BIOLOGY (BIOL)

Most courses are half courses (3.0 credit units) which are offered either in the fall or winter term if there is sufficient student interest. Some 900 level courses listed are 1.5 credit units. BIOL 899 and BIOL 999 are 6.0 credit units. Detailed outlines of course content are available during the summer of each year. Most courses are offered in alternate years.

BIOM 800 Introduction to Mathematical Modeling in Ecology and Evolution
Modeling will be presented in the context of biological examples drawn from ecology and evolution, including life history evolution, sexual selection, evolutionary epidemiology and medicine, and ecological interactions. Techniques will be drawn from dynamical systems, probability, optimization, and game theory with emphasis put on how to formulate and analyze models. Three term hours.

BIOL 801 Evolutionary Medicine
A survey of the ways in which concepts from evolutionary biology can be used to better address and understand issues related to human health. Topics might include the evolutionary biology of infectious diseases, the utility of phylogenetics in infectious diseases, the evolution of drug (e.g., vaccines) and antibiotic resistance, the evolutionary biology of human genetic disorders, aging and senescence. Three term hours. Fall.

BIOL 806 Plant Molecular Biology
Model systems for plant molecular genetics; gene identification and cloning; gene transfer techniques including vector construction; transposons; genetic regulation and expression.

BIOL 811 Plant Metabolism
This course explores contemporary research ideas and techniques used to elucidate plant metabolism and its control. Topics include plant signal transduction, plant metabolic adaptations to abiotic and biotic stress, as well as the application of proteomics, genomics, and molecular biology for comprehending plant metabolism and the production of 'improved' transgenic crops via metabolic engineering.

BIOL 812 Introduction to computational analysis in biology
This course will be a hands-on introduction to essential bioinformatics skills. The goal is to build a foundation of computational skills that enable analysis of large biological data. We will learn command line Unix/Linux, shell scripting, and installation/testing/usage of popular public bioinformatics packages. We will spend significant time learning Perl and/or Python and Matlab. The course will rely heavily on problem based learning and in class discussion. Assignments will involve analyses that use primary literature data, particularly next gen sequencing data. 50% of the final grade is based on a research project conceived and carried out independently. No prior programming experience is necessary. Three term hours. Winter.

BIOL 813 Statistical and Machine Learning in Biology
A course in advanced techniques for analyzing biological data. Possible topics include statistical and machine learning (e.g. likelihood models, Monte Carlo methods, approximate Bayesian computation), and neural networks (e.g. deep, recursive, convolutional). Topics covered will depend upon student and faculty interests. Lectures & Tutorials (3hrs). Course weight: 3.0 credit units. Three term hours.
PREREQUISITE: BIOL 860 & BIOL 812 or equivalent

BIOL 817 Contemporary Issues in Biology
The focus will be on biological issues of current importance to provide a broad exposure within a range of specific disciplines. Topics will include critical analysis of biological issues that have been featured as news items either in the popular press or in science news journals within the previous 12 months. Three term hours. Fall.

BIOL 818 Stress Biology
Environmental stress is addressed with respect to water, nutrition, temperature, toxins, and competition between organisms. Topics include adaptations to cope with stress; biological responses at the organismal, cellular, biochemical, physiological and molecular genetic levels. No specialized molecular biology background is required. Three term hours.

BIOL 819 Selected Topics in Molecular Genetics
Topics will range from population genetics to transcriptional regulation in both plants and animals. Application of the tools of molecular genetics to biological problems will be emphasized. No previous specialization in molecular biology is required, although some background in this area is highly recommended. Three term hours. Winter.

BIOL 820 Commercialization of Biological Research
Current issues relating to the biotechnology industry will be dealt with in detail. Topics covered include: grant writing; patenting; circumventing patents; funding sources; business plans; venture capital investments; public awareness; public perspective; and layperson presentations. Three term hours. Three term hours.
PREREQUISITE: At least one of the following: BIOL 201 , BIOL 205 , MBIO 318 , BIOL 441 , BIOL 330 /430 or equivalent.
EXCLUSION: PHGY 801.

BIOL 822 Long Term Environmental Change
The main focus of this course will be to review and assess the many techniques currently available to track long term environmental change. An emphasis will be placed on biological approaches dealing with sedimentary analyses, but other proxy methods (e.g. ice cores, bore holes, etc.) will also be covered. General topics to be covered will include climatic change, acidification, eutrophication, lake and reservoir management, UV penetration, etc. Three term hours.

BIOL 824 Gateway to graduate studies
This course will introduce intellectual and professional skills important for success in graduate school and in careers in Biology. Course structure and content is applicable to all fields of biology, from ecology and evolution to cell biology, biochemistry, and molecular biology. Sessions will span topics from study design and hypothesis testing, to communication skills, to career paths and mentoring. The final assignment will be a written research proposal, following the departmental guidelines for the PhD proposal. The goals of the course include 1) introducing graduate students to an array of skills and topics important to their success, 2) helping to develop a community among new graduate students, 3) improving students' communication skills, and 4) introducing graduate students to several Biology faculty who will lead some of the sessions. Students are required to attend a mandatory weekend at the Queen's University Biological Station, with a cost recovery fee for accommodation and meals. Three term hours. Fall.

BIOL 825 Professional Development for Biologists
This course provides the opportunity for graduate students to develop professional skills. Topics are flexible but could include time management strategies, project management strategies, teaching skills, working in a team, conflict resolution, leadership skills, I-EDIIAA modules, preparing CVs, resumes, and cover letters. (3.0 credit units)
PREREQUISITE: Students should be enrolled in the Biology graduate program.

BIOL 830 Ecological and Evolutionary Genetics
Each year brings new molecular tools and significant advances in analytical techniques for using molecular data to address evolutionary and ecological questions. This course is an exploration of these with emphases varying from year to year depending on the expertise of the instructor. Topics may span natural selection and phenotypic plasticity, parentage and mating systems, speciation, hybridization, macroevolution, and phylogenetics. Students gain a thorough theoretical grounding of pertinent topics via lectures, student seminars, and readings from the current primary literature. Hands on analytical experience will be provided through student exercises using the latest software applications. Three term hours. Fall.

BIOL 831 Bioremediation
Bioremediation is the use of organisms to alleviate environmental problems. Topics will include the biology of the organisms involved and their bioremediation processes. Plants act to absorb and concentrate heavy metals from soils whereas micro organisms, invertebrates and plants degrade organic toxins and remove excess nutrients from soils, substrates and water. The processes include extraction, absorption, concentration, and degradation of contaminants. Three term hours. Fall.

BIOL 839 Plant Ecology and Evolution
Mechanisms of natural selection involving adaptive strategies for growth, survival and reproduction in plants and the consequences of this selection on the characteristics of plant populations and communities. Recent research topics and theoretical developments are stressed. Three term hours.

BIOL 847 Data Analysis in Community and Paleoecology
A variety of quantitative techniques are now being used increasingly in the fields of community ecology, paleoecology and paleolimnology (e. g. linear and unimodal regression and calibration, direct and indirect multivariate ordination, quantitative reconstruction models, rate of change analysis and analysis of spatial and temporal data). This course will investigate these computational techniques and explore their applications in the above mentioned fields. This course assumes a working knowledge of classical statistics. Three term hours.
PREREQUISITE: BIOL 343 or permission by instructor.

BIOL 848 Field Course in Biodiversity
This two week field course introduces graduate students to field research and methods in evolutionary ecology, biodiversity science and conservation. The course involves a mix of lectures, natural history, field practice, research projects, and data analysis. Focus will depend on the instructor. A fee may be charged for travel, and room and board (3.0 credit units).

BIOL 849 Environmental Issues
Consideration will be given to environmental, legal, economic, political, sociological and biological aspects of current issues in the management of the Great Lakes. Models for managing nutrients, toxics and fisheries will be compared from a multidisciplinary viewpoint. Three term hours.

BIOL 850 Darwinism and cultural evolution
Contributions of Darwinian evolutionary theory to the understanding of contemporary culture. Through seminars, essays, and group discussions, students explore ideas,

research objectives, and recent discoveries in applying Darwinism to the interpretation of cultural products like art and literature, social cultural institutions like religion and marketing, societal problems like war and environmental conservation, and emerging designs for new models of sustainable civilization in the 21st century. Three term hours.

EXCLUSION: BIOL 535

BIOL 855 Conservation Biology
Key issues in conservation biology will be explored in seminars and discussions. Topics
will include: minimum viable populations, habitat configuration and sustainable populations, biodiversity, habitat fragmentation, edge effects, keystone species, meta populations, restoration ecology, endangered species, inbreeding, heterozygosity and fitness, genetics of captive breeding, population genetics and conservation. Three term hours.

BIOL 860 Introduction to Management and Statistical Analysis of Biological Data
This course is for students at early stages of planning research and collecting data. Topics include experimental design, matching hypotheses with statistical analyses, parameter estimation and graphing. Analyses will be based on a normal error distribution implemented in the R statistical language. Lectures. (3 hrs) & tutorials (3 hrs). Enrolment may be limited. Course weight: 3.0 credit units. Three term hours. Fall.
EXCLUSION: BIOL 343

BIOL 861 Introduction to Linear Models for Biological Data
This course is for students with introductory statistics/ experimental design training and a working knowledge of the R statistical language, and will cover fitting linear models to continuous data, model selection, diagnosis of key assumptions and data visualization. Lectures (3 hrs) & tutorials (3 hrs). Winter. Enrolment may be limited. Course weight: 3.0 credit units. Three term hours. PREREQUISITES: BIOL 860 or equivalent.

BIOL 862 Application of Generalized Linear Models to Biological Data
Data analysis in Biology often involves counts, densities or proportions that require non Normal analysis. This course introduce generalized linear models (GLMs) implemented using the R statistical language, including logistic regression, overdispersion and Poisson, quasi likelihood, negative binomial and mamma models. Lectures (3 hrs) & tutorials (3 hrs). Winter. Enrolment may be limited. Course weight: 3.0 credit units.

BIOL 863 Introduction to Mixed Effects Models for Biological Data
The course will focus on linear models that include random effects implemented using the R statistical language. Topics will include partitioning of random variance, nested, partially nested and repeated measures experimental designs, and modem approaches to evaluating competing models. Lectures (3 hrs) & tutorials (3 hrs). Enrolment may be limited. Course weight: 3.0 credit units.

BIOL 865 Advanced Statistical Analysis of Biological Data
A course in advanced statistical techniques for biological data. Possible topics include comparative methods, phylogenetic analysis, general additive models, nonlinear regression, network analysis, time series analysis, resampling, path analysis. Topics covered will depend upon student and faculty interests. Lectures & Tutorials (3hrs). Course weight: 3.0 credit units. PREREQUISITE: BIOL 860 & BIOL 812 or equivalent.

BIOL 870 Classical Studies in Molecular Biology
In this course we will explore advances in molecular biology and genetics with a historical perspective. We will read classical papers outlining major discoveries such as the molecular structure of nucleic acids, the genetic code, the genetic basis of inheritance, and others. Classical studies will be paired with modern studies that build upon these earlier findings. Modern studies will change each year depending on the interests of the students. A major goal of the course is to gain an appreciation for how creativity and carefully designed experiments drive innovation. Students should have foundational knowledge of molecular biology and genetics, as evidenced by a BSc degree that included courses in these subjects. Three term hours.

BIOL 893 Mentoring Experience in Biology
Students will advise and train other students in biological investigations, normally over a two term period. Open to full time students having completed two terms of study in Biology M.Sc. or Ph.D. programs. Activities include guidance on research proposals, research procedures, student presentations, and drafts of student work. This is a non-credit course, graded on a Pass/Fail basis.
PREREQUISITE: Permission of Coordinator of Graduate Studies

BIOL 897 Seminar Course
Attending a diverse array of seminars is an essential component in the development of a student, especially in a department as diverse as biology. The aim of this course is to develop skills in listening, synthesizing and critical thinking, as well as fostering the development of important oral and written communication skills. Students will be required to attend at least 30 department or specialized research

seminars, as well as present a seminar based upon their graduate thesis research. Enrolment is extended over six terms and is limited to new graduate students in Biology. Fall/Winter/Summer.

BIOL 899 Master's Thesis Research

BIOL 951 Advanced Studies in Ecology, Evolution and Behaviour I
Selected topics in ecology, evolution and behaviour. An advanced course on current research in ecology, evolution and behaviour, based on recent research literature. For detailed information, consult the course coordinator. Three term hours. Offered by special arrangement.

BIOL 953 Advanced Studies in Plant Sciences I
Selected topics in plant sciences. An advanced course on current research in plant science, based on recent research literature. For detailed information, consult the course coordinator. Offered by special arrangement.

BIOL 955 Advanced Studies in Molecular and Cellular Biology I
Selected topics in molecular biology. An advanced course on current research in molecular biology, based on recent research literature. For detailed information, consult the course coordinator. Offered by special arrangement.

BIOL 957 Advanced Studies in Animal Physiology I
Selected topics in animal physiology. An advanced course on current research in animal physiology, based on recent research literature. For detailed information, consult the course coordinator. Offered by special arrangement.

BIOL 959 Advanced Studies in Environmental Sciences I
Selected topics in environmental sciences. An advanced course on current research in environmental sciences. For detailed information, consult the course coordinator. Offered by special arrangement.

BIOL 961 Advanced Studies in Ecology, Evolution and Behaviour II
Selected topics in ecology, evolution and behaviour. An advanced course on current research in ecology, evolution and behaviour, based on recent research literature. For detailed information, consult the course coordinator. Offered by special arrangement. (1.5 credit units).

BIOL 963 Advanced Studies in Plant Sciences II
Selected topics in plant sciences. An advanced course on current research in plant science, based on recent research literature. For detailed information, consult the course coordinator. Offered by special arrangement. (1.5 credit units).

BIOL 965 Advanced Studies in Molecular and Cellular Biology II
Selected topics in molecular biology. An advanced course on current research in molecular biology, based on recent research literature. For detailed information, consult the course coordinator. Offered by special arrangement. (1.5 credit units).

BIOL 967 Advanced Studies in Animal Physiology II
Selected topics in animal physiology. An advanced course on current research in animal physiology, based on recent research literature. For detailed information, consult the course coordinator. Offered by special arrangement. (1.5 credit units).

BIOL 969 Advanced Studies in Environmental Sciences II
Selected topics in environmental sciences. An advanced course on current research in environmental sciences. For detailed information, consult the course coordinator. Offered by special arrangement. (1.5 credit units).

BIOL 999 Ph.D. Thesis Research