATH 1044|Minimum Grade of C|May not be taken concurrently
 OR MATH 1942|Minimum Grade of C|May not be taken concurrently
 OR MATH 1951|Minimum Grade of C|May not be taken concurrently
 OR MATH 2043 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently
 OR MA07 Y|May not be taken concurrently)

BIOL 3354. Neural Basis of Animal Behavior. 3 Credit Hours.

This course is typically offered in Fall.

An exploration of the relationship of neural activity and connectivity to behavior. Topics include motor control, object recognition, and feedback. Examples from both vertebrate and invertebrate species. Analytic and synthetic approaches.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3352|Minimum Grade of C|May not be taken concurrently.

BIOL 3356. Organization and Development of the Nervous System. 3 Credit Hours.

This course is typically offered in Spring.

This course covers developmental and anatomical aspects of the nervous system. The relationship of form to function will be studied in a variety of both invertebrate and vertebrate systems. The course is intended to complement Neurobiology 3352 (0352)/5452 (0452) so that students will have a perspective on neuroscience ranging from the molecular to the systems level.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3358. Cellular and Molecular Neuroscience. 3 Credit Hours.

This course is typically offered in Spring.

The course will focus on the molecular and cellular basis of neurological processing. The fundamentals of action potential generation, synaptic and receptor potentials generation and neuron-neuron communication will be discussed. The contemporary understanding of sensory processing will be covered in great detail with a particular focus on molecular sensors of light, sound, odorants, taste and touch and the signal transduction pathways that underlie the five senses.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3361. Synaptic Neuropharmacology: From Poppies to People. 3 Credit Hours.

This course is not offered every year.

In this course we will examine how drugs interact with the nervous system. Specifically, we will focus on the cellular and molecular actions of drugs such as opiates, hallucinogens, marijuana, and cocaine on synaptic transmission as a mechanism for understanding the structure and function of the synapse. In addition, we will discuss how toxins and venoms affect synaptic transmission in nature as well as how they have been (and continue to be) used as research tools. Through this approach - of relating natural to experimental - students will be able to appreciate both the simplicity of synaptic design and the complexity of synaptic transmission in the historical context of the study of neuroscience.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3352|Minimum Grade of C-|May not be taken concurrently.

BIOL 3363. Mammalian Development. 3 Credit Hours.

This course is not offered every year.

This course covers normal and abnormal embryonic and fetal development; sources of totipotent, pluripotent and determined embryonic and fetal stem cells; the production of gynogenotes and androgenotes and the evaluation of these embryos to determine the contribution of maternal and paternal genomes to the developing embryo; epigenetic and X chromosome imprinting; the use of transgenes to correct genetic defects in developing embryos; and the function of specific genes in determining body pattern.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3265|Minimum Grade of C-|May not be taken concurrently.

BIOL 3365. The New Neuroimmunology. 3 Credit Hours.

This course is typically offered in Spring.

It is now recognized that there is extensive communication between the immune and nervous systems. This course will examine the mechanisms and effects of this communication. Potential topics include effects of immune molecules on neuronal synaptic structure and function over the lifespan, and the implications for learning and memory; the biological basis of sickness behavior and links to depression and PTSD; possible effects of the microbiome on brain development and function; and links between immune deregulation and neurodegenerative disease.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3352|Minimum Grade of C|May not be taken concurrently.

BIOL 3367. Endocrinology. 3 Credit Hours.

This course is typically offered in Fall.

Broad coverage of "chemical messengers," occurrence, biochemistry, and physiology. Vertebrate endocrinology with minor treatment of invertebrates and plants.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3368. Biology of Cancer. 3 Credit Hours.

This course is typically offered in Spring.

This course will survey the categories of tumors and their varying natures. Known mechanisms that lead to tumor cell development, multistep tumorigenesis, metastasis, tumor immunology, and cancer treatments will be examined in depth.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C-|May not be taken concurrently)

AND (BIOL 3096|Minimum Grade of C-|May not be taken concurrently)

BIOL 3371. Cell Proliferation. 3 Credit Hours.

This course is typically offered in Spring.

Cell proliferation and its control: model systems, comparisons of proliferating cells with non-proliferating cells, controls of cell division and genomic stability and how that control is modified in proliferative diseases such as cancer, and the relationships between proliferation and differentiation. Readings will be taken from the literature.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C-|May not be taken concurrently)

AND BIOL 3096|Minimum Grade of C-|May not be taken concurrently)

BIOL 3373. Cell Signaling. 3 Credit Hours.

This course is typically offered in Spring.

The communication among cells is essential for the regulation of the development of an organism and for the control of its physiology and homeostasis. Aberrant cellular signaling events are often associated with human pathological conditions, such as cancer, neurological disorders, cardiovascular diseases and so on. The full characterization of cell signaling systems may provide useful insights into the pathogenesis of several human maladies. (Prior to spring 2017, this course was titled "Cell Signaling and Motility.")

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3374. Physical Biochemistry. 3 Credit Hours.

This course is typically offered in Spring.

Physical Biochemistry emphasizes physical techniques that are used in modern biochemical research. Topics include proteomics, protein structure, protein folding, protein misfolding in neurological disorders, interaction of light with proteins including optogenetics, the light reaction of photosynthesis, nitrogen fixation, absorption spectroscopy, emission spectroscopy, bioluminescence and BRET, MALDI-TOF mass spectrometry, NMR spectroscopy, natural and artificial membranes, and single molecule methods in biochemistry.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (MATH 1042|Minimum Grade of C|May not be taken concurrently
 OR MATH 1044|Minimum Grade of C|May not be taken concurrently
 OR MATH 1942|Minimum Grade of C|May not be taken concurrently
 OR MATH 1951|Minimum Grade of C|May not be taken concurrently
 OR MATH 2043 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently
 OR MA07 Y|May not be taken concurrently)
 AND (PHYS 1061|Minimum Grade of C-|May not be taken concurrently
 OR PHYS 2021|Minimum Grade of C-|May not be taken concurrently
 OR PHYS 2921|Minimum Grade of C-|May not be taken concurrently)
 AND (CHEM 1034|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 1044|Minimum Grade of C-|May not be taken concurrently
 OR CHEM 1954|Minimum Grade of C-|May not be taken concurrently)

BIOL 3379. Biotechnology. 3 Credit Hours.

This course is typically offered in Spring.

This course is designed to survey current issues in technologies including therapeutics and diagnostics, and to examine consequences of developments in this area. The course is designed in a Problem Based Learning format, where students research critical areas and provide oral and written reports for other members in the class. The course is organized by topics including Concepts in Genetics, Cloning and Ethics, Gene Therapy, Prenatal Diagnosis, Gene Therapy for Cancer, Cell Replacement Therapy, Genomics and Proteomics, Vaccines, Forensics, Plant Biotechnology, and Instrumentation. At the end of the course, each student makes a formal presentation on a specific advance in biotechnology.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

(BIOL 2296|Minimum Grade of C-|May not be taken concurrently
 AND BIOL 3096|Minimum Grade of C-|May not be taken concurrently)

BIOL 3380. Contemporary Biology. 3 Credit Hours.

This course is typically offered in Fall and Spring.

Advanced discussion of selected topics.

This course is repeatable for credit.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently)

BIOL 3396. Scientific Writing for Biology: The Art of Communicating. 3 Credit Hours.

This course is typically offered in Spring.

This course is designed for upper-level undergraduate students majoring in a natural science. This seminar course teaches students how to communicate scientific information in written and oral (PowerPoint) formats clearly and succinctly. The development and refinement of the primary research article represents the core of the course; however, other genres of scientific writing (and audiences) are explored. In addition, students develop their skills as revisers, editors, and reviewers through in-class exercises that focus on giving (and receiving) constructive criticism. As part of a secondary goal of the course, other professional forms of writing (e.g., cover letters, personal statements, and resumes) as well as careers in scientific writing are discussed.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C-|May not be taken concurrently
OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently.

BIOL 3403. Genomic Biology. 3 Credit Hours.

This course will cover the process of gene inheritance and descriptions of genome structure, as well as a discussion of gene content and function across lineages. Students will learn about genome-related technologies, including genome sequencing. They will also learn about how genomes vary across species, as well as the forces driving these evolutionary changes. A significant part of the course will cover genome-level data analyses, and students will complete assignments and exams to demonstrate understanding of the information present in genomes and how we know it. Note: Prior to fall 2016, the course title was "Genomics." Prior to fall 2015, the course title was "Genomics and Proteomics."

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C|May not be taken concurrently
OR BIOL 3101|Minimum Grade of C|May not be taken concurrently.

BIOL 3681. Cooperative Studies. 2 to 4 Credit Hours.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Students obtain a job through the Cooperative Placement Office. Course grade based entirely on a research paper, related in subject matter to the job, and prepared under the supervision of a Biology Department faculty member. NOTE: The student is responsible for finding a departmental supervisor. For students enrolled in a Cooperative Program; not available for Biology elective credit. This course is not repeatable.

Repeatability: This course may not be repeated for additional credits.

BIOL 3941. Honors Broader Impacts: The Art of Scientific Communication. 3 Credit Hours.

Honors Broader Impacts: The Art of Scientific Communication is an upper-level honors course designed to integrate students from different disciplines around a discussion of the interpretation and presentation of scientific results to the public. The course will begin with a motivation for public engagement in the sciences and how science and scientists are viewed by the public. This will include a discussion of the National Science Foundation requirements for the "Broader Impacts" of their submitted proposals. The course will continue with the presentation, evaluation, and discussion of various examples of scientific outreach including film, fine art, music, and museum exhibits, as well as direct communication outlets such as blogs, social media, and press releases. Over the course of the semester, the students will engage with each other in the discussion of what makes an effective science communication strategy and work together to develop materials that communicate scientific to a broad audience. This will ideally involve a pairing of CST graduate students with Honors undergraduates from a wide variety of disciplines.

Class Restrictions: Must be enrolled in one of the following Classes: Junior 60 to 89 Credits, Senior 90 to 119 Credits, Senior/Fifth Year 120+ Credits.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO

Repeatability: This course may not be repeated for additional credits.

BIOL 4275. Fundamentals of Medical Biochemistry. 4 Credit Hours.

Biochemistry is fundamental to understanding pathophysiology, pharmacology, and other medical sciences. This course delves into the principles of biomolecular structure and function, kinetics, bioenergetics, biosignaling, and metabolism to prepare the student for understanding the molecular basis of medicine.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Post Baccalaureate.

Repeatability: This course may not be repeated for additional credits.

BIOL 4291. Extradepartmental Research. 1 to 4 Credit Hour.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Prerequisite: Senior standing and a GPA of 3.2 or better with recommendation of a faculty sponsor and approval of the Biology Honors Committee.

Students must be Biology majors who have completed Biology 1111, 2112, and at least two of the other department core courses (Biology 2227, 2296 and 3096) with enrollment in the third in the Fall or Spring semester when offered. Students must obtain a sponsor on the Biology Department faculty to oversee their work and act as a liaison between the outside institution and the Biology Honors Committee. A student is eligible to apply for "Distinction in Biology" upon: 1) successful completion of 6 s.h. of Biology 4291; 2) submission of a written report on the student's research to the faculty sponsor and the Biology Honors Committee; and 3) a poster presentation on the student's research during the Biology Department's annual poster exhibition. Note: Not available for Biology major credit. This course is repeatable. Students wishing to complete additional credits of Biology 4291 beyond 6 s.h. may do so if they elect the CR/NC option.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 2296|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 2296|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May be taken concurrently
 OR BIOL 2296|Minimum Grade of C-|May be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May be taken concurrently)

BIOL 4327. Biological Impacts of Global Climate Change. 3 Credit Hours.

This course is typically offered in Fall.

This course will use primary research articles to examine the biological impacts of climate change, often mentioned as the greatest challenge facing humanity today. The course will focus on the climate change impacts on coastal and marine ecosystems; water resources and freshwater ecosystems; food and agriculture; forests, grasslands and deserts; biodiversity and protected areas; and population, health and human well-being. In addition to the biology, we will consider the overlapping social, economic, and ethical concerns rising from the climate changes. Class time will be devoted to reflections and reactions to readings and news articles, case studies, student presentations and lectures.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May not be taken concurrently)

BIOL 4338. Epigenetics. 3 Credit Hours.

This course is not offered every year.

The term "epigenetics" describes a heritable effect on chromosome or gene function that is not accompanied by a change in DNA sequence. Recent findings suggest an important role of epigenetics in both normal development and cancer. This course provides an overview of the field and examines selected phenomena in several eukaryotes, mechanisms regulating these effects, and their phenotypic consequences when normal regulation is lost. Topics include gene regulation through chromatin modification (acetylation, methylation), genomic imprinting, mechanisms of silencing (including small interfering RNAs), and the role of epigenetics in human diseases and cancer.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C|May not be taken concurrently
OR BIO6 Y|May not be taken concurrently)
AND (BIOL 3096|Minimum Grade of C|May not be taken concurrently
OR BIO7 Y|May not be taken concurrently)

BIOL 4341. Genome Editing. 3 Credit Hours.

Genome editing as such is not that new. Scientists have been "editing" genomes of bacteria, yeast and the mouse for some 30 years. Several recent technical advances, however, have pushed genome editing to the forefront of biological research. The first is discovery and development of nucleases, CRISPR/Cas9 in particular, which can be directed to cut DNA at just about any location. The second factor is a combination of stem cell technologies. They make it possible to produce stem cell out of many different tissues, which can then in turn be differentiated into various cell types, or carry out editing in the zygote. This will be a fast-paced seminar-like class. We will read and discuss primary research papers which describe advances relevant to the genome editing field, culminating in their application to edit the genomes of large mammals including the species *Homo sapiens*.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C|May not be taken concurrently.

BIOL 4344. Research Techniques in Biochemistry. 4 Credit Hours.

This course is typically offered in Spring.

Laboratory instruction in techniques used to investigate biochemical problems. Techniques include spectrophotometry, various types of electrophoresis, separation of macromolecules, two-dimensional protein separation, affinity chromatography, isolation of plasmid DNA, Western Blot, immunoassay, enzyme kinetics, and radioisotope techniques. If time permits, students will be given a small research project.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

CHEM 4401|Minimum Grade of C-|May not be taken concurrently
OR BIOL 4375|Minimum Grade of C-|May not be taken concurrently.

BIOL 4364. Biochemistry of Embryogenesis. 3 Credit Hours.

This course is typically offered in Fall.

This course will compare and contrast key biochemical mechanisms of embryonic development in a variety of model organisms ranging from humans to plants. We will examine the roles of enzymes, peptides, small RNA molecules and chromatin structure during embryogenesis. Topics will include micro RNAs, modification of DNA structure, and effects of mutation on enzyme activity. These basic principles will then be applied to subjects such as cell communication, stem cells, and cloning. Course material will be drawn from the experimental literature.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

BIOL 2296|Minimum Grade of C|May not be taken concurrently
OR BIO6 Y|May not be taken concurrently.

BIOL 4365. Evolutionary Developmental Biology: Evo-Devo. 3 Credit Hours.

This course is typically offered in Spring.

An overview of the relationship between organisms' development and phenotypic changes during evolution. Includes historical, theoretical and mechanistic themes of Evo-Devo, molecular and genetic basis of development and evolution.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C-|May be taken concurrently
OR BIOL 3101|Minimum Grade of C-|May not be taken concurrently)
AND (BIOL 3096|Minimum Grade of C-|May not be taken concurrently)

BIOL 4366. Stem Cell Biology. 3 Credit Hours.

This course is typically offered in Fall.

The purpose of this course is two-fold. The first is to present the developmental biology of stem cells, with an overview of the various types of stem cells that exist and an emphasis on embryonic stem cells. The overview will include the important functional differences between embryonic, hematopoietic, and adult stem cells as well as the differences in their biomedical potentials. Techniques such as somatic cell nuclear transfer (SCNT) and other methods for the derivation of stem cell lines will be outlined so that differences that may seem subtle at first glance are clarified. The second purpose is to look into the larger debate on human embryonic stem cell research while continually drawing connections to the established fields of bioethics, politics, and philosophy. The course will ground the issues by looking at the history of the debate over the embryo, with careful attention paid to the language used in arguments. An exploration of important social, ethical, political, and economic issues and how they arose with respect to the stem cell debate will round out the remainder of the course.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 2296|Minimum Grade of C|May not be taken concurrently
OR BIO6 Y|May not be taken concurrently)
AND (BIOL 3096|Minimum Grade of C|May not be taken concurrently
OR BIO7 Y|May not be taken concurrently)

BIOL 4370. Advanced Special Topics in Biochemistry. 3 Credit Hours.

This course is not offered every year.

Advanced lecture course. Subject matter varies from semester to semester.

This course is repeatable for credit.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

CHEM 4401|Minimum Grade of C-|May not be taken concurrently
OR BIOL 4375|Minimum Grade of C-|May not be taken concurrently.

BIOL 4375. General Biochemistry I. 3 Credit Hours.

This course is typically offered in Fall.

Properties of water (pH and buffers); chemistry of amino acids and proteins including non-covalent interactions; carbohydrates, nucleotides and nucleic acids; lipids and membranes; enzyme mechanisms and kinetics; control of enzyme activity; bioenergetics and oxidative metabolism; and chemistry of photosynthesis.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

(BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
AND (MATH 1041|Minimum Grade of C|May not be taken concurrently
OR MATH 1941|Minimum Grade of C|May not be taken concurrently
OR MATH 1038|Minimum Grade of C|May not be taken concurrently
OR MATH 1042|Minimum Grade of C-|May be taken concurrently
OR MATH 1044|Minimum Grade of C-|May be taken concurrently
OR MATH 1942|Minimum Grade of C-|May be taken concurrently
OR MATH 1951|Minimum Grade of C-|May be taken concurrently
OR MATH 2043 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MA06 Y|May not be taken concurrently)

BIOL 4376. General Biochemistry II. 3 Credit Hours.

This course is typically offered in Fall.

Emphasis on the biochemical reactions in various metabolic pathways. Biosynthesis and degradation of carbohydrates, lipids, proteins and amino acids. Regulation and integration of metabolic pathways. Bioenergetics and oxidative phosphorylation. Signal transduction. Transcription, translation and their control.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites:

CHEM 4401|Minimum Grade of C-|May not be taken concurrently
OR BIOL 4375|Minimum Grade of C-|May not be taken concurrently.

BIOL 4391. Accelerated Research in Biology. 1 to 4 Credit Hour.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Prerequisites: Senior standing and a GPA of 3.2 or better with recommendation of a faculty sponsor and approval of the Biology Honors Committee. Research under the supervision of a faculty member in the Biology Department. Students must be Biology majors who have completed Biology 1111, 2112, and at least two of the other department core courses (Biology 2227, 2296 and 3096) with enrollment in the third in the Fall or Spring semester when offered. A student is eligible to apply for "Distinction in Biology" upon: 1) successful completion of 6 s.h. of Biology 4391; 2) submission of a written report on the student's research to the faculty sponsor and the Biology Honors Committee; and 3) a poster presentation on the student's research during the Biology Department's annual poster exhibition. Students completing a minimum of 6 s.h. of Biology 4391 over two semesters may petition the Biology Honors Committee to have the two semesters count for one Biology elective course. This course is repeatable. Students wishing to complete additional credits of Biology 4391 beyond 6 s.h. may do so if they elect the CR/NC option.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently
 OR BIOL 1911|Minimum Grade of C|May not be taken concurrently
 OR BIO3 Y|May not be taken concurrently)
 AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently
 OR BIOL 2912|Minimum Grade of C|May not be taken concurrently
 OR BIO4 Y|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 2296|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 2296|Minimum Grade of C-|May not be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May not be taken concurrently)
 AND (BIOL 2227|Minimum Grade of C-|May be taken concurrently
 OR BIOL 2296|Minimum Grade of C-|May be taken concurrently
 OR BIOL 3096|Minimum Grade of C-|May be taken concurrently)

BIOL 4483. Accelerated Research in Biochemistry. 3 Credit Hours.

This course is typically offered in Fall, Summer I and Summer II.

This course is required for graduation with distinction in the major. Student presentation of research done in this course [and 4491 (0394)] or a comprehensive presentation of a topic selected jointly by student and advisor. Emphasis placed on analysis of experimental techniques, quantitative interpretation of the data, logical analysis of controls, and implication of the results. Admission to this course and the distinction track, as well as recommendation for graduation with distinction, must be approved by the Biochemistry Committee. Not available for Biology major credit.

Repeatability: This course may be repeated for additional credit.

BIOL 4491. Research in Biochemistry. 3 Credit Hours.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Research under the supervision of one of the Biochemistry faculty. If repeated, a presentation of the student's research is required during the second semester. Upon successful completion of two semesters of Biology 4491 (0394), the student may petition for them to be counted as one of the Biochemistry electives. Not available for Biology major credit.

Repeatability: This course may be repeated for additional credit.

BIOL 4591. Research in Neuroscience. 1 to 4 Credit Hour.

This course is typically offered in Fall, Spring, Summer I and Summer II.

Prerequisites: Senior standing and a GPA of 3.2 or better with recommendation of a faculty sponsor and approval of the Neuroscience Honors Committee. Research under the supervision of a faculty member conducting neuroscience research. Students must be Neuroscience majors who have completed Biology 1111, 2112, 2296, and 3096. A written presentation of the student's research is required during the second semester. A student is eligible to apply for "Distinction in Neuroscience" upon: 1) successful completion of 6 s.h. of Biology 4591; 2) submission of a written report on the student's research to the faculty sponsor and the Biology Honors Committee; and 3) a poster presentation on the student's research during the Biology Department's annual poster exhibition. Not available for Biology major credit. This course is repeatable. Students who complete additional credits of Biology 4591 beyond 6 s.h. must take the additional credits as CR/NC only.

Repeatability: This course may be repeated for additional credit.

Pre-requisites:

(BIOL 1111|Minimum Grade of C|May not be taken concurrently

OR BIOL 1911|Minimum Grade of C|May not be taken concurrently

OR BIO3 Y|May not be taken concurrently)

AND (BIOL 2112|Minimum Grade of C|May not be taken concurrently

OR BIOL 2912|Minimum Grade of C|May not be taken concurrently

OR BIO4 Y|May not be taken concurrently)

AND (BIOL 2296|Minimum Grade of C-|May not be taken concurrently)

AND (BIOL 3096|Minimum Grade of C-|May not be taken concurrently)