BIOLOGY

Section 31.030

Faculty

Chair
PATRICK J. GULICK, PhD *University of California, Davis*; *Professor*

Distinguished Professors Emeriti
RAGAI K. IBRAHIM, PhD *McGill University*
ELAINE B. NEWMAN, PhD *Harvard University*

Professors
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JAMES GRANT, PhD *University of Guelph*
VINCENT MARTIN, PhD *University of British Columbia*
ROBERT M. ROY, PhD *University of Toronto*
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MALCOLM WHITEWAY, PhD *University of Alberta*; *Provost's Distinction*
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Associate Professors
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SELVADURAI DAYANANDAN, PhD *Boston University*
EMMA DESPLAND, PhD *University of Oxford*
DYLAN FRASER, PhD *Université Laval*
ALISA PIEKNY, PhD *University of Calgary*
MICHAEL SACHER, PhD *McGill University*
LUC VARIN, PhD *Concordia.University*
ROBERT WELADJI, PhD *Norwegian University of Life Sciences*

Assistant Professors
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IAN FERGUSON, PhD *Concordia.University*
MADOKA GRAY-MITSUMUNE, PhD *University of British Columbia*
JIN SUK LEE, PhD *University of British Columbia*
JEAN-PHILIPPE LESSARD, PhD *University of Tennessee*
DAVID WALSH, PhD *Dalhousie University*

For the complete list of faculty members, please consult the Department website.

Location

Loyola Campus
Richard J. Renaud Science Complex
514-848-2424, ext. 3400

Department Objectives

The Biology Department is dedicated to teaching and research that advance understanding of life from molecules and cells to organisms, populations, and entire ecosystems. The Department's programs inspire students with an appreciation of the rich diversity of the living world.
Students acquire a comprehensive grounding in modern biology through classroom study as well as extensive hands-on training in research methodology. A variety of specialized laboratories and equipment supports both research and teaching activities.

Programs

The Biology Department offers Honours and Specialization programs in Biology, Cell and Molecular Biology, and Ecology, as well as Major and Minor programs in Biology. Students planning a career or graduate studies in the biological sciences normally follow the appropriate honours or specialization program. The major program is designed for students who wish to study biology

and either obtain a more general education or pursue an additional program in another discipline. The major program can be combined with a major in another department.
Students registered in the Honours, Specialization, or Major in Biology may select Biology electives in various subject areas in order to obtain a broad overview of the discipline. However, it is possible for students to pursue in-depth studies in specific areas such as animal biology, plant biology, or microbiology and biotechnology.
The minor program can only be taken by students registered in another degree program and provides an opportunity to gain a basic exposure to the main sub-disciplines of Biology or to pursue one such area in some depth.
Students are strongly encouraged to take advantage of academic counselling services available in the Biology Department in order to select the program and courses that best meet their needs. Students may transfer among programs after the first year of study since the core courses in all programs are quite similar.

Students are responsible for satisfying their particular degree requirements.
The superscript indicates credit value.
Students seeking admission to the honours program may apply either for direct entry on the University application form or, once in the program, to the departmental honours advisor normally following the completion of 30 credits.

72 BSc Honours in Biology
30 BIOL 225^3, 226^3, 227^3, 261^3, 266^3, 367^3, 490^6; CHEM 221^3*, 271^3
3 Chosen from BIOL 322^3; CHEM 212^3
9 Chosen from BIOL 330^3, 337^3, 340^3, 364^3, 371^3, 382^3, 385^3
30 Chosen from CHEM 222^3; Biology credits** at the 300 and 400 levels with at least nine credits at the 400 level
NOTE: Students seeking admission to the honours program may apply either for direct entry on the University application form or, once in another program, to the departmental honours advisor normally following the completion of 30 credits. Admission, retention, and graduation in an honours program requires that the student has a cumulative and last annual GPA of at least 3.30 with no grade below C.

72 BSc Honours in Cell and Molecular Biology
51 BIOL 225^3, 226^3, 261^3, 266^3, 364^3, 366^3, 367^3, 368^3, 466^3, 490^6; CHEM 212^3, 221^3*, 222^3*, 271^3, 375^3, 477^3
21 Chosen from BIOL 227^3; Biology or Chemistry/Biochemistry credits** at the 300 and 400 levels, with at least 12 credits at the 400 level
NOTE: Students seeking admission to the honours program may apply either for direct entry on the University application form or, once in another program, to the departmental honours advisor normally following the completion of 30 credits. Admission, retention, and graduation in an honours program requires that the student has a cumulative and last annual GPA of at least 3.30 with no grade below C.

72 BSc Honours in Ecology
36 BIOL 225^3, 226^3, 227^3, 261^3, 266^3, 322^3, 367^3, 450^3, 490^6; CHEM 221^3*, 271^3
9 Chosen from BIOL 330^3, 337^3, 340^3, 364^3, 371^3, 382^3, 385^3
12 Chosen from BIOL 321^3, 350^3, 351^3, 353^3, 354^3
6 Chosen from BIOL 451^3, 452^3, 453^3, 457^3, 459^3, 473^3
9 Chosen from CHEM 222^3; Biology credits** at the 300 and/or 400 levels
NOTE: Students seeking admission to the honours program may apply either for direct entry on the University application form or, once in another program, to the departmental honours advisor normally following the completion of 30 credits. Admission, retention, and graduation in an honours program requires that the student has a cumulative and last annual GPA of at least 3.30 with no grade below C.

60 BSc Specialization in Biology
24 CHEM 221^3*, 271^3; BIOL 225^3, 226^3, 227^3, 261^3, 266^3, 367^3
3 Chosen from BIOL 322^3; CHEM 212^3
9 Chosen from BIOL 330^3, 337^3, 340^3, 364^3, 371^3, 382^3, 385^3
24 Chosen from CHEM 222^3; Biology credits** at the 300 and 400 levels with at least six credits at the 400 level

66 BSc Specialization in Cell and Molecular Biology
45 CHEM 212^3, 221^3*, 222^3*, 271^3, 375^3, 477^3; BIOL 225^3, 226^3, 261^3, 266^3, 364^3, 366^3, 367^3, 368^3, 466^3
21 Chosen from BIOL 227^3; Biology or Chemistry/Biochemistry credits** at the 300 and 400 levels, with at least 12 credits at the 400 level

60 BSc Specialization in Ecology
27 BIOL 225^3, 226^3, 227^3, 261^3, 266^3, 322^3, 367^3; CHEM 221^3*, 271^3
9 Chosen from BIOL 330^3, 337^3, 340^3, 364^3, 371^3, 382^3, 385^3
9 Chosen from BIOL 321^3, 350^3, 351^3, 353^3, 354^3
6 Chosen from BIOL 450^3, 451^3, 452^3, 453^3, 457^3, 459^3, 473^3
9 Chosen from CHEM 222^3; Biology credits** at the 300 and/or 400 levels

45 BSc Major in Biology
24 CHEM 221[3]*, 271[3]; BIOL 225[3], 226[3], 227[3], 261[3], 266[3], 367[3]
3 Chosen from BIOL 322[3]; CHEM 212[3]
6 Chosen from BIOL 330[3], 337[3], 340[3], 364[3], 371[3], 382[3], 385[3]
12 Chosen from CHEM 222[3]; Biology credits** at the 300 and 400 levels with at least three credits at the 400 level

24 Minor in Biology
9 BIOL 225[3], 226[3], 227[3]
3 Chosen from BIOL 206[3], 210[3], 261[3]
12 Biology elective credits

**Students entering the program with Cegep Organic Chemistry must replace these credits with an equivalent number of credits in Biology or Chemistry/Biochemistry.*
***In addition to BIOL courses at the 300 and 400 levels, these courses can include BIOL 227 (only in the Cell and Molecular Biology programs and counting as a 300-level elective) and the following CHEM courses: 222 (counting as a 300-level elective), 326, 335, 375, 425, 470, 471, 472, 475, 476, 478, 481, and 498 if the topic is approved by formal student request through the Biology departmental advisor.*

Courses

Because of the renumbering of courses in the Department, students should see §200.1 for a list of equivalent courses.

BIOL 200 ***Fundamentals of Human Biology*** (3 credits)
A series of lectures, demonstrations, and seminars to provide non-biologists with a general survey of the fundamental principles of life, with special emphasis on the structures and functions of human beings. Lectures only.
NOTE: Students registered in a Biology or Biochemistry program may not take this course for credit. Students who have completed Cegep Biology 921/931 may not take this course for credit.

BIOL 201 ***Introductory Biology*** (3 credits)
Fundamentals of plant and animal biology: basic physics and chemistry of life; cell and tissue structures and functions; anatomy and physiology of human systems; survey of plant and animal taxonomy, ecology, heredity, and evolution. Lectures and laboratory.
NOTE: Students with Cegep Biology 301 or equivalent may not take this course for credit. Students entering BIOL programs without Cegep Biology 301 or equivalent must take this course, but not for program credit.

BIOL 202 ***General Biology*** (3 credits)
This course presents the fundamentals of biology including the basic physics and chemistry of life, the structure and functions of cell and tissues, and aspects of anatomy, physiology, taxonomy, heredity and evolution, with examples ranging from micro-organisms to humans. Lectures only.
NOTE: Students with Cegep Biology 301, 101-NYA or BIOL 201 may not take this course for credit. Students enrolled in BSc programs may not take this course for credit.

BIOL 203 ***Fundamental Nutrition*** (3 credits)
This course deals with food composition (carbohydrates, lipids, proteins, vitamins, and minerals), its absorption and utilization, energy balance, special diets, and food technology. Lectures only.
NOTE: Students registered in a Biology or Biochemistry program may not take this course for credit.

BIOL 205 ***Introduction to Sustainability*** (3 credits)
This course begins with an introduction to the science of ecology and to the concept of sustainability as an ecological principle. The concept of sustainability is then broadened to include humans, as students are introduced to ethics, economics, and resource management from an eco-centric point of view. Students are encouraged to think critically about current environmental problems and to take action on an individual project.
NOTE: Students who have received credit for BIOL 208, BIOZ 208 or for this topic under a BIOL 298 number may not take this course for credit.

BIOL 206 ***Elementary Genetics*** (3 credits)
A survey of classical and contemporary developments in the study of heredity, with particular attention to human examples. This course is open to the general student body. Lectures only.
NOTE: Students who have received credit for BIOL 261 may not take this course for credit.
NOTE: Students transferring into a Biology program may retain degree credit for this course.

BIOL 208 ***Environmental Biology*** (3 credits)
This course examines the principles and concepts of ecosystems, the interaction of organisms and their environment. Energy flow and nutrient cycling in ecosystems, population dynamics, and community organization. Lectures only.
NOTE: Students registered in a Biology or Biochemistry program may not take this course for credit.
NOTE: Students who have received credit for BIOZ 208, BIOL 205 or for this topic under a BIOL 298 number may not take this course for credit.

BIOL 210 ***Genetics and Human Welfare*** (3 credits)
This course is an introduction to the principles of inheritance, the structure and manipulation of DNA, the organization of genomes and the function of genes. Applications based on DNA structure include exploring human origins and forensic DNA. Gene function and manipulation are illustrated by human traits and genetic diseases, cancer, genetic testing, production of proteins for medical and industrial use, and the production of genetically modified organisms. Scientific progress is illustrated and societal and ethical questions raised by progress in genetics are discussed. This course assumes students have no science background.
NOTE: Students registered in a Biology or Biochemistry program other than the Minor in Biology may not take this course for credit.
NOTE: Students who have received credit for BIOZ 210 may not take this course for credit.

BIOL 225 ***Form and Function of Organisms*** (3 credits)
Prerequisite: Cegep Biology 301 or 101-NYA or BIOL 201. An introduction to plant and animal form and function is presented. This course provides an overview of basic physiological and morphological aspects of plants and animals that allow survival and reproduction. Topics in animal biology include animal architecture, internal fluids, homeostasis, digestion and nutrition, nervous and chemical coordination; topics in plant biology include plant organization, photosynthesis, respiration, water relations, and growth regulation. Reproduction and development of both plants and animals are introduced. Lectures only.

BIOL 226 ***Biodiversity and Ecology*** (3 credits)
Prerequisite: Cegep Biology 301 or 101-NYA or BIOL 201. This course introduces the evolution, biodiversity, and ecology of organisms. The origin and diversity of life, from prokaryotes, through simple eukaryotes to multi-cellular organisms are introduced. Natural selection, speciation, and phylogeny, stressing evolutionary relationships in conjunction with changing conditions on earth, are presented. The course introduces major concepts in ecology: the physical and chemical environment, population structure, life histories, species interactions, communities, and ecosystems. Lectures only.

BIOL 227 ***Laboratory Studies in Biodiversity*** (3 credits)
Prerequisite: BIOL 225; BIOL 226 previously or concurrently. This course reviews the diversity of organisms and introduces methods used in their study. The tutorials focus on key evolutionary mechanisms associated with organism diversity, model organisms that illustrate it and phylogenies that integrate diversity. The laboratory exercises are in basic protocols and may include bacterial classification; the structural diversity of protists; reproductive diversity among fungi; invertebrate internal morphology and behaviour; arthropod and mollusk classification; exercises in vertebrate homology; and studies on plant structure, development and physiology. Laboratory and tutorial.

BIOL 261 ***Molecular and General Genetics*** (3 credits)
Prerequisite: Cegep Biology 301 or 101-NYA or BIOL 201; CHEM 221 previously or concurrently. Basic genetic principles, including mechanisms of meiosis and mitosis, Mendelian genetics, recombination, gene mapping, and chromosome rearrangements; an introduction to molecular genetics, including nucleic acid structure and biosynthesis transcription and translation; the course also includes an introduction to recombinant DNA technology and to concepts of population genetics. Lectures and tutorials.

BIOL 266 ***Cell Biology*** (3 credits)
Prerequisite: Cegep Biology 301 or 101-NYA or BIOL 201. Structure and functions of the cell and its organelles: cytoskeleton, chromosomes, cell cycle and cell division, organelle biogenesis, molecular motors, trafficking of proteins and membranes, signal transduction, trans-membrane transport, cancer, apoptosis. Lectures only.

BIOL 298 ***Selected Topics in Biology*** (3 credits)
Specific topics for this course, and prerequisites relevant in each case, will be stated in the Undergraduate Class Schedule.

BIOL 321 ***Evolution*** (3 credits)
Prerequisite: BIOL 225, 226. Through readings, discussions, and lectures, students explore the evidence for evolution, as well as current theories for the mechanisms that cause evolutionary change. Topics covered include principles of inheritance and variation, adaptation through natural selection, random processes in evolution, and the role of molecular and macroevolutionary processes in shaping current patterns of biodiversity. Lectures and tutorials.

BIOL 322 ***Biostatistics*** (3 credits)
Prerequisite: Nine BIOL credits in a Biology major, honours, or specialization program or completion of Stage I of the Geography honours or specialization programs in Environmental Science or permission of the Department. This course examines statistical methods for the biological sciences; experimental design; data description; binomial, Poisson and Normal distributions; statistical inference; hypothesis testing; chi-square; one and two sample tests of the mean; analysis of variance including 2-way and nested ANOVAs; correlation; regression; and analogous non-parametric techniques. Lectures and laboratory.
NOTE: Students who have received credit for COMM 215, ECON 222, GEOG 362, MAST 333 , PSYC 316, SOCI 213 or STAT 250 may not take this course for credit.

BIOL 330 ***Vertebrate Biology*** (3 credits)
Prerequisite: BIOL 225, 226. This course explores how the anatomy, physiology, life history, ecology and behaviour of vertebrates interact to generate animals that function effectively in their environments, and how different vertebrate groups have evolved over the past few hundred million years. Major vertebrate groups discussed are cartilaginous fishes, bony fishes, amphibians, reptiles, birds and mammals. Other special topics on vertebrate biology considered include the role of ecology in vertebrate speciation, vertebrate adaptations to extreme environments, seasonal migrations, human evolution, as well as conservation issues facing different vertebrate groups worldwide.
NOTE: Students who have received credit for BIOL 387 may not take this course for credit.

BIOL 337 ***Invertebrate Biology*** (3 credits)
Prerequisite: BIOL 225, 226, 227. This course surveys the diversity of invertebrates and their functional systems, emphasizing the basic themes that define each phylum and those that are common to all animals. The course focuses on evolution, life histories, physiology, and anatomy of the major phyla and the diversity of the minor phyla. Lectures and laboratory.
NOTE: Students who have received credit for this topic under a BIOL 398 number may not take this course for credit.

BIOL 340 ***Plant Biology*** (3 credits)
Prerequisite: BIOL 225, 226. This course surveys the biology of the plant kingdom. Topics include the evolution of the major groups and a comparative analysis of the form (anatomy), function (physiology), and life history of plants. Examples from the local flora are emphasized. Lectures and laboratory.

BIOL 350 ***The Ecology of Individuals*** (3 credits)
Prerequisite: BIOL 225, 226. This course is designed to introduce students to the diversity of adaptations possessed by individuals which enables them to interact successfully with the abiotic and biotic environment. Major topics include responses to temperature, water, gas exchange, light, and other species. In addition, sensory ecology and escape in time and space are covered. Physiological adaptations are emphasized. Lectures only.

BIOL 351 ***Basic Population Ecology*** (3 credits)
Prerequisite: BIOL 226. This course introduces the processes which determine the distribution and abundance of individuals in populations. Population growth, density-dependent and density-independent population regulation, survivorship, life history parameters, the population dynamics of competition, predation and parasitism, and the roles of predation and competition in affecting community structure are discussed. Lectures and tutorials.

BIOL 353 ***Communities and Ecosystems*** (3 credits)
Prerequisite: BIOL 225, 226. This course presents an introduction to biological communities, the processes that maintain them and their emergent properties. Topics include the interactions between abiotic and biotic factors in determining community composition, the concepts of niche and habitat, succession theory, community diversity and stability, energy flow and nutrient cycling. Examples emphasize both aquatic and terrestrial ecosystems, and the major global biomes. Lectures only.

BIOL 354 ***Behavioural Ecology*** (3 credits)
Prerequisite: BIOL 226. Behavioural ecology is the study of behavioural adaptation. The topics include foraging, anti-predator, fighting, mating, reproductive and social behaviour. Students will be introduced to optimality and game theories. Lectures and tutorials.

BIOL 364 ***Cell Physiology*** (3 credits)
Prerequisite: BIOL 266; CHEM 271. This course covers general and specialized processes at the molecular and cellular level in eukaryotes and prokaryotes; protein folding and degradation, signalling by nerves, bioenergetics (respiration and photosynthesis), cell motility, muscle contraction, eukaryotic cilia and flagella, sensory perception, and fundamental immunology. Lectures only.

BIOL 366 ***Mechanisms of Development*** (3 credits)
Prerequisite: BIOL 261, 266. This course explores the mechanisms of cellular interactions and genetic control that govern cell differentiation and development in a range of organisms, from simple model systems to mammals. Specific questions address how cell movement and cell recognition take place, how the genome is restricted in differentiation, how cytoplasmic signals influence differentiation, how gradients affect development, how genes control segmentation, and how growth factors and hormones influence development. The role of genetic engineering in the understanding of developmental processes is discussed. The course is based on gaining an understanding of the basic concepts, mechanisms, and experimental tools used in developmental research. Lectures only.

BIOL 367 ***Molecular Biology*** (3 credits)
Prerequisite: BIOL 261; CHEM 271. This course examines DNA structure, recombinant DNA methodologies, gene structure, transcriptional and post-transcriptional regulation, RNA processing events, translation, chromatin modification, chromatin remodelling and DNA replication. The experimental evidence supporting these concepts is also discussed. Lectures and tutorials.

BIOL 368 ***Genetics and Cell Biology Laboratory*** (3 credits)
Prerequisite: BIOL 261, 266; CHEM 212 or 217 or BIOL 227. This course introduces students to the basic laboratory techniques of cell biology, microbiology, bacterial genetics, and molecular biology. Experiments include cell membrane functions in red blood cells, bacterial identification, mutagenesis, genetic transformation, gene mapping, DNA isolation and recombinant DNA techniques. Through tutorials, students learn the theory behind techniques and their use in research. Special focus is placed on lab manipulation skill, data organization, and data interpretation. Laboratory and tutorials.

BIOL 371 ***Microbiology*** (3 credits)
Prerequisite: Six credits chosen from BIOL 226, 261, CHEM 271; or permission of the Department. This course provides an in-depth study of the structure and function of microbes. It emphasizes the genetic and biochemical characteristics of microbes which distinguish them from plants and animals. Consideration is also given to the impact of microbes on the global environment and on the quality of human life. Lectures only.

BIOL 380 ***Nutrition*** (3 credits)
Prerequisite: CHEM 221, 271. The concept of a balanced diet is studied in relation to caloric content and to protein, lipid, carbohydrate, vitamin, and mineral requirements. The consequences of dietary deficiencies are examined. Special topics such as dieting, organic foods, vitamins, food additives, and toxins are discussed. Lectures only.

BIOL 381 ***Environmental Toxicology*** (3 credits)
Prerequisite: BIOL 225, 226. The purpose of this course is to study the impact of pollution on ecosystems. The major classes of pollutants are considered in relation to their nature, origin, and distribution, and particularly their mode of action on individual organisms and ecosystems. Air, water, and soil are examined with their respective pollutants and a major emphasis is given to quantitative assessments of various agents and their effects. The course also includes theoretical and practical aspects of bio-assays, and an overview of case studies and of control measures. Lectures only.

BIOL 382 ***Comparative Animal Physiology*** (3 credits)
Prerequisite: BIOL 225, 226, 266. This course offers a comparative analysis of physiological processes across diverse animal groups at the cellular and systems levels. Topics include endocrinology, muscle contraction, sensory integration, nervous systems, respiration, digestion, and circulation. Lectures and laboratory.

BIOL 385 ***Entomology*** (3 credits)
Prerequisite: BIOL 225; BIOL 226 previously or concurrently, BIOL 227 recommended. This course introduces the student to the variety and complexity of insect life. Basic classification is followed by a more detailed study of morphology and anatomy, together with some physiological considerations. Other topics such as adaptations for aquatic life and social behaviour are discussed. Laboratories include the identification of insects collected by students, as well as structured laboratory sessions which complement the lectures. Lectures and laboratory.

BIOL 398 ***Intermediate Topics in Biology*** (3 credits)
Specific topics for this course, and prerequisites relevant in each case, will be stated in the Undergraduate Class Schedule.

BIOL 443 ***Plant Molecular Genetics*** (3 credits)
Prerequisite: BIOL 367. This course covers a survey of specialized topics in plant molecular genetics including plant disease resistance, flower induction, signal transduction, bioinformatics and genetically modified organisms (GMOs) which have strongly influenced plant improvement in modern agriculture through genetic engineering. Lectures only.

BIOL 450 ***Techniques in Ecology*** (3 credits)
Prerequisite: BIOL 227, 322 or equivalent, and a minimum of six credits from BIOL 321, 350, 351, 353, 354. This course introduces students to a variety of techniques of experimental design, data collection, and quantitative analysis. Students participate in a series of modules, each of which presents experimental and analytical techniques appropriate for one area of modern research in ecology, behaviour, or evolution. Some modules require students to collect and subsequently analyze original data from field or laboratory settings. Modules and their contents may vary from year to year. Tutorials and laboratory.

BIOL 451 ***Plant Field Ecology*** (3 credits)
Prerequisite: BIOL 322 or equivalent, BIOL 353. This course is designed to give students practical experience working with plant communities. It is offered at a field station during the last two weeks of August, and residence is mandatory. Students learn to identify plant species occurring in field, forest, and mountain communities, with the aim of describing and understanding plant community patterns. Methods of sampling and statistical analysis of population and community data are discussed and applied. The course is a combination of formal lectures, organized field studies, and informal discussions. Students are required to hand in a series of written reports and a plant collection after the course has ended.

BIOL 452 ***Population and Conservation Genetics*** (3 credits)
Prerequisite: BIOL 261; three credits chosen from BIOL 321, 351, 353, 367. Conservation genetics employ the principles of population genetics and systematics to address problems related to conservation of biodiversity. This course examines the main factors that affect genetic variation within and among populations, including natural selection, random genetic drift, mutation and gene flow. The impact of human activities on levels and patterns of genetic variation in both plant and animal communities is discussed. The utility of molecular markers in determining conservation units is examined. Several case studies from the current literature are used to illustrate the many applications of modern molecular techniques in conservation genetics. The course comprises lectures, student presentations, and use of software in genetic data analysis.

BIOL 453 ***Microbial Ecology*** (3 credits)
Prerequisite: BIOL 353. This course examines the role of the microbial community in the fundamental processes of decomposition and nutrient cycling. We discuss the role of microbes in the breakdown of organic molecules and the release and transformation of mineral elements. Emphasis is placed on the interactions between bacteria, fungi, and the microfauna in decomposition and on the role of interactions between plants and microbes in the maintenance of nutrient cycles. Lectures only.

BIOL 457 ***Applied Ecology and Conservation Biology*** (3 credits)
Prerequisite: A minimum of nine credits chosen from BIOL 321, 350, 351, 353, 354. This course introduces students to the scientific principles of conservation biology, an interdisciplinary science which aims at identifying and managing environmental problems. Topics may include pollution, climate change, farming, renewable resources, designing nature reserves and conserving biodiversity. Course assignments emphasize effective scientific communication, collaboration and problem-solving skills. Lectures and tutorials.

BIOL 459 ***Aquatic Ecology*** (3 credits)
Prerequisite: BIOL 322 or equivalent, BIOL 353.The course begins with the molecular structure of water and its relationship to life in aquatic ecosystems. Lectures deal with primary and secondary production in streams, lakes, oceans and estuaries. The role of fish in aquatic communities is introduced in the second half of the course and is the subject of a field trip. Lectures, field trips, and laboratory.

BIOL 461 ***Advanced Genetics*** (3 credits)
Prerequisite: BIOL 367. Through lectures and directed readings in classical and contemporary genetics, students are exposed to research literature and problems in this area. Students probe in greater depth areas of particular interest in order to develop a critical sense and deepen an understanding of past and current work in this field. Lectures only.

BIOL 462 ***Immunology*** (3 credits)
Prerequisite: BIOL 266, 364, 367. The role of the immune system in maintenance of body homeostasis will be presented with particular reference to cells and tissues of the immune system, their organization as well as their structural and functional relationships. Topics include: maturation and differentiation of B and T lymphocytes; structure and properties of antibodies; immune responses to antigens; genetic aspects of anti-body synthesis; immunological considerations in AIDS, cancer, and autoimmune diseases. Lectures and seminars.

BIOL 463 ***Comparative Genomics and Genome Evolution*** (3 credits)
Prerequisite: BIOL 367. This course covers modern comparative genomics including the nature and scope of the various genome projects, gene discovery and data mining, molecular phylogenies, origin of the eukaryotic cell, evolution of gene regulatory networks, concerted evolution, and haplotype mapping. Lectures and seminars.
NOTE: Students who have received credit for this topic under a BIOL 498 number may not take this course for credit.

BIOL 466 ***Advanced Techniques in Molecular Biology*** (3 credits)
Prerequisite: BIOL 367, 368. This course covers the theory and practice of modern experimental procedures in molecular biology, including use of restriction enzymes, gene cloning and hybridizations, DNA sequencing, site-directed mutagenesis, RT-PCR, and yeast two-hybrid analysis. Laboratory and tutorials.

BIOL 467 ***Advanced Cell Biology*** (3 credits)
Prerequisite: BIOL 266, 364. This course examines selected topics in cell and molecular biology including the growth and division of differentiated and non-differentiated eukaryotic cells. The focus is on the control of cell cycling under normal and abnormal states, such as cancer and viral infection. Lectures only.
NOTE: Students who have received credit for BIOL 464 or this topic under a BIOL 498 number may not take this course for credit.

BIOL 468 ***Gene Structure*** (3 credits)
Prerequisite: BIOL 367. This course covers fundamental principles and essential concepts underlying the present understanding of gene expression in eukaryotes. Topics may include the role of RNA transcription, RNA localization, RNA transport and microRNAs in eukaryotic gene regulation; the role of DNA methylation, alternative splicing, the histone code and chromatin remodelling in genomic imprinting and epigenetics; and large scale approaches to understanding gene expression such as high throughput sequencing methods, genome wide profiling of mRNA expression, proteomics, and CHIP and CHIP-CHIP analysis. Lectures only.

BIOL 470 ***Microbial Physiology*** (3 credits)
Prerequisite: BIOL 225, 226; CHEM 271. Comparative biochemistry of prokaryoles — a study of the biochemical activities underlying the life of micro-organisms. A description of the diverse biochemical adaptations used by micro-organisms to obtain energy and building materials from their various environments. Lectures and tutorials.

BIOL 472 ***Virology*** (3 credits)
Prerequisite: BIOL 266, 367. The life cycles of viruses are discussed with emphasis on the molecular basis of their entry into, reproduction in, and exit from host cells. These life cycles are related to the pathogenicity of different groups of viruses to provide an understanding of the variety of viral diseases.
NOTE: Students who have received credit for this topic under a BIOL 498 number may not take this course for credit.

BIOL 473 ***Environmental Microbiology*** (3 credits)
Prerequisite: BIOL 371 or 353. This course surveys microbial diversity and ecophysiology with emphasis on how the activities and interactions of individual organisms influence Earth systems at the ecosystem scale. Topics may include the origin and evolution of the biosphere, microbial interactions and ecosystems, nutrient cycling, molecular and genomic methods in environmental microbiology, microbial associations with plants and animals, and the application of microorganisms to environmental sustainability and bioremediation, human welfare, health, and biotechnology. Lectures only.
NOTE: Students who have received credit for this topic under a BIOL 498 number may not take this course for credit.

BIOL 474 ***Cellular Neuroscience*** (3 credits)
Prerequisite: BIOL 364. This course familiarizes students with current theory and research in cellular neuroscience through student presentations and discussions of original scientific literature. Topics include neural circuitry, brain genomics, neuronal structure, synaptic plasticity, neurotransmission, and molecular basis of neurological disease. Lectures only.
NOTE: Students who have received credit for this topic under a BIOL 498 number may not take this course for credit.

BIOL 480 ***Bioinformatics*** (3 credits)
Prerequisite: BIOL 367; within 30 credits of graduating with a BSc in a Department of Biology honours or specialization program and permission of the Department. In this course, students become familiar with the theory and methodologies of bioinformatics. The course is comprised of three general themes: (1) biological sequence data and evolutionary analysis, (2) structural and functional analysis of genes and genomes and (3) comparative genomics. Lecture material is supplemented by in-class activities, assignments and a bioinformatics project where students have the opportunity to apply their skills and knowledge to a self-generated research question.
NOTE: This is primarily a graduate course with a limited number of places for undergraduate students depending upon availability.

BIOL 481 ***Structural Genomics*** (3 credits)
Prerequisite: BIOL 367; within 30 credits of graduating with a BSc in a Department of Biology honours or specialization program and permission of the Department. This course provides an overview of genome analysis including cloning systems; sequencing strategies; methods of detecting genes and approaches to mapping genomes. It covers the theory and design of the different approaches, and the analysis of genomic data generated from them. Lectures only.
NOTE: This is primarily a graduate course with a limited number of places for undergraduate students depending upon availability.

BIOL 482 ***Functional Genomics*** (3 credits)
Prerequisite: BIOL 367; within 30 credits of graduating with a BSc in a Department of Biology honours or specialization program and permission of the Department. This course focuses on the functional analysis of expressed genes and their products. Course content includes cDNA library construction, expressed sequence tags (ESTs), functional analysis by gene knock-outs, localization of gene products by gene knock-ins, transcription profiling using microarrays and RNA-Seq, systematic identification of proteins using mass spectrometry, *in vivo* and *in vitro* recombinant protein synthesis and functional analysis of proteins by detection of protein-protein interactions using affinity co-purification and protein complementation assays. Lectures only.
NOTE: This is primarily a graduate course with a limited number of places for undergraduate students depending upon availability.

BIOL 484 ***Industrial and Environmental Biotechnology*** (3 credits)
Prerequisite: BIOL 367; within 30 credits of graduating with a BSc in a Department of Biology honours or specialization program and permission of the Department. This course provides an in-depth evaluation of current biotechnology tools used in pharmaceutical and forestry industries, and in environmental remediation. New technologies and genomic approaches that can be applied to these processes are also discussed. Lectures only.
NOTE: This is primarily a graduate course with a limited number of places for undergraduate students depending upon availability.

BIOL 485 ***Agriculture and Agri-Food Biotechnology*** (3 credits)
Prerequisite: BIOL 367; within 30 credits of graduating with a BSc in a Department of Biology honours or specialization program and permission of the Department. This course provides an overview on the use of biotechnology in agriculture and in the agri-food industry. Plant genomics and genetic manipulation of plants are emphasized. Also discussed are biotechnology methods used in reducing agricultural pollutants and converting agricultural surplus to energy. Lectures only.
NOTE: This is primarily a graduate course with a limited number of places for undergraduate students depending upon availability.

BIOL 486 ***High-throughput Instrumentation*** (3 credits)
Prerequisite: BIOL 367; within 30 credits of graduating with a BSc in a Department of Biology honours or specialization program and permission of the Department. This course provides an in-depth look at high-throughput instruments used in biotechnology and genomics. Students are exposed to technologies such as massively parallel sequencing, high-throughput genotyping, construction of DNA microarrays, proteomics, robotics platform, mass spectrometry, fluorescence-activated cell sorting, chemical screening, microfluidics, surface plasmon resonance, protein microarrays.
NOTE: This is primarily a graduate course with a limited number of places for undergraduate students depending upon availability.

BIOL 490 ***Independent Study*** (6 credits)
Prerequisite: Within 30 credits of graduating with a BSc in a Department of Biology honours or specialization program and permission of the Department. In this course, the student undertakes a special research project selected in consultation with, and conducted under, the supervision of a faculty member of the Department. The project is intended to develop the student's knowledge of standard scientific procedures, including methods of researching scientific literature, the planning and execution of experimental and analytical procedures, the writing of a formal report, and the presentation of a seminar on the project.
NOTE: Work in this course must be carried out over two consecutive terms: either summer and fall or fall and winter.

BIOL 498 ***Advanced Topics in Biology*** (3 credits)
Specific topics for this course, and prerequisites relevant in each case, will be stated in the Undergraduate Class Schedule.