BIOLOGY (BIOL)

BIOL 102 Fundamentals of Biology: Molecular and Cell Biology Units: 3.00

The essential biochemistry, genetics, cell biology, and metabolic pathways underlying the survival and success of all living organisms. Themes and case studies could range from the application of genetic engineering in biotechnology to the role of cellular dysregulation in inheritable diseases.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
NOTE Also offered at Bader College, UK (Learning Hours may vary).
Learning Hours: 111 (24 Lecture, 6 Laboratory, 9 Group Learning, 12 Online Activity, 60 Private Study)
Requirements: Prerequisite None. Recommended 4U Biology and Chemistry, or equivalent high school background.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply strategies for time management and collaboration.
2. Complete assignments using analytical skills to synthesize results in order to communicate biological questions, concepts, and results in the context of the primary scientific literature.
3. Explain and interpret cellular processes, including how cells respond to external signals and how they process energy.
4. Explain and interpret DNA in the context of molecular genetics, inheritance, and DNA technologies.
5. Explain and interpret the cellular chemistry of living organisms and how this relates to cellular function, diversity, and evolution.
6. Use group activities to establish and hone your ability to work on a team.

BIOL 103 Fundamentals of Biology: Organisms to Ecosystems Units: 3.00

The origins and diversification of multicellular organisms, their form, function and adaptation to stress and a changing world. Themes and case studies include energy flow from molecules to ecosystems, organismal interactions including parasitism and disease dynamics, and the impacts of human activity.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
NOTE Also offered at Bader College, UK (Learning Hours may vary).
Learning Hours: 123 (36 Lecture, 24 Laboratory, 24 Online Activity, 39 Private Study)
Requirements: Prerequisite None. Recommended BIOL 102/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply knowledge of tissue and organ system functioning and integration to diagnose or predict common diseases and organismal dysfunctions.
2. Compare the nature of interactions between organisms at the level of the population, the community and the ecosystem.
3. Describe the main cycles governing the flow of nutrients and energy through communities and ecosystems and recognize the importance of ecological interactions and biodiversity in building a sustainable future.
4. Describe the structure and function of nerves and muscles and explain how they contribute to physiological and behavioural processes.
5. Discuss the mechanisms by which evolution shapes biological diversity, citing examples from the history of life captured in the fossil record, in extant diversity, or through direct observation of evolution in action.
6. Identify the roles of the major physiological systems in diverse animals and how they are regulated through electrical and chemical signals to achieve change or maintain homeostasis.

BIOL 110 Human Genetics and Evolution Units: 3.00
Introductory genetics and evolutionary processes as they relate to the human condition - genetic diseases, medical techniques, inheritance and ethical issues such as cloning and genetically modified foods.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
Learning Hours: 118 (26 Lecture, 10 Tutorial, 10 Group Learning, 36 Online Activity, 36 Private Study)
Requirements: Prerequisite None. One-Way Exclusion May not be taken with or after BIOL 102/3.0; BIOL 103/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Appreciate the role of genetics in contemporary medical issues such as stem cell research, longevity research, genetic testing, and cancer.
2. Describe the role of genetic variation and its interaction with the environment in human evolution.
3. Distinguish between "older-school" research approaches and cutting edge approaches and evaluate how life might be affected by these new technologies in the Genomics Age.
4. Identify and define basic concepts and structures in basic biology such as the gene, chromosomes, genome, inheritance and the cell.
5. Recognize how genetic concepts apply to both individuals and to populations.

BIOL 111 Ecology and the Environment Units: 3.00
Introduces the basic concepts of ecology and shows how they relate to environmental issues such as population growth, resource management, biodiversity, agriculture, air and water pollution, energy, and climate change, and to solutions leading to a sustainable environment.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
Learning Hours: 108 (36 Lecture, 72 Private Study)
Requirements: Prerequisite None. One-Way Exclusion May not be taken with or after BIOL 300/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Analyze the factors controlling human population growth in developed and developing countries.
2. Describe the basic principles of community ecology and population ecology.
3. Describe the earth's renewable and non-renewable resources, their current status, the factors that influence them and explain how humans can use them in more sustainable ways.
4. Identify the main biomes on Earth and explain the factors that influence them.
5. Predict most likely future trends of current environmental problems and formulate potential solutions.

BIOL 200 Diversity of Life Units: 3.00
This course provides a phylogenetically based overview of biodiversity across the Tree of Life including viruses; archaea, bacteria, algae, fungi, plants, invertebrates and vertebrates. Patterns of organizational complexity and species diversity are explained in the context of evolutionary processes, structure function relationships and ecology.
NOTE Textbook and onQ course site for distributing reading material.
Learning Hours: 120 (36 Lecture, 18 Tutorial, 18 Online Activity, 48 Private Study)
Requirements: Prerequisite None. Exclusion BIOL 201/3.0*; BIOL 202/3.0*. Recommended BIOL 102/3.0 and BIOL 103/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Describe and discuss the diversity of living organisms across the "Tree of Life" from both evolutionary and ecological perspectives.
2. Describe the timelines of major steps in evolution.
3. Explain the primary and secondary mechanisms that generate biological diversity across the 'Tree of Life'.
4. Interpret the relative success and diversity of the major groups organisms in terms of adaptations for growth, survival and reproduction.
5. Recognise, describe, and compare the principal unique features of a wide range of organisms including archaea, bacteria, algae, fungi, plants, and invertebrate and vertebrate animals.

BIOL 205 Mendelian and Molecular Genetics Units: 3.00
An introduction to Mendelian and molecular genetics covering the basic mechanisms of genetic transmission, gene structure and function, as well as the application of molecular genetics in medicine and biotechnology.
Learning Hours: 120 (36 Lecture, 18 Tutorial, 18 Online Activity, 48 Private Study)
Requirements: Prerequisite A GPA of 1.90 in (BIOL 102/3.0 and BIOL 103/3.0).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply knowledge of various molecular genetics methodologies used to analyze DNA, RNA, and protein to demonstrate how these molecular techniques are used to understand gene function.
2. Explain and differentiate the key features of DNA replication and repair, transcription, and protein translation, including cellular constituents involved, in both prokaryotes and eukaryotes to gain an understanding of how genes function.
3. Explain inheritance ratios in terms of chromosome behaviour at meiosis to be able to infer genetic interaction of different genes based on modified Mendelian ratios.
4. Explain the way in which modern genetics developed and how it has influenced modern medicine, agriculture, and evolution to gain an understanding of how the scientific method is applied to biological problems.
5. Perform a quantitative analysis of test crosses to assess genetic linkage and mapping of multiple genes.
6. Predict the effects of various types of mutations on gene function to propose reasonable hypotheses to explain dominance and recessive phenotypes at the molecular level.

BIOL 206 Evolutionary Genetics Units: 3.00
An introduction to the genetic mechanisms of population differentiation and evolutionary change - from molecules to species. The genetical theory of evolution is also applied to problems involving conservation, biotechnology and the evolution of disease.
Learning Hours: 120 (36 Lecture, 18 Tutorial, 18 Online Activity, 48 Private Study)
Requirements: Prerequisite A minimum grade of C- in BIOL 205/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply evolutionary principles to help solve important problems of modern civilization.
2. Discuss variation in the distribution of species in space and time.
3. Predict the effects of the major mechanisms of microevolutionary change and their interactions.
4. Recognize common misunderstandings of evolutionary theory.

BIOL 212 Scientific Methods in Biology Units: 3.00
A hands on laboratory course that establishes the fundamentals of scientific investigation and applies them to selected biological questions. Students will learn to develop hypotheses, design and execute experiments, and to analyze and present results. There will be four modules structured as: Cell, Organism, Population, and Ecosystem.
NOTE Blended learning, online material and hands on activities in the lab.
NOTE QUBS Field Trip: Estimated cost $70.
Learning Hours: 119 (9 Lecture, 66 Laboratory, 12 Online Activity, 8 Off-Campus Activity, 24 Private Study)
Requirements: Prerequisite A GPA of 1.90 in (BIOL 102/3.0 and BIOL 103/3.0).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply the scientific method: develop specific hypotheses with testable predictions, determine appropriate treatments and controls that provide a fair test of the predictions, identify potential sources of methodological errors, design and execute an unbiased sampling protocol, test predictions by summarizing and visualizing data in a statistical context, evaluate the hypothesis based on your results, and identify the scope of inference.
2. Undertake writing all phases of a scientific article including an introduction that integrates primary literature with experimental questions, methods, results, and discussion.
3. Show proficiency in the following skills: proper lab notebook, proper pipetting technique and working with volumes, general numeracy skills, accurate use of a balance, aseptic technique, and cell culture.
4. Identify how biological systems respond to their environment at the hierarchical levels of cells, organisms, populations, and ecosystems.
5. Identify and distinguish the mechanisms that allow biological systems to respond over short versus long time periods (cellular, physiological, demographic, evolution, community composition).

BIOL 243 Introduction to Statistics Units: 3.00
An introduction to the analysis of data from real life situations. Covers study design, descriptive and inferential statistics. Topics include probability, t-tests, regression, Chi-square tests, analysis of variance. Emphasis is in the foundation of statistical inference and practical application of statistical methods using statistical software.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
Learning Hours: 120 (36 Lecture, 12 Tutorial, 72 Private Study)
Requirements: Prerequisite None. Exclusion CHEE 209/3.5; COMM 162/3.0; ECON 250/3.0; GPHY 247/3.0; HSCI 190/3.0; KNPE 251/3.0; NURS 323/3.0; POLS 285/3.0; POLS 385/3.0*; PSYC 202/3.0; SOCY 211/3.0; STAM 200/3.0; STAT 263/3.0. One-Way Exclusion May not be taken with or after STAT 269/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Identify the study design for a given question, and define the accompanying statistical population, sample, and observation unit.
2. Distinguish descriptive statistics from inferential statistics and define the role of each in quantitative analyses.
3. Compute descriptive statistics for a dataset using contemporary software and create the appropriate visualizations.
4. Identify and conduct the appropriate statistical test for a question and dataset using contemporary software.
5. Connect the results of statistical tests to the scientific question to draw appropriate conclusions.
6. Communicate the results of statistical analyses in written form.

BIOL 300 Ecology Units: 3.00
An exploration of the relationships between living things and their environment in an evolutionary framework. Topics include constraints, organismal ecology, population dynamics, interactions, community structure, energy and elemental flow through ecosystems, and global diversity patterns. We will collect, analyze, and interpret ecological data.
NOTE QUBS Field Trip: estimated cost $70.
Learning Hours: 118 (36 Lecture, 21 Laboratory, 12 Online Activity, 16 Off-Campus Activity, 33 Private Study)
Requirements: Prerequisite BIOL 103/3.0. Recommended BIOL 206/3.0, BIOL 212/3.0, and a second year statistics (e.g., BIOL 243/3.0, PSYC 202/3.0, STAT 269/3.0).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Analyze and interpret student collected data, which includes data management, visualization and statistical analysis.
2. Apply life-history, population, community and ecosystem concepts to generate hypotheses and understand patterns in ecological data collected by students.
3. Apply practical field and laboratory skills to collect data.
4. Explain the basic concepts underlying life history, population, community and ecosystem ecology, and provide a critique of their strengths, shortcomings and significance.
5. Identify and assess the linkages between evolution and ecology at all ecological scales.
6. Integrate across ecological scales to understand and assess current environmental issues.

BIOL 307 Field Biology I Units: 3.00
Two weeks of field work plus written assignments in one or two areas of study to be done when specialized modules are available in May, July, August or February. Studies may include ecology of birds, fish, insects, small mammals, plants, tundra and taiga, lakes and caves. The schedule of offerings for each year is available in January.
NOTE Field trip: estimated cost of each module and the schedule of offerings for each year is available in January.
Requirements: Prerequisite Registration in a BIOL Major, BIOL Science Minor/General, or a BIMA, BIPS, BTEC, or EBIO Specialization, and BIOL 102/3.0 and BIOL 103/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Build competency in sampling protocols and data analysis.
2. Gain a deep understanding of an ecological concept/ problem.
3. Investigate relationships based on field-collected data.
4. Resolve a problem/question by designing, conducting, and interpreting data from a field study.

BIOL 315 Plants and Human Culture Units: 3.00
Human civilization depends on plants. We have changed them and they have changed us. This course investigates the biology and evolution of valuable economic plants, the science of plant domestication and genetic manipulation, and how our interactions with plants have altered the economy, politics, and sociology of human civilization.
Learning Hours: 120 (36 Lecture, 24 Online Activity, 60 Private Study)
Requirements: Prerequisite BIOL 102/3.0 and BIOL 103/3.0. Corequisite (BIOL 200/3.0 or BIOL 201/3.0*).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Analyze how individual choices in the types of plant-based products individuals use scale up to global effects on human health and the environment.
2. Anticipate how altered use of plants by humans will impact the sustainability of human civilization.
3. Appreciate the biological diversity of plants that have provided food, clothing, fuel, building materials, and inspiration to human cultures.
4. Explain how modern experimental and genomic techniques have been used to understand the key evolutionary changes in economically important plants spurred by human cultivation.
5. Express an informed opinion informed by science concerning current controversies surrounding our use and genetic modification of utilitarian plants.
6. Identify the similarities and differences in how plant biology, changing environments and human culture resulted in the domestication of different globally important food plants.
7. Integrate and apply fundamental concepts and knowledge in genetics, evolution, physiology ecology acquired over core biology courses to the major questions concerning how humans and plants have influenced each other's ecology and evolution.
8. Review and synthesize information from the primary scientific literature to effectively present an important issue in plant-human interactions in a way that the general public can readily understand.

BIOL 316 Fisheries Biology Units: 3.00
An introduction to the basic principles of fisheries biology and examination of the biological foundations of current problems affecting the world's fisheries, with an emphasis on developing sound science-based strategies to resolve these problems.
Learning Hours: 120 (36 Lecture, 84 Private Study)
Requirements: Prerequisite BIOL 103/3.0. Corequisite (BIOL 200/3.0 or BIOL 202/3.0*). Equivalency BIOL 415/3.0*.
Course Equivalencies: BIOL316, BIOL415
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Develop an appreciation for fisheries as a renewable resource.
2. Develop an appreciation for the role of biology in conserving wild fish populations.
3. Evaluate different fisheries management models based on sustainable biological principles.
4. Interpret current global fisheries issues from a fundamental biological perspective.

BIOL 317 Field Biology II Units: 3.00
Two weeks of field work plus written assignments in one or two areas of study to be done when specialized modules are available in May, July, August or February. Studies may include ecology of birds, fish, insects, small mammals, plants, tundra and taiga, lakes and caves. The schedule of offerings for each year is available in January.
NOTE Field trip: estimated cost of each module and the schedule of offerings for each year is available in January.
Requirements: Prerequisite BIOL 307 and prior to registering in this course students must complete the application process, be placed in a module and complete the field work. Equivalency BIOL 407.
Course Equivalencies: BIOL317, BIOL407
Offering Faculty: Faculty of Arts and Science

BIOL 321 Animal Behaviour Units: 3.00
An evolutionary approach to the study of animal behaviour. This course explores processes and patterns in behaviour, with emphasis on perception, communication, foraging, spacing, reproduction and social behaviour in a variety of animals. Methods of studying and analyzing behaviour are explored through laboratory exercises.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
Learning Hours: 132 (36 Lecture, 12 Tutorial, 12 Individual Instruction, 12 Online Activity, 24 Off-Campus Activity, 36 Private Study)
Requirements: Prerequisite None. Corequisite 6.0 units from (BIOL 200/3.0; BIOL 201/3.0*; BIOL 202/3.0*; BIOL 205/3.0; BIOL 206/3.0). Recommended BIOL 200/3.0 or BIOL 202/3.0*.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply your knowledge of the relative importance of genetic, hormonal and neural causes of behavioural variation in invertebrates and vertebrates to describe, both orally and in writing, how the behaviour of animals might be altered by changes in selective conditions (e.g. environmental change).
2. Develop an experiment around a problem in animal behaviour using the scientific method, including: independent identification of a question, development of hypothesis with testable predictions; design and implementation of an experiment; data collection and appropriate statistical analyses; interpretation of statistical findings to draw appropriate inferences.
3. Develop hypotheses based on evolutionary theory to predict how the behaviour of animals might be altered by changes in selective conditions.
4. Discuss the findings of independent research in manuscript form, by integrating the experimental findings with relevant information from the primary literature to improve your writing and communication skills.

BIOL 322 Environmental Physiology of Animals Units: 3.00
A comparative examination of interaction between animals and their environment including: physiological adaptations to extreme environments (e.g., arctic, desert); responses to acute and chronic environmental stress (e.g., hypoxia, temperature); environmental regulation of normal physiological processes; uses of comparative models in other fields.
Learning Hours: 120 (36 Lecture, 24 Online Activity, 60 Private Study)
Requirements: Prerequisite BIOL 339/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Appreciate physiological mechanisms from both comparative and evolutionary perspectives.
2. Delineate the physiological mechanisms allowing animals to face extreme natural and anthropogenic challenges.
3. Integrate physiological responses at whole-organismic level as well as cellular and molecular level in coping with the comprehensive environmental variation such as temperature, osmolarity and oxygen in aquatic and terrestrial settings.
4. Identify the physiological challenges for animals living in different environments.

BIOL 323 Vertebrate Diversity and Evolution Units: 3.00
Vertebrate biodiversity including characteristics and adaptations of the major classes of the living vertebrates; major environmental and geological changes associated with vertebrate evolution.
Learning Hours: 120 (36 Lecture, 12 Laboratory, 72 Private Study)
Requirements: Prerequisite BIOL 206/3.0 and (BIOL 200/3.0 or BIOL 201/3.0* or BIOL 202/3.0*).
Offering Faculty: Faculty of Arts and Science

BIOL 327 Field Biology III Units: 3.00
Two weeks of field work plus written assignments in one or two areas of study to be done when specialized modules are available in May, July, August or February. Studies may include ecology of birds, fish, insects, small mammals, plants, tundra and taiga, lakes and caves. The schedule of offerings for each year is available in January.
NOTE Field trip: estimated cost of each module and the schedule of offerings for each year is available in January.
Requirements: Prerequisite BIOL 307/3.0 and BIOL 317/3.0 and prior to registering in this course, students must complete the application process, be placed in a module and complete the field work.
Offering Faculty: Faculty of Arts and Science

BIOL 330 Cell Biology Units: 3.00
An introduction to the cellular basis of biological variation. The course explores the control of cell function exerted by the nucleus, the pathways for building and fuelling cells, and the control of integrative cellular events.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
Learning Hours: 120 (36 Lecture, 12 Tutorial, 24 Online Activity, 48 Private Study)
Requirements: Prerequisite BIOL 205/3.0 or BCHM 218/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply bioinformatic skills using public gene databases to solve the structure of genes.
2. Assess the impact of genetic mutations on the ability of proteins to function normally.
3. Design experimental approaches to determine gene and protein function.
4. Differentiate nucleic acid and protein quantity and quality through the analysis of published results.
5. Explain how external signals impact gene expression and protein localization and function.
6. Invent a creative project to convey gene and protein function to a broad audience.

BIOL 331 Analytical Genomics Units: 3.00
This course will explore the structure of genomes and the nature and origin of gene families as well as large scale functional genomics methods for analysis of novel gene function.
Learning Hours: 124 (36 Lecture, 12 Tutorial, 40 Online Activity, 36 Private Study)
Requirements: Prerequisite BIOL 205/3.0 or BCHM 218/3.0. Exclusion BCHM 370/3.0 (formerly BMED 370/3.0*).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Competent to design experiments to test hypotheses derived from genomics resources.
2. Investigate strategies for linking genomic data to phenotype.
3. Proficient in computational methods for evaluating sequence based evolutionary relationships among organisms.
4. Search, extract, and evaluate all types of information from genomic databases.
5. Understand the nature of big data in a genomics context.
6. Understand the statistical basis of sequence comparison.

BIOL 333 Applied Biology Units: 3.00
The course explores biological contributions to society in the fields of environmental assessment and management, materials and food production, and biotechnology. Emphasis is placed on understanding of applied processes in relevant service and production industries.
Learning Hours: 108 (36 Lecture, 12 Tutorial, 60 Private Study)
Requirements: Prerequisite BIOL 205/3.0 and (BIOL 200/3.0 or BIOL 201/3.0*).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply conceptual understanding of the numerous areas of applied biology to the broader context of their inclusion in the manufacturing and service industries.
2. Apply your knowledge of the concepts and practice of applied biology in the context of agriculture, aquaculture, food processing, biofuels, biotechnology, phytoremediation, bioremediation, and forensics, to gain an understanding of how it relates to the sub-disciplines of basic biology.
3. Conduct self-driven, independent research on a problem in applied biology including implementation of procedures, product biosynthesis and data collection and their analyses to gain an understanding of the present state of knowledge, an awareness of relevant processes, an understanding of their limitations and a synthesis of how to overcome these limitations.
4. Describe applied biological questions, concepts and results individually or within small and large groups by written, oral and visual means to improve your writing, communication and teamwork skills.
5. Discuss, evaluate and reflect the general issues pertaining to the interface of applications of applied biology with relevant societal concerns including regulatory processes and laws pertaining to the use of applied biology.
6. Evaluate and critique applied biological concepts and processes through reviewing the primary scientific literature, assessing their credibility, interconnectedness, broad significance, and applied and conceptual limitations.

BIOL 334 Comparative Biochemistry Units: 3.00
A survey of selected topics including: general principles of enzymology; bioenergetics; metabolism and its control; the importance of proteomic and enzyme research in functional genomics and biotechnology; mechanisms whereby animals and plants acclimate at the biochemical level to environmental stress.
Learning Hours: 110.4 (36 Lecture, 24 Online Activity, 50.4P)
Requirements: Prerequisite (BIOL 103/3.0 and CHEM 112/6.0 and [BIOL 205/ or BCHM 218/3.0]).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Describe how evolution of key adaptations at the metabolic/biochemical level allows diverse organisms from the various kingdoms of life to inhabit a wide range of frequently "harsh" environments.
2. Identify fundamental similarities and distinctions between animal, plant, and microbial bioenergetics, and the organization and control of their major pathways of central metabolism.
3. Outline the pivotal importance of intracellular "second messengers" and protein kinase-mediated phosphorylation in extracellular signal transduction.
4. Provide a basic understanding of the overall design of cellular metabolism, bioenergetics, and metabolic control.
5. Survey the crucial role that metabolic and enzyme biochemistry is playing in biotechnology, particularly for the targeted modification of metabolic pathways in transgenic organisms via "rational metabolic engineering".
6. Understand how metabolic biochemistry and proteomics research is helping to "close the gap" in understanding the function of sequenced genes.

BIOL 335 Limnology and Aquatic Ecology Units: 3.00
Physics, chemistry and biology of freshwater lakes. Emphasis on: morphometry; light and temperature; water chemistry in relation to nutrients; physiological requirements; composition and interaction of algal and invertebrate populations; eutrophication; pollution; environmental change.
NOTE QUBS Field trip: estimated cost $70.
Learning Hours: 113 (36 Lecture, 18 Laboratory, 8 Off-Campus Activity, 51 Private Study)
Requirements: Prerequisite CHEM 112/6.0. Recommended BIOL 200/3.0 or BIOL 201/3.0* or BIOL 202/3.0*.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Analyze and interpret chemical and biological data collected using limnological techniques to improve skills drawing valid conclusions from complex data sets.
2. Apply limnological concepts and critical thinking to demonstrate an integrated understanding of the roles of physical, chemical and biological characteristics and processes in structuring aquatic communities (at all trophic levels from microbes to fish), in Arctic, temperate and tropical systems.
3. Appraise, logically predict, and clearly communicate the impact of a variety of human activities (e.g. watershed disturbances, mining, industrial activities) on ecosystems and environmental health, and formulate appropriate remediation techniques.
4. Conduct, analyze, and interpret the laboratory exercises to gain understanding of limnological concepts, and gain experience in the writing of clear, concise and integrated reports.
5. Explain and effectively communicate how basic principles and concepts associated with the physical, chemical, and biological -aspects of limnology can be applied to understand lake ecosystems.
6. Understand, recognize, and describe contributions from the disciplines of physics, chemistry, biology, geography, environmental studies and engineering to develop an overarching understanding of limnological systems.

BIOL 338 Marine Biology Units: 3.00
Introduction to life in the World's oceans and seas from a global, ecological, and evolutionary perspective. Study of marine habitats, food webs, biodiversity, ecological processes, functional biology, adaptations of marine organisms, and human impacts on marine life (fisheries and environmental impacts).
NOTE Only offered at the Bader College, UK. Learning hours include four days of fieldwork.
Learning Hours: 116 (18 Lecture, 24 Laboratory, 12 Tutorial, 12 Online Activity, 32 Off-Campus Activity, 18 Private Study)
Requirements: Prerequisite BIOL 103 (https://www.queensu.ca/academic-calendar/search/?P=BIOL%20103)/3.0 and registration at Bader College.
Exclusion ENSC 307 (https://www.queensu.ca/academic-calendar/search/?P=ENSC%20307)/3.0; GEOL 200 (https://www.queensu.ca/academic-calendar/search/?P=GEOL%20200)/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:
1. Identify and effectively communicate the fundamental principles of oceanography and marine biology including climate oscillation and ecological and evolutionary principles.
2. Recognize, measure, and analyze the chemical and physical properties of marine environments during lab and fieldwork. Be able to apply critical thinking to demonstrate how these chemical and physical factors have driven the evolution and life strategies of marine organisms.
3. Identify and describe diagnostic characters of organisms from the open sea, from plankton to nekton and other marine vertebrates. Be able to correlate form and function and effectively propose how morphological and ecological adaptations have resulted in species distributions in the water column.
4. Understand and clearly communicate processes that occur in the water column that drive productivity and food webs. Be able to appraise and critique the effects of pollutants and climate change on productivity, and logically predict future outcomes based on the integration of chemical, physical and biological data from diverse marine systems.
5. Distinguish organisms of the seabed, from the tidelands and shallow coastal seas to the deep sea and assess how they have specialized to live in such environments. Use statistical analyses to assess biodiversity, degrees of endemism and species richness in marine environments and what this tells us about anthropogenic effects and species gradients in relation to geographic location.
6. Appraise, logically predict, and clearly communicate the impact that humanity has had on the on the seas and oceans, looking at fisheries (past, present, and future) and the environmental impacts of industrial activities and human populations on a global scale. Critically assess proposed marine sanctuaries, catch limits, no take zones, fisheries policies, aquaculture, and new fishing innovations and how we can conserve and sustainably use the oceans, seas, and marine resources if the appropriate measures are put in place to protect ecosystems (UN SDG 14).

BIOL 339 Animal Physiology Units: 3.00
Focus is placed on adaptive physiology and integrative function (nervous and hormonal, movement, excretion, circulation and digestion) with examples selected from various phylogenetic levels as appropriate.
NOTE Also offered online, consult Arts and Science Online (Learning Hours may vary).
Learning Hours: 120 (36 Lecture, 18 Online Activity, 66 Private Study)
Requirements: Prerequisite BIOL 205/3.0 or BCHM 218/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply the concept of homeostasis to explain how specific physiological systems are regulated in different animal systems.
2. Describe how environmental conditions lead to physiological responses, comparing mechanisms that come into play in short term, long term, and how the responses change over evolutionary time.
3. Describe how evolution has influenced the diversity in physiological systems.
4. Explain how muscles, nerves, and cell signaling form the basis of physiological systems.
5. Explain how physiological systems operate, integrating between biological levels of organization: from molecules to cells, tissues, and organisms.
6. Identify similarities and differences in how diverse animals use physiology to solve similar problems.

BIOL 341 Plant Physiology Units: 3.00
The course examines various aspects of plant cell biology, physiology, and biochemistry including carbon and nitrogen metabolism (photosynthesis, respiration, etc.), water relations, mineral nutrition, response to environmental stress, roles of plant hormones, plant biotechnology.
Learning Hours: 115 (36 Lecture, 10 Group Learning, 15 Online Activity, 54 Private Study)
Requirements: Prerequisite BIOL 205/3.0 or BCHM 218/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. You will be using a group project, such as a plant magazine article, to discuss, evaluate, and critique the latest findings and ideas in plant biology by reading and synthesizing results from the primary scientific literature and like sources, and assessing their credibility and its broad significance to society.
2. You will be using plant biology case studies to research, analyze, and communicate biological questions, concepts and results to a variety of audiences using written and discussion forums.
3. You will be working in teams and will thus establish your ability to work individually and on a team to produce high-quality, synthetic and incisively written and social media projects, applying strategies for time management and collaboration.
4. You will integrate, explain, and apply foundational and advanced knowledge underlying metabolic and physiological processes unique to plants.
5. You will integrate, explain, and apply foundational and advanced knowledge underlying the interactions that occur between the environment and plant growth and development.
6. You will integrate, explain, and apply foundational and advanced knowledge underlying the relationship between structure and function as it relates to plant macromolecules, cells, and tissues.

BIOL 343 Data Analysis for Biologists Units: 3.00
Advanced topics in using R for data management, exploratory data analysis, data visualization, and statistical analysis using the general linear model, with particular focus on statistical literacy and biological examples from both laboratory and field research.
Learning Hours: 120 (36 Lecture, 12 Tutorial, 12 Online Activity, 60 Private Study)
Requirements: Prerequisite (3.0 units from BIOL 243/3.0; CHEE 209/3.0; COMM 162/3.0; ECON 250/3.0; GPHY 247/3.0; KNPE 251/3.0; NURS 323/3.0; PSYC 202/3.0; POLS 285/3.0; SOCY 211/3.0; STAM 200/3.0; STAT 263/3.0) or STAT 269/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

BIOL 350 Evolution and Human Affairs Units: 3.00
An exploration of how evolutionary thinking can affect our understanding of our lives, our species, and our ability to share the planet with other species.
NOTE Also offered online. Consult Arts and Science Online. Learning Hours may vary.
Learning Hours: 120 (36 Lecture, 24 Online Activity, 60 Private Study)
Requirements: Prerequisite Level 3 or above.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Describe how and why the effects of Darwinian evolution have brought us to this critical stage in the history of humanity.
2. Evaluate why philosopher, Blaise Pascal considered that, "All of humanity's problems stem from man's inability to sit quietly in a room alone"- (Penses, 1670) and why poet, T.S. Eliot mused, "humankind cannot bear very much reality"- (No. 1 of Four Quartets, 1943).
3. Explain how an understanding of this "human journey" helps to account for a wide range of contemporary human affairs and cultural norms.
4. Identify and define the urgent challenges facing human civilization today, and why many authorities warn that "business as usual" cannot be sustained.
5. Participate in prescribing a way forward for the design of a new, more sustainable, and more humanistic model of civilization for our descendants.
6. Predict how the genetic legacies inherited from our ancestors, and how our continuing evolution as a species (informed by both natural selection and cultural selection) are likely to affect our human natures, our social lives, and our cultures in future generations.

BIOL 360 Biotechnology and Society Units: 3.00
The contributions and effects of biotechnology on humanity will be explored from the perspective of their impacts on society including moral and ethical issues. Biotechnological contributions to society to be explored will include those in medicine, industry, and agriculture.
Learning Hours: 120 (36 Lecture, 12 Tutorial, 72 Private Study)
Requirements: Prerequisite BIOL 205/3.0 or BCHM 218/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Explain and interpret government regulations and laws that determine the safety of biotechnological products.
2. Explain and interpret the benefits and drawbacks of using biotechnology in the fields of agriculture, food processing, medicine, and forensics.
3. Explain and interpret the moral and ethical issues that are associated with the use of biotechnology.

BIOL 369 Sex and Evolution Units: 3.00
Why sex? The evolutionary origins and consequences of sex and sexual reproduction. Topics include costs and benefits of sexual reproduction, the evolution and coevolution of sexes, gametes and genitalia, mating systems, gender differences and sex determination throughout the biotic world.
Learning Hours: 122 (36 Lecture, 8 Tutorial, 18 Online Activity, 60 Private Study)
Requirements: Prerequisite (BIOL 102/3.0 and BIOL 103/3.0 and 3.0 units from [BCHM 218/3.0; BIOL 200/3.0; BIOL 201/3.0*; BIOL 202/3.0*; BIOL 205/3.0, or BIOL 206/3.0]). Recommended BIOL 206/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply theories seeking to explain the evolution of complex secondary sexual characters and mating behaviours to examples from nature.
2. Compare and evaluate the nature and quality of media coverage of recent scientific discoveries related to the evolution of sex and resultant processes such as disease / parasitism, competition for mates, and coevolution.
3. Contrast competing theories for the evolutionary advantages conferred by sexual reproduction and the origins of distinct mating types.
4. Explain the consequences of sharing a gene pool with other organisms (the benefits and costs) at the level of the individual, the population and the species.
5. Interpret, explain, and contextualize recent research findings published in the primary scientific literature in accessible written assignments.
6. Recognize the paradoxical origins of sexual reproduction and its central role in the evolution of multi-celled life on earth.

BIOL 401 Experimental Approaches to Animal Physiology Units: 3.00
Laboratory-based course emphasizing experimental approaches to understanding the principles of animal physiology covered in BIOL 339.
Learning Hours: 108 (36 Laboratory, 12 Tutorial, 60 Private Study)
Requirements: Prerequisite BIOL 339/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Develop an understanding of how experiments are designed, and the importance of controls and analyses.
2. Gain an improved understanding of the function of animal physiological systems through experimental approaches and hands-on learning.
3. Gain expertise using diverse tools and equipment used in laboratory-based physiological studies.
4. Learn how to prepare reports with specific requirements, integrating what is known from previous studies with novel data collected in lab.

BIOL 402 Experiments in Plant Physiology Units: 3.00
Laboratory-based course emphasizing experimental approaches to understanding the principles of plant physiology covered in BIOL 341.
Learning Hours: 114 (36 Laboratory, 24 Tutorial, 6 Online Activity, 48 Private Study)
Requirements: Prerequisite A minimum GPA of 2.0 in the Biological Foundations List. Corequisite BIOL 341/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. As part of a team, you will communicate biological questions, concepts, and results to a variety of audiences in written and oral formats.
2. The core plant biology labs as designed will allow you to develop, apply, and master the skills for scientific investigation, from hypothesis development and testing to proper experimental design to statistical analysis.
3. The plant biology labs will allow you to establish, apply and master a number of technical skills and experimental strategies applicable to a broad range of scientific endeavours in the field of plant biology, and this includes troubleshooting.
4. The plant biology labs will allow you to hone your ability to work individually and, on a team, to produce high-quality, synthetic and incisively written and oral projects, applying strategies for time management and collaboration.
5. You will advance and integrate your knowledge of plant biology and its principles with core experimental techniques to analyze real-world problems and phenomena associated with plants.
6. You will as part of a team conduct self-driven, independent research on a problem in plant biology that involves the analysis of existing research on the topic and undertaking new research on new or related aspects. This independent research project encompasses all stages of scientific investigation including: the development of research questions and formulation of appropriate hypotheses; development of experimental design; data collection, data management and application of appropriate statistics; critical interpretation of empirical evidence to test hypotheses; synthetic integration with core concepts; communication of findings in oral and written formats, such as a grant proposal, a journal report, and seminar.

BIOL 403 Experimental Techniques in Biology Units: 3.00
Self-directed and self-selected hands-on experimental techniques used in fundamental biology research, biotechnologies, and medical sciences.
Learning Hours: 120 (36 Laboratory, 12 Tutorial, 72 Off-Campus Activity)
Requirements: Prerequisite BIOL 205/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Generate and analyze experimental data.
2. Modify experimental protocols to use appropriately the scientific tools available.
3. Operate and understand the inner working of scientific devices used in biology, chemistry, biotechnology and medicine.
4. Produce experimental protocol from published techniques.
5. Select and design experimental strategies to detect and quantify a molecule of interest.
6. Verbally synthesize experimental protocol and results.

BIOL 404 Techniques in Molecular Biology Units: 3.00
Intensive laboratory work (8h/day) to be carried out over two and a half weeks in May. Practical work includes DNA isolations, DNA cloning, PCR, production of proteins, biochemical and immunological analysis of proteins.
Learning Hours: 112.5 (100 Laboratory, 12.5P)
Requirements: Prerequisite ([BCHM 218/3.0 or BIOL 330/3.0] and a minimum GPA of 2.0 in the Biological Foundations List).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Combine experimental techniques to complete a scientific inquiry.
2. Defend and criticize experimental results.
3. Generate and analyze experimental data.
4. Modify experimental protocols to use appropriately the scientific tools available.
5. Operate and understand the inner working of scientific devices used in biology, chemistry, biotechnology, and medicine.
6. Produce experimental protocol from published techniques.

BIOL 409 Bioremediation Units: 3.00
Throughout Canada and around the world, land and water is contaminated by anthropogenic activities related to mining, manufacturing, agriculture, urbanization and other human activities. We explore opportunities to clean up this contamination using biological systems including plants, fungi and bacteria.
Learning Hours: 109 (36 Lecture, 12 Tutorial, 6 Off-Campus Activity, 55 Private Study)
Requirements: Prerequisite BIOL 330/3.0 and a minimum GPA of 2.0 in the Biological Foundations List. Recommended BIOL 322/3.0 or BIOL 339/3.0 or BIOL 341/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Work effectively and fairly in a collaborative team environment.
2. Discuss, evaluate, and critique biological findings and ideas by reading and synthesizing results from the primary scientific literature.
3. Prepare high-quality, synthetic and incisively written and oral projects.
4. Critically evaluate written and oral presentations by your peers.

BIOL 410 Ecology of Lakes and Streams Units: 3.00
An in-depth look at the ecology and evolution of freshwater aquatic ecosystems, considering the role of populations, interspecific interactions, and the flow of energy and matter. There will be an emphasis on linking ecological theory with empirical evidence from aquatic systems. Topics will include dispersal and colonization, ecological genetics, resource competition, predator-prey interaction, evolution of life-history strategies, habitat coupling, and biogeochemical cycling.
Learning Hours: 120 (24 Lecture, 12 Seminar, 84 Private Study)
Requirements: Prerequisite BIOL 300/3.0 and a minimum GPA of 2.0 in the Biological Foundations List. Recommended BIOL 335/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Communicate the results of the literature synthesis in written format.
2. Critically evaluate and synthesize the scientific literature about the ecology of lakes and streams to reveal strengths and weakness of published studies.
3. Describe the major anthropogenic impacts on aquatic ecosystems.
4. Describe the role of nutrient cycling and stoichiometry across diverse aquatic systems.
5. Describe the major forms of adaptation in aquatic systems including phenotypic plasticity and evolution.
6. Identify the biological linkages such as material and energy flow within aquatic systems as well as linkages between aquatic and terrestrial systems.

BIOL 411 Global Change Biology Units: 3.00
This course focuses on the fundamental biology underlying the major global change issues that humanity currently faces. Strong emphasis will be placed on the critical interconnections among issues across hierarchical levels from molecule to biosphere that explain the patterns and mechanisms which have led to our current environmental predicament.
Learning Hours: 117 (24 Lecture, 18 Tutorial, 12 Group Learning, 24 Online Activity, 3 Off-Campus Activity, 36 Private Study)
Requirements: Prerequisite BIOL 300/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Describe the patterns and causes of previous civilisations' rises and falls to appraise our current global environmental predicament within an historical context.
2. Explain and contrast the major global environmental issues that our civilisation faces.
3. Identify and analyze the fundamental biological root causes of our civilisation's current environmental predicament, and use that assessment to develop lasting personal solutions for coping with, and constructively responding to, the major global change issues of the 21st century.
4. Identify and organize the principal interactions among the major global change issues that ramify their impacts by developing and applying an over-arching conceptual framework.
5. Summarize the impacts of western "progress" based, individualist, and capitalist ideologies on humanity's relationship with the rest of the nature, and contrast those with the more holistic ideologies of Indigenous and eastern cultures.
6. Use concepts such as Progress trap, Global Planetary Boundaries, the Anthropocene, Deep Ecology, Socio-Ecological Stewardship, and Complex Adaptive Systems to discuss, evaluate, and critique potential solutions for addressing individual global change issues.

BIOL 416 Terrestrial Ecosystems Units: 3.00
Principles of terrestrial ecosystem ecology: soils; plant-soil interactions; energy and water balance; carbon and nutrient cycling; species effects; landscape-level and whole earth biogeochemistry; global change.
NOTE Field Trip: estimated cost $130.
Learning Hours: 124 (12 Lecture, 24 Seminar, 18 Laboratory, 12 Practicum, 12 Group Learning, 12 Online Activity, 16 Off-Campus Activity, 18 Private Study)
Requirements: Prerequisite ([BIOL 300/3.0 or GPHY 317/3.0] and a minimum GPA of 2.0 in the Biological Foundations List). One-Way Exclusion May not be taken with or after BIOL 510/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Describe and contrast the major processes and features that distinguish local terrestrial ecosystems, including farm-types.
2. Develop, conduct, analyze, and write a lab/field research study on a student-inspired question in agroecosystem ecology.
3. Explain and evaluate the major concepts underlying terrestrial ecosystem ecology.
4. Present a synthetic, logical, and individualistic seminar on a fundamental issue in agroecosystem ecology.
5. Synthesize, evaluate, and critique the potential solutions to meeting future global food demand.

BIOL 418 Fisheries Techniques Units: 3.00
This course will introduce students to many "hands-on" techniques currently used in fisheries. This will include fish identification, different capture techniques for fisheries assessment, bioacoustics, environmental monitoring, techniques for ageing fish, diet analysis, fish tracking (biotelemetry approaches), and data management.
Learning Hours: 120 (30 Laboratory, 10 Tutorial, 40 Group Learning, 40 Private Study)
Requirements: Prerequisite BIOL 316/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Assess the status of fish populations based on information commonly collected by fisheries biologists (e.g. fork length, round weight, condition factor, stomach contents, age based on hard structures) so that we can determine the health of populations and take action to conserve them, or manage them more effectively if needed.
2. Demonstrate practical skills involved in working with fisheries data including data entry, organization and analysis to understand the health of individuals and the population, to understand demographics (e.g. age of population), their required habitat, and other biologically relevant factors so we can conserve or manage fisheries more effectively.
3. Demonstrate practical skills required to use different fish capture equipment including gill nets, trap nets, minnow traps and seine nets and apply these to sample fish communities.
4. Describe the basic principles of modern technology used in fisheries such as hydroacoustics and biotelemetry, the benefits and limitations of these approaches and demonstrate basic skills required to use this technology to sample fisheries.
5. Describe the most common fish species in Ontario and their basic life history in order to identify them and understand how different factors might influence their populations, so they can be properly managed and conserved.
6. Design sampling programs based on varying assessment techniques appropriate for different fisheries to be able to effectively monitor population levels.

BIOL 422 Conservation Biology Units: 3.00
The application of biological research to the conservation of biodiversity and natural resources, as well as the interaction of biology with philosophy, politics and economics in influencing conservation policy.
Learning Hours: 108 (36 Lecture, 36 Tutorial, 36 Private Study)
Requirements: Prerequisite BIOL 300/3.0 and a minimum GPA of 2.0 in the Biological Foundations List. Exclusion ENSC 320/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Communicate conservation challenges and solutions from the viewpoints of different stakeholders in written and oral forms.
2. Critically explain and evaluate threats to biodiversity and alternative conservation solutions, ranging from solutions to specific conservation challenges to broader goals of global sustainability.
3. Discuss, evaluate, and reflect on the importance of biodiversity generally, and to humans specifically.
4. Hone the ability to work individually and in a team to produce high-quality and synthetic projects presented in written and oral form, applying strategies for time management and collaboration.

BIOL 430 Molecular Genetics of Development Units: 3.00
The use of genetic analysis to understand developmental processes such as cell fate determination, pattern formation and morphogenesis. Emphasis will be on the molecular pathways used during embryonic development, highlighting applications and techniques using model organisms.
Learning Hours: 126 (36 Lecture, 18 Seminar, 24 Group Learning, 12 Individual Instruction, 12 Online Activity, 24 Private Study)
Requirements: Prerequisite ([BCHM 218/3.0 or BIOL 330/3.0] and a minimum GPA of 2.0 in the Biological Foundations List).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Compare and differentiate the major model organisms used to understand development at the genetic and molecular level.
2. Develop hypothesis-driven experiments to explain cellular behaviour to gain practical skills and methodologies used to understand how organisms develop.
3. Discuss the history of the study of embryonic development and how the basic concepts were formulated to develop a conceptual framework for the study of developmental biology.
4. Discuss, evaluate, and critique biological findings and ideas by reading and synthesizing results from the primary scientific literature, assessing their credibility, broad significance, and the limits to inference to gain experience in the writing of clear, concise and integrated reports.
5. Prepare high-quality, synthetic, and incisively written and oral projects, applying strategies for time management and collaboration to develop your ability to work individually and on a team.
6. Summarize biological questions, concepts, and results to a variety of audiences in written, oral and visual forms to improve your writing and communication skills.

BIOL 431 Cellular Basis of Adaptation Units: 3.00
The cellular origins of diversity in physiological processes, with consideration of the role of evolutionary, developmental and molecular mechanisms.
Learning Hours: 108 (6 Lecture, 30 Seminar, 8 Tutorial, 4 Group Learning, 60 Private Study)
Requirements: Prerequisite ([BCHM 218/3.0 or BIOL 330/3.0] and [BIOL 334/3.0 or BIOL 339/3.0 or BIOL 341/3.0] and a minimum GPA of 2.0 in the Biological Foundation List).
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Communicate the findings from integrating previous courses, literature synthesis and group discussions in a seminar format. Evaluate the effectiveness of seminars by colleagues.
2. Connect the effects of abiotic or biotic stress from genetics and cellular to the physiological and ecological processes of organisms.
3. Describe the cellular basis of adaption that organisms use in response to biotic and abiotic stress.
4. Integrate single-stressors process within groups to describe the range of adaptations for suite of stressors.
5. Prepare a communication strategy to transition scientific insight about adaptation to stressors to a general public audience.
6. Synthesize the literature on the effects of a single stressor and critically evaluate the limits of scientific understanding.

BIOL 432 Computation and Big Data in Biology Units: 3.00
Application of basic coding and analytical methods to obtain, organize, analyze, visualize, and interpret information from large, complex datasets (i.e. 'Big Data') in biology. Datasets may include climate/weather records, 'omics' data, specimen collections, long-term observational studies, journal articles, and other historical and online sources.
Learning Hours: 120 (36 Lecture, 12 Tutorial, 72 Private Study)
Requirements: Prerequisite BIOL 343/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Analyze data commonly used in genomics (e.g. FASTA, FASTQ, SAM, BED, BAM) to answer biological questions.
2. Apply regular expressions to manipulate biological data.
3. Create publication-ready visualizations of biological data.
4. Design and implement a strategy for project management in biological research, based on the philosophy that scientific research should be OPEN and REPRODUCIBLE.
5. Write custom scripts to curate, merge, subset, reformat, and parse large biological datasets.
6. Write programs for 'big data' in biology, using high-performance computing infrastructure maintained by Queen's Centre for Advanced Computing.

BIOL 433 History and Philosophy of Biology Units: 3.00
An examination of the foundations of evolution, classification and other selected topics from historical, philosophical and scientific perspectives.
Learning Hours: 120 (36 Lecture, 24 Tutorial, 60 Private Study)
Requirements: Prerequisite BIOL 300/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Analyze and report on an important controversy in the history of biology.
2. Discuss and debate philosophical issues related to evolutionary biology.
3. Identify some of the major discoveries in the history of biology.
4. Investigate, discuss, and assess the contributions of biology to general philosophical issues.
5. Read, analyze, and summarize one important book in the history of biology.

BIOL 439 Natural Selection and Microevolution Units: 3.00
The mechanisms of evolutionary change - from genes to societies. How natural selection interacts with genetic and population processes to make organisms adapted to their environment and to create biological diversity.
Learning Hours: 120 (36 Lecture, 6 Seminar, 18 Laboratory, 60 Private Study)
Requirements: Prerequisite BIOL 206/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Outline the historical development of the modern synthesis of evolution by natural selection.
2. Explain how evolution generates biological diversity.
3. Investigate genetic models simulating how gene frequencies change in populations over time.
4. Produce professional oral and written critiques of current evolutionary research literature.
5. Assess and discuss the impact of genomics technology on traditional population genetics.

BIOL 440 Speciation and Macroevolution Units: 3.00
An exploration of higher-level processes in evolution spanning considerations of mechanisms of speciation, extinction, adaptive radiation, and phylogenetics.
Learning Hours: 120 (24 Lecture, 24 Tutorial, 60 Group Learning, 12 Online Activity)
Requirements: Prerequisite BIOL 206/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Define micro- and macroevolution, and articulate alternative views on the importance of distinguishing between them.
2. Discuss mechanisms of diversification and genetic mechanisms that contribute to origination of species.
3. Analyze DNA sequence data to produce phylogenetic hypotheses of evolutionary relationships, and use these to understand broad-scale patterns in speciation and macroevolution.
4. Describe major events in the history of life on Earth including organismal diversification in the Ediacaran Period, the Cambrian Explosion, and mass extinction events, particularly at the ends of the Permian and Cretaceous.
5. Express the importance of different approaches to understanding origins and patterns of diversity including palaeontology, biogeography, genomics, and evolutionary developmental biology.
6. Critique articles from the primary evolutionary literature, distil their most salient conclusions, and situate these findings in the broader context of evolutionary biology.

BIOL 441 Molecular Genetics Units: 3.00
Research in eukaryotic molecular genetics with an emphasis on epigenetics. Epigenetic phenomena will be examined in a range of models from single-celled organisms to metazoans, with student discussions on topics as diverse as bioethics, disease controls, and eugenics.
Learning Hours: 125 (30 Lecture, 8 Seminar, 12 Laboratory, 10 Group Learning, 65 Private Study)
Requirements: Prerequisite ([BCHM 218/3.0 or BIOL 330/3.0] and a minimum GPA of 2.0 in the Biological Foundations List). Exclusion PATH 425/3.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Attain a competent appreciation of current techniques in molecular biology as applied to a chosen problem in epigenetics.
2. Critically evaluate selected scientific literature and be able to lead discussions on this literature, both in writing and verbally.
3. Devise a novel approach to further our understanding of a selected epigenetic phenomenon.
4. Integrate epigenetic discoveries and biotechnology with the ethical concerns of our times.
5. Integrate epigenetic mechanisms in an understanding of genetic regulation in diverse organisms.

BIOL 442 Evolutionary Medicine Units: 3.00
An exploration of human disease, illness, and injury, and the symptoms and treatments of medical conditions, with an evolutionary framework.
Learning Hours: 120 (24 Lecture, 20 Tutorial, 10 Online Activity, 66 Private Study)
Requirements: Prerequisite BIOL 206/3.0 and a minimum GPA of 2.0 in the Biological Foundations List.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Critically evaluate evidence available in the primary research literature to assess several evolutionary hypotheses to explain medical conditions, pathogen traits, and clinical outcomes.
2. Develop an appreciation for the benefits and impacts of the application of an evolutionary framework to considerations of human medical conditions.
3. Develop the ability to effectively synthesize and clearly communicate findings from their reviews and critical evaluation of scientific literature relevant to a topic of their choice in the field of evolutionary medicine.
4. Devise alternative hypotheses and predictions to address questions of relevance to evolutionary medicine, and analyze data and critically evaluate evidence to test among those hypotheses.

BIOL 501 Recent Research in Molecular Units: 3.00
This course will focus on how molecular biology is used in basic and medical research to dissect the mechanisms involved in a large variety of biological problems. Students in the course will explore molecular literature and techniques that are relevant to their interest through seminar presentations, writing critiques, scientific reviews.
Learning Hours: 120 (36 Seminar, 84 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List) or permission of the Department. Recommended BIOL 430/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 502 Plant Cell Responses to Environmental Stress Units: 3.00
This course will dissect signal transduction pathways and molecular responses in plants exposed to environmental stresses such as pathogen infection, drought, or temperature fluctuations. Emphasis is on understanding techniques used to investigate changes in gene expression, protein-protein interactions, sub-cellular localization, as well as the analysis of mutant and transgenic plant lines.
Learning Hours: 120 (36 Seminar, 84 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List and [BIOL 330/3.0 or BIOL 334/3.0 or BIOL 341/3.0 or BIOL 430/3.0]) or permission of the Department.
Offering Faculty: Faculty of Arts and Science

BIOL 503 Plant Biotechnology Units: 3.00
This is an experiential course on the business of science and the steps leading to the commercialization of an agrobiotech product. Students will go through a series of workshops to develop their own ideas into a commercially valuable product, plus an assessment of all related social and economic issues using business-oriented exercises.
Learning Hours: 120 (15 Lecture, 9 Seminar, 24 Group Learning, 72 Private Study)
Requirements: Prerequisite {Level 4 or above and registration in a Biology Honours Plan (BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH) and a minimum GPA of 2.0 in the Biological Foundations List and ([BIOL 205/3.0 or BCHM 218/3.0] and BIOL 341/3.0])} or permission of the Department.
Offering Faculty: Faculty of Arts and Science

BIOL 504 Extremophiles Units: 3.00
The course explores biology of extraordinary organisms that flourish under conditions of stress and how more ordinary organisms deal with periodically unfavourable circumstances. Emphasis is placed on understanding of the relevant adaptations and processes involved.
NOTE No textbook is required. The course website will be used to provide lecture notes and assigned readings from scientific books, journals and selected websites.
Learning Hours: 116 (30 Lecture, 2 Seminar, 12 Group Learning, 12 Online Activity, 60 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA- P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List and [BIOL 339/3.0 or BIOL 341/3.0]) or permission of Department. Exclusion BIOL 533/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 505 Cell Signaling in Development and Disease Units: 3.00
Organisms arise from a single cell into functional tissues, patterns, and structures by orchestrating cell behaviors, such as cell divisions, cell differentiation, pattern formations, cell shape changes and cell movements. This course will focus on the genetic and molecular analyses of how these cell behaviors occur.
NOTE No textbook is required. The course website will be used to provide lecture notes and assigned readings from scientific books, journals and selected websites.
Learning Hours: 120 (24 Lecture, 12 Seminar, 12 Individual Instruction, 24 Online Activity, 48 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List and BIOL 330/3.0) or permission of Department. Exclusion BIOL 535/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 506 Biochemical Adaptations to Life Under Extreme Conditions Units: 3.00
Biochemical adaptation is a fundamental aspect of biological diversity because it integrates molecular structure, with metabolic function and control. The course evaluates the mechanisms whereby animals, plants, and microbes acclimate at the biochemical level to 'extreme' environmental conditions such as temperature stress, high pressure, hypoxia, salt stress, oxidative stress, and desiccation.
Learning Hours: 120 (36 Seminar, 84 Private Study)
Requirements: Prerequisite {Level 4 or above and registration in a Biology Honours Plan (BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH) and a minimum GPA of 2.0 in the Biological Foundations List and (BIOL 334/3.0 or [BCHM 315/3.0 and BCHM 316/3.0] or BCHM 310/9.0)} or permission of the Department. Recommended BIOL 322/3.0 and BIOL 341/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 507 Biotechnology Units: 3.00
This course covers the ethical, societal and environmental impacts of biotechnology. There will be critical analysis of public policy and the value of biotechnologies to science and the public. Topics will likely include synthetic biology, human cloning, xenotransplants, stem cells, nanomaterials, marine biotechnology, eugenics, patenting, GMOs and the release of biotech products to the environment.
Learning Hours: 120 (36 Seminar, 84 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List) or permission of the Department. One-Way Exclusion May not be taken with or after BIOL 441/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 508 Biology of the Cell Cycle Units: 3.00
Cell proliferation underlies development and tissue renewal and is implicated in many diseases. Our universal model of eukaryotic cell cycle control is based on studies in a number of model systems. The course will focus on control mechanisms, deriving information from systems as diverse as yeast and human cells.
Learning Hours: 120 (36 Seminar, 84 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List and [BCHM 218/3.0 or BIOL 330/3.0]) or permission of the Department.
Offering Faculty: Faculty of Arts and Science

BIOL 509 Limnological Environmental Studies Units: 3.00
This course will explore ecological and evolutionary aspects of species invasions, with an emphasis on aquatic invaders. Course discussions will include such topics as invasive species and factors that influence their arrival, establishment, and spread, as well as management strategies that can be employed to reduce the arrival, establishment, and spread of invasive species.
Learning Hours: 120 (9 Lecture, 9 Seminar, 18 Group Learning, 84 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List) or permission of the Department. Recommended BIOL 335/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 510 The Biology of Sustainability Units: 3.00
This ecology course will identify and critique potential mechanisms by which our civilization could most effectively move toward more sustainable living. The topic incorporates many fundamental aspects of biology, and each course iteration may include biogeochemical, ecological, economic, social, genetic, philosophical, and behavioural components.
Learning Hours: 120 (36 Seminar, 12 Tutorial, 12 Group Learning, 36 Individual Instruction, 12 Online Activity, 12 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List) or permission of the Department. Recommended BIOL 300/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 527 Paleolimnology and Global Environmental Change Units: 3.00
This course is mainly to provide students with a background in studies of long-term environmental change, with a focus on research that is especially relevant to today's environmental problems. Key topics include: climatic change, lake pollution, atmospheric deposition of contaminants and related topics.
Learning Hours: 132 (21 Lecture, 15 Seminar, 96 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List) or permission of the Department. Recommended BIOL 335/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 530 Origins of Biodiversity Units: 3.00
This course uses the latitudinal increase in diversity towards the equator as a launching point to explore how diversity forms, is maintained, and disappears, and why we find such dramatic variation in diversity around the world. Discussions will focus on both evolutionary and ecological perspectives of diversity, and we will review various hypotheses to explain latitudinal diversity gradients.
Learning Hours: 120 (9 Lecture, 9 Seminar, 18 Group Learning, 84 Private Study)
Requirements: Prerequisite (Level 4 or above and registration in a Biology Honours Plan [BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH] and a minimum GPA of 2.0 in the Biological Foundations List) or permission of the Department.
Offering Faculty: Faculty of Arts and Science

BIOL 531 Darwinism and Cultural Evolution Units: 3.00
Through seminars, essays, and group discussions, students explore ideas, research objectives, and recent discoveries in the application of Darwinian evolutionary theory to the interpretation of human nature, social life, and culture - and how these advances impact on our understanding of civilization and the challenges it faces for the 21st century.
Learning Hours: 120 (9 Lecture, 9 Seminar, 18 Group Learning, 84 Private Study)
Requirements: Prerequisite BIOL 350/3.0.
Offering Faculty: Faculty of Arts and Science

BIOL 535 Selected Topics in Biology Units: 3.00
Topics vary from year to year. Please consult the Department of Biology website for more information.
NOTE This course is repeatable for credit under different topic titles.
Learning Hours: 120 (9 Lecture, 9 Seminar, 18 Group Learning, 84 Private Study)
Requirements: Prerequisite Level 4 or above and registration in a Biology Honours Plan (BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, BTEC-P-BSH, EBIO-P-BSH) and a minimum GPA of 2.0 in the Biological Foundations List and permission of the Department.
Offering Faculty: Faculty of Arts and Science

BIOL 537 Research in Biology Units: 12.00
Individual research projects under the supervision of a staff member; reported in the form of a thesis, poster, and seminar.
NOTE In the spring preceding fourth year, students must select projects in consultation with potential supervisors. Registration is subject to availability of a supervisor. Work on the project during summer is advantageous if field studies are required. See also the statement on BIOL 501/3.0-BIOL 536/3.0 in the BIOL Department Information, preliminary information section.
Learning Hours: 444 (8 Lecture, 36 Seminar, 300 Practicum, 100 Online Activity)
Requirements: Prerequisite Admission to the final year of a BSCH program in Biology and a minimum GPA of 2.0 in the Biological Foundations List and permission of the project supervisor and course coordinator. Exclusion BIOL 541/12.0*.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Apply fundamental scientific principles and critical thinking skills to independently develop and conduct a novel and discrete biological research study.
2. Demonstrate key professional skills, such as advanced laboratory and/or field biological techniques, effective proposal and manuscript writing, oral communication, critical evaluation of the literature, lab team-work, and problem-solving.
3. Verbally synthesize the study and defend the main research findings and their interpretation at a standard appropriate for a professional scientific conference.
4. Analyze and interpret the study results, and present them and an evaluation of their significance in writing at a standard appropriate for a peer-reviewed science journal.
5. Constructively critique the strengths and weaknesses of other students' studies to refine and improve their scientific value.

BIOL 538 Research Mentorship in Biology I Units: 3.00
Research practicum under the supervision of a Biology faculty member. The course will involve a combination of research in the host laboratory, attendance of BIOL 537 or other seminars in the Department, and literature research to present as a major paper and seminar.
NOTE Students will normally be enrolled in the fourth year of their Program, having completed the third year core requirements of their Plan.
Learning Hours: 128 (8 Seminar, 12 Tutorial, 60 Practicum, 48 Private Study)
Requirements: Prerequisite Registration in a Biology Honours Plan (BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, EBIO-P-BSH) and a minimum GPA of 2.0 in the Biological Foundations List and permission of the Department. One-Way Exclusion Not to be taken concurrently with BIOL 537/12.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Demonstrate the ability to use advanced lab and field biological techniques to conduct novel scientific research on a problem or question relevant to a particular faculty's lab group program.
2. Describe and evaluate the background information and contemporary arguments from the literature associated with that problem or question, so as to explain the rationale for its investigation.
3. Present the results of their experiments in a seminar format, discuss the implications of the findings, and orally defend the conclusions.
4. Present the research findings in the form of a manuscript or essay that is accessible to a broad audience ranging from experts to the general public.
5. Demonstrate key professional skills, such as laboratory techniques, effective writing, oral communication, critical evaluation of the literature, lab team-work, and problem-solving.
6. Constructively critique the strengths and weaknesses of other students' studies to refine and improve their scientific value.

BIOL 539 Research Mentorship in Biology II Units: 3.00
Research practicum under the supervision of a Biology faculty member. The course will involve a combination of research in the host laboratory, attendance of BIOL 537 or other seminars in the Department, and literature research to present as a major paper and seminar.
NOTE Students will normally be enrolled in the fourth year of their Program, having completed the third year core requirements of their Plan.
Learning Hours: 128 (8 Seminar, 12 Tutorial, 60 Practicum, 48 Private Study)
Requirements: Prerequisite Registration in a Biology Honours Plan (BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, EBIO-P-BSH) and a minimum GPA of 2.0 in the Biological Foundations List and permission of the Department. Corequisite BIOL 538/3.0. One-Way Exclusion Not to be taken concurrently with BIOL 537/12.0.
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Demonstrate the ability to use advanced lab and field biological techniques to conduct novel scientific research on a problem or question relevant to a particular faculty's lab group program.
2. Describe and evaluate the background information and contemporary arguments from the literature associated with that problem or question, so as to explain the rationale for its investigation.
3. Present the results of their experiments in a seminar format, discuss the implications of the findings, and orally defend the conclusions.
4. Present the research findings in the form of a manuscript or essay that is accessible to a broad audience ranging from experts to the general public.
5. Demonstrate key professional skills, such as laboratory techniques, effective writing, oral communication, critical evaluation of the literature, lab team-work, and problem-solving.
6. Constructively critique the strengths and weaknesses of other students' studies to refine and improve their scientific value.

BIOL 540 Research Mentorship in Biology Units: 6.00
Research practicum under the supervision of a Biology faculty member. The course will involve a combination of research in the host laboratory, attendance of BIOL 537 or other seminars in the Department, and literature research to present as a major paper and seminar.
NOTE Students will normally be enrolled in the fourth year of their Program, having completed the third year core requirements of their Plan.
Learning Hours: 248 (8 Seminar, 24 Tutorial, 120 Practicum, 96 Private Study)
Requirements: Prerequisite Registration in a Biology Honours Plan (BIOL-M-BSH, BIOL-P-BSH, BIMA-P-BSH, BIPS-P-BSH, EBIO-P-BSH) and a minimum GPA of 2.0 in the Biological Foundations List and permission of the Department. One-Way Exclusion Not to be taken concurrently with BIOL 537/12.0.
Course Equivalencies: BIOL540; BIOL540B
Offering Faculty: Faculty of Arts and Science
Course Learning Outcomes:

1. Demonstrate the ability to use advanced lab and field biological techniques to conduct novel scientific research on a problem or question relevant to a particular faculty's lab group program.
2. Describe and evaluate the background information and contemporary arguments from the literature associated with that problem or question, so as to explain the rationale for its investigation.
3. Present the results of their experiments in a seminar format, discuss the implications of the findings, and orally defend the conclusions.
4. Present the research findings in the form of a manuscript or essay that is accessible to a broad audience ranging from experts to the general public.
5. Demonstrate key professional skills, such as laboratory techniques, effective writing, oral communication, critical evaluation of the literature, lab team-work, and problem-solving.
6. Constructively critique the strengths and weaknesses of other students' studies to refine and improve their scientific value.

BIOL 594 Independent Study Units: 3.00
Exceptionally qualified students entering their third- or fourth-year may take a program of independent study provided it has been approved by the Department or Departments principally involved. The Department may approve an independent study program without permitting it to be counted toward a concentration in that Department. It is, consequently, the responsibility of students taking such programs to ensure that the concentration requirements for their degree will be met.
NOTE Requests for such a program must be received one month before the start of the first term in which the student intends to undertake the program.
NOTE Also offered at Bader College, UK.
Requirements: Prerequisite Permission of the Department or Departments principally involved.
Offering Faculty: Faculty of Arts and Science

BIOL 595 Independent Study Units: 6.00
Exceptionally qualified students entering their third- or fourth-year may take a program of independent study provided it has been approved by the Department or Departments principally involved. The Department may approve an independent study program without permitting it to be counted toward a concentration in that Department. It is, consequently, the responsibility of students taking such programs to ensure that the concentration requirements for their degree will be met.
NOTE Requests for such a program must be received one month before the start of the first term in which the student intends to undertake the program.
Requirements: Prerequisite Permission of the Department or Departments principally involved.
Offering Faculty: Faculty of Arts and Science

BIOL 596 Independent Study Units: 12.00
Exceptionally qualified students entering their third- or fourth-year may take a program of independent study provided it has been approved by the Department or Departments principally involved. The Department may approve an independent study program without permitting it to be counted toward a concentration in that Department. It is, consequently, the responsibility of students taking such programs to ensure that the concentration requirements for their degree will be met.
NOTE Requests for such a program must be received one month before the start of the first term in which the student intends to undertake the program.
Requirements: Prerequisite Permission of the Department or Departments principally involved.
Offering Faculty: Faculty of Arts and Science

BIOL 597 Independent Study Units: 18.00
Exceptionally qualified students entering their third- or fourth-year may take a program of independent study provided it has been approved by the Department or Departments principally involved. The Department may approve an independent study program without permitting it to be counted toward a concentration in that Department. It is, consequently, the responsibility of students taking such programs to ensure that the concentration requirements for their degree will be met.
NOTE Requests for such a program must be received one month before the start of the first term in which the student intends to undertake the program.
Requirements: Prerequisite Permission of the Department or Departments principally involved.
Offering Faculty: Faculty of Arts and Science

BIOL 598 Independent Study Units: 9.00
Exceptionally qualified students entering their third- or fourth-year may take a program of independent study provided it has been approved by the Department or Departments principally involved. The Department may approve an independent study program without permitting it to be counted toward a concentration in that Department. It is, consequently, the responsibility of students taking such programs to ensure that the concentration requirements for their degree will be met.
NOTE Requests for such a program must be received one month before the start of the first term in which the student intends to undertake the program.
Requirements: Prerequisite Permission of the Department or Departments principally involved.
Offering Faculty: Faculty of Arts and Science