11 Academic Programs and Courses

11.1 Anatomy and Cell Biology (504)

Strathcona Anatomy and Dentistry Building
3640 University Street, Room 1/48
Montreal, QC H3A 2B2
Telephone: (514) 398-6335

Chair — John J.M. Bergeron

Emeritus Professor
Yves Clermont; B.Sc.(Montr.), Ph.D.(McG.), F.R.C.S.

Professors
Alain Beaudet; M.Sc., Ph.D., M.D.(Montr.) *(joint appt. with Neurology & Neurosurgery)*
Gary C. Bennett; B.A., B.Sc.(Sir G.Wms.), M.Sc., Ph.D.(McG.)
John J.M. Bergeron; B.Sc.(McG.), Ph.D., D.Phil.(Oxon.)
James R. Brawer; B.S.(Tufts), Ph.D.(Harv.)
M. Burnier; M.D.,M.Sc.,Ph.D-.(Brazil) *(joint appt. with Ophthalmology)*
Louis Hermo; B.A.(Loyola), M.Sc., Ph.D.(McG.)
Charles P. Leblond; M.D.(Paris), Ph.D.(Montr.), D.Sc.(Acad.), F.R.S., F.R.S.C.
Sandra C. Miller; B.Sc.(Sir G.Wm.), M.Sc., Ph.D.(McG.)
Richard Murphy; M.S.(Northeastern), Ph.D.(Rutgers) *(joint appt. with Neurology & Neurosurgery)*
Barry I. Posner; M.D.(Man.), F.R.C.P.(C) *(joint appt. with Medicine)*
Charles E. Smith; D.D.S., Ph.D.(McG.) *(joint appt. with Dentistry)*

Associate Professors
Orest W. Blaschuk; B.Sc.(Winn.), M.Sc.(Manit.), Ph.D.(Tor.) *(joint appt. with Surgery)*
Eugene Daniels; M.Sc., Ph.D.(Man.)
Samuel David; Ph.D.(Man.) *(joint appt. with Neurology & Neurosurgery)*
Paul F. Lasko; A.B.(Harv.), Ph.D.(M.I.T) *(joint appt. with Biology)*
Marc D. McKee; B.Sc., M.Sc., Ph.D. (McG) *(joint appt. with Dentistry)*
Marilyn M. Miller; B.Sc.(Marquette), M.S., Ph.D.(Loyola) *(joint appt. with Obstetrics & Gynecology)*
Carlos R. Morales; DVM.(U.N., Argentina), Ph.D.(McG.)
Alfredo Riberio-da-Silva; M.D., Ph.D.(Oporto) *(joint appt. with Pharmacology and Therapeutics)*
Hojatollah Vali; B.Sc., M.Sc., Ph.D.(Munich) *(joint appt. with Earth and Planetary Sciences)*

Assistant Professors
Chantel Autexier; B.Sc.(C'dia), Ph.D.(McG.)
Danny Baranes; B.Sc., M.Sc., Ph.D. (Jerusalem)
Philip Barker; Ph.D.(Alta.), B.Sc.(S.Fraser) *(joint appt. with Neurology & Neurosurgery)*
Michael T. Greenwood; B.Sc.,M.Sc.(C'dia), Ph.D.(McG) *(joint appt. with Medicine)*
Timothy Kennedy; B.Sc.(McM.), M.Phil, Ph.D.(Columbia) *(joint appt. with Neurology & Neurosurgery)*
Antonis E. Koromilas; B.Sc., Ph.D.(Aristotelian U., Greece) *(joint appt. with Oncology)*
Nathalie Lamarche; B.Sc., Ph.D.(Montr.)
Peter McPherson; B.Sc.(Manit.), Ph.D.(Iowa) *(joint appt. with Neurology & Neurosurgery)*
Jackson G. Snipes; Ph.D., M.D.(Vanderbilt) *(joint appt. with Neuropathology)*
Wayne Sossin; S.B.(M.I.T.), Ph.D.(Stan.) *(joint appt. with Neurology & Neurosurgery)*
Stefano Stifani; Ph.D.(Rome), Ph.D.(Alta.) *(joint appt. with Neurology & Neurosurgery)*
Dominique Walker; B.Sc., Ph.D.(Geneva) *(joint appt. with Psychiatry)*
Gary E. Wild; B.Sc., Ph.D., M.D.,C.M.(McG.) *(joint appt. with Medicine)*

Adjunct Professors
Daniel Cyr; B.Sc., M.Sc.(C'dia), Ph.D.(Manit.)
Jacques Drouin; B.Sc., D.Sc.(Laval)
Sadayuki Inoue; M.Sc., Ph.D.(Hok. U.)
André Nantel; B.Sc., M.Sc.(Laval), Ph.D.(Chapel Hill)
David Y. Thomas; B.Sc.(Brist.); M.Sc., Ph.D.(Lond.)

The Department of Anatomy and Cell Biology offers courses which deal with cell biology, histology, embryology, neuroanatomy, and gross anatomy. The Honours Program is designed as the first phase in the training of career cell biologists. This is the most desirable path for entry into graduate studies in Anatomy and Cell Biology since only a few additional courses are required for the Ph.D. degree which therefore consists almost entirely of basic research. The Major and Faculty programs offer decreasing levels of specialization in Anatomy and Cell Biology, but with a broader base in other biological sciences. These programs also form a sound background for graduate studies in Anatomy and Cell Biology, or for further professional training in schools of medicine, dentistry and other health sciences. A B.Sc. in Anatomy and Cell Biology provides an excellent preparation for technical and administrative positions in laboratories of universities, research institutions, hospitals and pharmaceutical and biotechnological industries.

The teachers within the program are scientists who are themselves pursuing research into the structure and function of cells, tissues and organs, usually at a detailed molecular level. For this research, modern techniques of cellular and molecular biology, including immunological and ultrastructural methodologies, are employed. The Department is equipped to perform cell fractionation, protein purification, recombinant DNA technology, microinjection of molecules into single cells, cytochemical, immunocytochemical and fluorescent analysis and electron microscopy. The Department has a well equipped centre for electron microscopy as well as a centre for confocal and immunofluorescence. The advanced courses are all given by investigators who have contributed to the knowledge in the field. Consequently, students in the program of Anatomy and Cell Biology have a unique opportunity to work closely with and, in many cases, carry out original research projects with people actively engaged in research.

Inquiries about programs should be directed to the Department of Anatomy and Cell Biology.

FACULTY PROGRAM IN ANATOMY AND CELL BIOLOGY
(57 credits) [MARS Program Code 4-080100]

Required Courses (39 credits)

504-212B	(3)	Molecular Mechanisms of Cell Function
504-214A	(3)	Systemic Human Anatomy
504-261A	(4)	Introduction to Dynamic Histology (must be taken in U1)
504-262B	(3)	Introductory Molecular & Cell Biology
504-321A	(3)	Circuitry of the Human Brain
177-200A	(3)	Molecular Biology
177-202B	(3)	General Genetics
180-212A,B*	(4)	Organic Chemistry I
180-222A,B*	(4)	Organic Chemistry II
552-209A	(3)	Mammalian Physiology I
552-210B	(3)	Mammalian Physiology II
189-203A*	(3)	Principles of Statistics I
or 204-204A,B	(3)	Introduction to Psychological Statistics
or 177-373A	(3)	Biostatistical Analysis

* If the equivalents to these courses were passed in CEGEP, they are not required for the Anatomy and Cell Biology programs, and may not be re-taken at McGill. Students must take the equivalent number of credits in Elective Courses to satisfy the total credit requirement for their degree.

Complementary Courses (18 credits)
9 credits selected from:

504-322B	(3)	Neuroendocrinology
504-365A	(3)	Cell Biology of the Secretory Process
504-381B	(3)	Experimental Basis of Embryology
504-458B	(3)	Membranes and Cellular Signaling

9 credits selected from biologically oriented courses (BOC) in the following list:
177-300A, 177-301A,B, 177-303B, 177-306A, 177-313B, 177-314A, 177-357A, 177-370B, 177-389B, 177-416B, 177-420B, 177-430B, 177-431A, 177-451A, 177-468B, 177-472A, 177-475B, 177-518B, 177-522B, 177-524A, 177-532B, 177-588A;
202-505B; 382-307B;
504-322B, 504-365A, 504-381B, 504-432A,B,L, 504-541B;
507-311A, 507-312B, 507-450A, 507-454A, 507-455A, 507-503B;
516-401B, 516-502A, 516-503B, 516-504A, 516-506B, 516-507A, 516-508B, 516-509B, 516-510A, 516-511A, 516-512D;
528-314B, 528-323A, 528-324A, 528-386D, 528-387B, 528-413B, 528-414A, 528-465A, 528-466B, 528-509B;
531-310B; 546-300B;
549-300A, 549-301B, 549-562A,549-563B;
552-311A, 552-312B, 552-313B, 552-423A, 552-444B, 552-451A, 552-502B, 552-508A, 552-513A, 552-515A, 552-516B, 552-517B, 552-518A, 552-520B, 552-531B, 552-552B, 552-556B; 555-500B.

MAJOR PROGRAM IN ANATOMY AND CELL BIOLOGY
(68 credits) [MARS Program Code 1-080100]

Required Courses (59 credits)
all Faculty Program required courses, plus:

504-322B	(3)	Neuroendocrinology
504-365A	(3)	Cell Biology of the Secretory Process
504-381B	(3)	Experimental Basis of Embryology
504-458B	(3)	Membranes and Cellular Signaling
177-301A,B	(3)	Cell and Molecular Laboratory
528-314B	(3)	Immunology
552-212D	(2)	Introductory Physiology Lab

Complementary Courses (9 credits)
9 credits of biologically oriented courses (BOC), as defined in the Faculty Program.

HONOURS PROGRAM IN ANATOMY AND CELL BIOLOGY
(80 credits) [MARS Program Code 2-080100]
(Program Revisions Awaiting University Approval)

The Department offers an Honours Program. Students should register at the Major level in U1 and, if accepted, may enter the Honours Program at the beginning of U2. To enter the program, the student must obtain a CGPA of at least 3.00 at the end of U1. For promotion to the U3 year of the Honours program, or for entry into the program at this level, the student must have a CGPA of at least 3.20 at the end of their U2 year. It is expected that at the beginning of the third year the students who wish to continue in the Honours Program will be those who feel that they are seriously interested in a career in Cell Biology. The Honours Degree will be recommended after successful completion of the Program with a CGPA of at least 3.20.

Required Courses (77 credits)
all Major Program required courses, plus:

504-432D,A,B,L	(9)	Research Project in Anatomy & Cell Biology
504-541B	(3)	Cell and Molecular Biology of Aging
507-311A	(3)	Metabolic Biochemistry
507-312B	(3)	Biochemistry of Macromolecules

Complementary Courses (3 credits)
3 credits of biologically oriented courses (BOC), as defined in the Faculty Program.

COURSE DESCRIPTIONS

NOTE: Enrolment in all Anatomy and Cell Biology courses is limited by space restrictions. Admission is guaranteed for all students enrolled in programs in the Department of Anatomy and Cell Biology for which the course in question is a required course. Other students may register for courses, but the Department reserves the right to make a selection, if necessary, after the first lecture of the course.

The course credit weight is given in parentheses (#) after the course title.

● Denotes courses not offered in 2000-01.
▭ Denotes limited enrolment.
★ Denotes courses taught only in alternate years.

504-205B ASTROBIOLOGY. (3) (3 hours lecture) (Not open to students who have taken or are taking 186-205A.) Astrobiology is the search for the origin, evolution and destiny of life in the universe. The course will provide insight into the formation and evolution of habitable worlds, the evolution of life and the biogeochemical cycles in the Earth's oceans and atmosphere, and the potential for biological evolution beyond an organism's planet of origin.
Professor Vali and Staff

504-212B MOLECULAR MECHANISMS OF CELL FUNCTION. (3) (Prerequisite: 177-200A) (This course is also listed as Biochemistry 507-212B, and is not open to students who have taken or are taking the latter course.) An introductory course describing the biochemistry and molecular biology of selected key functions of animal cells, including: gene expression; mitochondrial production of metabolic energy; cellular communication with the extra-cellular environment; and regulation of cell division.
Professor Branton and Staff

504-214A SYSTEMIC HUMAN ANATOMY. (3) (2 hours lectures, 2 hours practical tutorial) (Open to students in biological sciences.) Introduction to the gross anatomy of the various organ systems of head, neck and trunk regions of the human body. Practical tutorials include studies of prepared specimens, use of the anatomical museum and audio-visual materials. This course is limited in size. Selection of students (other than those requiring the course as part of their program) will be made after the first lecture. (See NOTE following Course Descriptions above.) **Professor Hermo**

504-261A INTRODUCTION TO DYNAMIC HISTOLOGY. (4) (3 hours lectures, 2 hours laboratory) (Must be taken in U1 by students in Anatomy and Cell Biology programs) (Open to students in biological sciences and others by special permission.) An introduction to light and electron microscopic anatomy in which cell and tissue dynamics will be explored in the principal tissues and organs of the body. **Professor Morales**

504-262B INTRODUCTORY MOLECULAR & CELL BIOLOGY. (3) (3 hours lecture) (Corequisites: 504-212B or 177-201B) (Open to students in biological sciences and others by special permission.) The architectural, functional and temporal continuity of organelles and the cytoskeleton of mammalian cells is introduced as well as their functional integration in the phenomena of exocytosis, endocytosis, protein trafficking and cell motility and adhesion.
Professor Bergeron and Staff

504-315A REGIONAL ANATOMY OF THE LIMBS AND BACK. (4) (2 hours lectures, 4 hours laboratory) (Open to students in Physical and Occupational Therapy; and to Honours students in Anatomy and Cell Biology, with permission of instructor.) A dissection course in regional human gross anatomy of the skeleton, joints, muscles and neurovascular structures of the limbs and back.
Professor Bennett

504-316B HUMAN VISCERAL ANATOMY. (2) (2 hour lecture, 2 hours laboratory) (Prerequisite: 504-315A) (Open to students in Physical and Occupational Therapy, and to others by special permission.) The gross anatomy of the various organ systems of the human body, with emphasis on those aspects of greatest relevance to physical and occupational therapists. Laboratories include studies of prepared specimens, use of the anatomical museum and audiovisual materials. **Professor Bennett**

504-321A CIRCUITRY OF THE HUMAN BRAIN. (3) (2 hour lectures, 2 hours laboratory/tutorial) (Prerequisite: at least one 3-credit university level course in biology or psychology.) This course explores the functional organization of the human brain and spinal cord. The course focuses on how neuronal systems are designed to subserve specific motor, sensory, and cognitive operations.
Professor Brawer

● ★**504-322B NEUROENDOCRINOLOGY.** (3) (2 hours lectures, 1 hour conference) (Prerequisite: 504-261A and 504-321A)

★**504-365A CELL BIOLOGY OF THE SECRETORY PROCESS.** (3) (2 hours lectures, 2 hours conference) (Prerequisites: 504-261A, 177-200A, 177-201B) An intensive study of the processes of protein secretion and cell membrane biogenesis. Emphasis on morphological aspects of the above processes, and on the major techniques which have provided experimental evidence, namely, subcellular fractionation, cytochemistry and quantitative electron microscope radioautography. **Professor Kennedy and Staff**

● ★**504-381B EXPERIMENTAL BASIS OF EMBRYOLOGY.** (3) (2 hours lectures, 2 hours laboratory or conference) (Prerequisites: 504-214A, 504-261A, or by special permission.)

504-432D,A,B,L RESEARCH PROJECT IN ANATOMY & CELL BIOLOGY. (9) (Minimum 2 days per week – D, 4 days per week – A,B or 5 days per week – L) (For students in the Honours program. The course may also be taken, with special permission, by students in Anatomy Major and Faculty programs as well as by students of other Departments.) An intensive exposure to individually supervised, original research in anatomical sciences. A variety of methods, including electron microscopy, cytochemistry, immunolabeling, radioautography, and cell fractionation and biochemical analysis are applied to basic problems in cell biology. A substantial written report, followed by an oral presentation and defence are required. Students should consult the course coordinators several weeks before registration. **Professors Baranes, Brawer, Hermo and Morales**

504-458B MEMBRANES AND CELLULAR SIGNALING. (3) (3 hours lectures) (Prerequisites: 507-212B, 504-262B, one of 552-201A, 552-209A or 177-205B; one of 507-312B or 504-365A; 507-311A recommended) (Not open to students who are taking or who have taken 507-458B.) An integrated treatment of the properties of biological membranes and of intracellular signaling, including the major role that membranes play in transducing and integrating cellular regulatory signals. Biological membrane organization and dynamics; membrane transport; membrane receptors and their associated effectors; mechanisms of regulation of cell growth, morphology, differentiation and death. **Professor Greenwood and Staff**

▭ **504-541B CELL AND MOLECULAR BIOLOGY OF AGING.** (3) (2 hours lecture, 2 hours conference) (Prerequisites: 504-261A, 504-262B, or by special permission.) This course will focus on how the complex aging process can be studied by modern cell and molecular approaches. Topics will include discussion on animal model systems for aging, gene regulation controlling the aging process and age-dependent diseases. **Professor Autexier and Staff**

11.2 Atmospheric and Oceanic Sciences (195)

Burnside Hall, Room 705
805 Sherbrooke Street West
Montreal, QC H3A 2K6
Telephone: (514) 398-3764
Fax: (514) 398-6115
Internet: uginfo@zephyr.meteo.mcgill.ca
Website: http://zephyr.meteo.mcgill.ca

Chair — Charles A. Lin

Emeritus Professors
Roddy R. Rogers; B.S.(Texas), S.M.(M.I.T.), Ph.D.(N.Y.U.)
Edward J. Stansbury; M.A., Ph.D.(Tor.)

Professors
Jacques F. Derome; M.Sc.(McG.), Ph.D.(Mich.)
Lawrence A. Mysak; B.Sc.(Alta.), M.Sc.(Adel.), A.M., Ph.D.(Harv.), F.R.S.C. *(Canada Steamship Lines Professor of Meteorology)*
Isztar I. Zawadzki; B.Sc.(Buenos Aires), M.Sc., Ph.D.(McG.)

Associate Professors
John R. Gyakum; B.Sc.(Penn.), M.Sc., Ph.D.(M.I.T.)
Henry G. Leighton; M.Sc.(McG.), Ph.D.(Alta.)
Charles A. Lin; B.Sc.(U.B.C.), Ph.D.(M.I.T.)
Man Kong (Peter) Yau; S.B., S.M., Sc.D.(M.I.T.)
David Straub; B.S., M.S.(SW Louisiana), Ph.D.(Wash)

Assistant Professor
Parisa Ariya; B.Sc., Ph.D.(York) *(joint appt. with Chemistry)*

Assistant Professors (Special Category)
Peter Bartello; B.Sc., M.Sc., Ph.D.(McG.)
Frédéric Fabry; B.Sc., M.Sc., Ph.D.(McG.)

Lecturer
Alan P. Schwartz

Adjunct Professors
Jean-Pierre Blanchet, Gilbert Brunet, Eddy Carmack, R.Grant Ingram, René Laprise, Stéphane Laroche

The Department of Atmospheric and Oceanic Sciences offers, at the undergraduate level, a broad range of courses and degree programs in atmospheric science. At the postgraduate level, programs of study are offered in physical oceanography, air-sea interaction, and climate research as well as in different branches of atmospheric science. The study of atmospheric science is based largely on physics and applied mathematics. All required courses except those at the introductory level generally have prerequisites or corequisites in physics, mathematics, and atmospheric science. One of the goals of the discipline is to develop the understanding necessary to improve our ability to predict the weather, but atmospheric science is more than weather forecasting. Another important area of study focuses on the possible changes in global climate caused by the changing chemical composition of the atmosphere. The approach is always quantitative. Like other parts of physics, atmospheric science attempts to create theoretical models of its complex processes, as a means of analyzing the motion and composition of the air, its thermodynamic behaviour, and its interaction with radiation and with the solid or liquid surface beneath it. From one viewpoint, the atmosphere may be studied as a large volume of gas by the methods of fluid mechanics: winds, circulation patterns, turbulence, and energy and momentum exchanges are the ideas employed in this approach. Alternatively, the atmosphere may be studied from the point of view of its detailed physics: how water condenses in the air, how cloud droplets make rain, how sunlight warms the ground and the ground warms the air above it by radiation and convection, and how the atmosphere and ocean interact to shape the weather and climate. A comprehensive understanding requires both viewpoints, and these are reflected in the curriculum.

The Department of Atmospheric and Oceanic Sciences offers four main programs in Atmospheric Science: Honours, Major, Minor, and a Joint Major in Atmospheric Science and Physics. The Honours program is meant for students with high standing. It is based on courses similar to those in the Major program, but provides the opportunity to take advanced optional courses. The Major program, although somewhat less intensive, satisfies the requirements for a professional career as a meteorologist, and like the Honours program equips the student to undertake postgraduate study in meteorology, atmospheric science, and related sciences (for example physical oceanography) at any of the leading universities. The Department also offers a special one-year Diploma program to B.Sc. or B.Eng. graduates.

A degree in Atmospheric Science can lead to a professional career in government service or private industry. The meteorological service of Canada has traditionally been the main employer of graduating students, but certain provincial governments and environmental consulting and engineering firms also employ graduates trained in atmospheric science. Positions in teaching and research are available to graduates with M.Sc. and Ph.D. degrees. Students interested in any of the undergraduate programs should consult the Undergraduate Adviser, Room 705, Burnside Hall.

An industrial internship year is available to students enrolled in Atmospheric Science programs. IYES, the internship year program in Engineering and Science, is a pre-graduate work experience program available to eligible students and normally taken between their U2 and U3 years. See Faculty of Engineering section 2.8 for further information on IYES.

MINOR PROGRAM IN ATMOSPHERIC SCIENCE (18 credits)
[MARS Program Code 6-662000]

The Minor may be taken in conjunction with any program in the Faculty of Science.

Required Courses (15 credits)
195-214A (3) Intro. to the Physics of the Atmosphere
195-215B (3) Weather Systems and Climate
195-219B (3) Intro to Atmosp. Chemistry
or 180-219B
195-308A (3) Principles of Remote Sensing
or 183-308A
195-315A (3) Water in the Atmosphere

Complementary Course (3 credits)
195-402A (3) Atmosphere-Ocean Transports
or 195-540A (3) Synoptic Meteorology I

MAJOR PROGRAM IN ATMOSPHERIC SCIENCE (61 credits)
[MARS Program Code 1-662000]

Required Courses (49 credits)
195-214A (3) Intro. to the Physics of the Atmosphere
195-215B (3) Weather Systems and Climate
195-308A (3) Principles of Remote Sensing
or 183-308A
195-315A (3) Water in the Atmosphere
195-512A (3) Atmospheric and Oceanic Dynamics
195-513B (3) Waves and Stability
195-540A (3) Synoptic Meteorology I
195-541B (3) Synoptic Meteorology II
195-546B (1) Current Weather Discussion
189-222A,B (3) Calculus III
189-223A,B (3) Linear Algebra
189-314A,B (3) Advanced Calculus
189-315A,B (3) Ordinary Differential Equations
198-230A (3) Dynamics of Simple Systems
198-232B (3) Heat and Waves
198-259D (3) Lab. in Mechanics, Heat & Optics
308-208A,B (3) Computers in Engineering

Complementary Courses (12 credits)
3 - 6 credits to satisfy a statistics requirement, usually:
189-203A,B (3) Principles of Statistics I
or 189-323A,B (3) Probability Theory
and 189-324A,B (3) Statistics

3 credits selected from:
198-333B (3) Thermal & Statistical Physics
198-340A (3) Electricity and Magnetism

3 - 6 credits ordinarily selected from:
183-522A (3) Advanced Environmental Hydrology
189-317A (3) Numerical Analysis
189-319B (3) Partial Differential Equations
195-414B (3) Applications of Remote Sensing
195-419B (3) Adv. In Chem. of Atmosphere
or 180-419B
195-515B (3) Turbulence
198-241B (3) Signal Processing
198-248A (3) Physics of Energy
198-331B (3) Mechanics
198-340A (3) Electricity and Magnetism
198-342B (3) Electromagnetic Waves
198-332B (3) Physics of Fluids
or 305-331A,B (3) Fluid Mechanics I

JOINT MAJOR PROGRAM IN ATMOSPHERIC SCIENCE AND PHYSICS (70 credits) [MARS Program Code 1-662200]

This Major provides a solid basis for postgraduate study in meteorology, atmospheric physics, or related fields, and the necessary preparation for embarking on a professional career as a meteorologist directly after the B.Sc.

The program is jointly administered by the Departments of Physics, and Atmospheric and Oceanic Sciences. Students should consult undergraduate advisers in both departments.

Required Courses (67 credits)
195-214A (3) Intro. to the Physics of the Atmosphere
195-215B (3) Weather Systems and Climate
195-308A (3) Principles of Remote Sensing
or 183-308A
195-315A (3) Water in the Atmosphere
195-512A (3) Atmospheric and Oceanic Dynamics
195-513B (3) Waves and Stability
195-540A (3) Synoptic Meteorology I
195-541B (3) Synoptic Meteorology II
195-546B (1) Current Weather Discussion
198-230A (3) Dynamics of Simple Systems
198-232B (3) Heat and Waves
198-241B (3) Signal Processing
198-259D (3) Lab. in Mechanics, Heat & Optics
198-331B (3) Mechanics
198-333B (3) Thermal and Statistical Physics
198-339B (3) Measurements Laboratory
198-340A (3) Electricity and Magnetism
198-342B (3) Electromagnetic Waves
198-446A (3) Quantum Physics
189-222A,B (3) Calculus III
189-223A,B (3) Linear Algebra
189-314A,B (3) Advanced Calculus
189-315A,B (3) Ordinary Differential Equations

Complementary Course (3 credits)
198-434A (3) Optics
or 198-439A (3) Laboratory in Modern Physics

HONOURS PROGRAM IN ATMOSPHERIC SCIENCE
(70 credits) [MARS Program Code 2-662000]

Students can be admitted to the Honours program after completion of the U1 year of the Major in Atmospheric Science program with a minimum GPA of 3.30. Students having completed a U1 year in a different program with high standing may be admitted to the Honours program on the recommendation of the Department.

A minimum GPA of 3.30 in the Honours Program courses (taken as a whole) is required to remain in the program. A CGPA of 3.30 on the total program is also required to graduate with honours.

Required Courses (58 credits)
195-214A (3) Intro. to the Physics of the Atmosphere
195-215B (3) Weather Systems and Climate
195-308A (3) Principles of Remote Sensing
or 183-308A
195-315A (3) Water in the Atmosphere
195-480A,B (3) Honours Research Project
195-512A (3) Atmospheric and Oceanic Dynamics
195-513B (3) Waves and Stability
195-530A (3) Climate Dynamics I
195-540A (3) Synoptic Meteorology I
195-541B (3) Synoptic Meteorology II
195-546B (1) Current Weather Discussion
189-222A,B (3) Calculus III
189-223A,B (3) Linear Algebra
189-314A,B (3) Advanced Calculus
189-315A,B (3) Ordinary Differential Equations
189-319B (3) Partial Differential Equations
198-230A (3) Dynamics of Simple Systems
198-232B (3) Heat and Waves
198-259D (3) Lab in Mechanics, Heat & Optics
308-208A,B (3) Computers in Engineering

Complementary Courses (12 credits)
3-6 credits to satisfy a statistics requirement, usually:
189-203A,B (3) Principles of Statistics I
or 189-323A,B (3) Probability Theory
and 189-324A,B (3) Statistics

3 credits selected from:
198-333B (3) Thermal and Statistical Physics
198-340A (3) Electricity and Magnetism

3-6 credits ordinarily selected from:

183-522A	(3)	Advanced Env. Hydrology
189-317A	(3)	Numerical Analysis
195-414B	(3)	Applications of Remote Sensing
195-419B or 180-419B	(3)	Adv. in Chem. of Atmosphere
195-515B	(3)	Turbulence
198-241B	(3)	Signal Processing
198-248B	(3)	Physics of Energy
198-331B	(3)	Mechanics
198-340B	(3)	Electricity and Magnetism
198-342B	(3)	Electromagnetic Waves
198-332B	(3)	Physics of Fluids
or 305-331A,B	(3)	Fluid Mechanics I

DIPLOMA IN METEOROLOGY (30 credits)

The Department offers an intensive, one-year program in theoretical and applied meteorology to B.Sc. or B.Eng. graduates of suitable standing in Physics, Applied Mathematics, Engineering, Science, or other appropriate disciplines, leading to a Diploma in Meteorology. The program is designed for students with little or no previous background in meteorology who wish to direct their experience to atmospheric or environmental applications, or who need to fulfil academic prerequisites in meteorology to qualify for employment. For further information, consult the Graduate Coordinator, Burnside Hall, Room 705.

An exemption of up to 6 credits may be allowed for courses already taken. Students granted such exemptions are required to add complementary courses from an approved list to maintain a total credit count of 30 completed at McGill.

Required Courses (18 credits)

195-512A	(3)	Atmospheric & Oceanic Dynamics
195-513B	(3)	Waves and Stability
195-530A	(3)	Climate Dynamics I
195-531B	(3)	Climate Dynamics II
195-540A	(3)	Synoptic Meteorology I
195-541B	(3)	Synoptic Meteorology II

Complementary Courses (12 credits)

6 credits selected from:

195-308A or 183-308A	(3)	Principles of Remote Sensing
195-315A	(3)	Water in the Atmosphere
195-414B	(3)	Applications of Remote Sensing
195-419B or 180-419B	(3)	Adv. in Chem. of Atmosphere

6 credits ordinarily selected from:

183-522A	(3)	Advanced Env. Hydrology
189-317A	(3)	Numerical Analysis
189-319B	(3)	Partial Differential Equations
195-515B	(3)	Turbulence
198-331B	(3)	Mechanics
198-340A	(3)	Electricity and Magnetism
198-342B	(3)	Electromagnetic Waves
198-332 B	(3)	Physics of Fluids
or 305-331A,B	(3)	Fluid Mechanics I

INTERNSHIP PROGRAMS – INTERNSHIP YEAR FOR ENGINEERING AND SCIENCE (IYES)

The following programs are also available with an Internship component. For more information, please see section 2.8 in the Faculty of Engineering section.

Major in Atmospheric Science
Honours in Atmospheric Science

COURSE DESCRIPTIONS

The course credit weight is given in parentheses (#) after the course title.

● Denotes courses not offered in 2000-01.
▭ Denotes limited enrolment.
★ Denotes courses taught only in alternate years.

▭ **195-199B FYS: WEATHER, CLIMATE, HISTORY.** (3) (2 hours lectures; 1 hour seminar) (FYS - for first year students only, maximum 25.) A seminar course on how weather and climate have influenced human history. The impact of weather and climate on agriculture, disease, demography, economic cycles and history. The Little Ice Age in Eurpose will be used as an example for study. Methods to establish linkage between weather, climate and history. (Revision to title and description Awaiting University Approval)

195-210A,B INTRODUCTION TO ATMOSPHERIC SCIENCE. (3) (3 hours lectures) (Open to all students except those who have taken 195-214A.) A survey of the Earth's atmosphere, weather and climate system. Topics include the fundamental processes that determine interactions between the atmosphere, ocean and biosphere; anthropogenic effects such as global warming, the ozone hole and acid rain; a perspective on future climate change.

195-214A INTRO. TO THE PHYSICS OF THE ATMOSPHERE. (3) (3 hours lectures) (Prerequisite: CEGEP Physics.) An introduction to physical meteorology designed for students in the physical sciences. Topics include: composition of the atmosphere; heat transfer; the upper atmosphere; atmospheric optics; formation of clouds and precipitation; instability; adiabatic charts.

195-215B WEATHER SYSTEMS AND CLIMATE. (3) (3 hours lectures) (Prerequisite: CEGEP Physics or permission of the instructor.) Laws of motion, geostrophic wind, gradient wind. Surface and upper-level charts. Local wind systems, global wind systems. Air masses, fronts and middle latitude cyclones. Thunderstorms, tornadoes and hurricanes. Global climate, climate change. Weather on the "web".

★**195-219B INTRODUCTION TO ATMOSPHERIC CHEMISTRY.** (3) (3 hours lectures) (Prerequisite: CEGEP DEC in Science or permission of instructor.) (Not open to students who have taken 180-219, 180-419 or 195-419.) (Offered in odd years. Students should register in 180-219 in even years.) An introduction to the basic topics in atmospheric chemistry. The fundamentals of the chemical composition of the atmosphere and its chemical reactions. Selected topics such as smog chamber, acid rain, and ozone hole will be examined.

195-220A,B INTRODUCTION TO OCEANIC SCIENCES. (3) (3 hours lectures) (Not open to students who have taken 186-360A or 186-560A.) Air-sea interaction; oceanic properties; global climate change, carbon cycle; polar oceans, sea ice, polynyas; El Niño; remote sensing of oceans; physical control of biological processes in the sea.

● **195-230B CLIMATE AND CLIMATE CHANGE.** (3) (3 hours lectures) (Prerequisite: CEGEP Physics or 183-203.)

195-250A NATURAL DISASTERS. (3) (3 hours lectures) (Not open to students who have taken or are taking 186-250.)This course examines the science behind different types of disasters and our ability or inability to control and predict such events. From this course the student will gain an appreciation of natural disasters beyond the newspaper headlines, and will better understand how the effects of disasters can be reduced.

195-308A PRINCIPLES OF REMOTE SENSING. (3) (3 hours lectures) (Not open to students who have taken or are taking 183-308.) A conceptual view of remote sensing and the underlying physical principles are presented. Ground-based and satellite systems and various components of the acoustic and electromagnetic spectrum – from visible to microwave – are discussed. Substantial emphasis is devoted to the application of remote sensed data in geography and atmospheric sciences.

● **195-310B PHYSICAL OCEANOGRAPHY.** (3) (3 hours lectures) (Prerequisite: 195-220, 189-141 or equivalent. Not open to students who have taken 186-360A.)

195-315A WATER IN THE ATMOSPHERE. (3) (3 hours lectures) (Prerequisite: 195-214.) Global distribution of water in the atmosphere. Moist processes. Global and mesoscale precipitation sys-

tems.Quantitative forecasting of precipitation. Extreme precipitation events. Large-scale influences. Precipitation modification.

● **195-330A PHYSICAL METEOROLOGY.** (3) (3 hours lectures) (Prerequisite: 195-214A OR permission of instructor. Not open to students who have taken 195-320A and -321B.)

195-400D INDEPENDENT STUDY OF AN ENVIRONMENTAL PROBLEM. (3) (Restricted to students taking a joint program in Atmospheric and Environmental Science or with permission of Department.) A reading or research project, conducted under the guidance of an instructor, on the meteorological processes related to an environmental problem. A written report will be required. Students should consult the departmental undergraduate student adviser for the names of available supervisors.

195-402A ATMOSPHERE-OCEAN TRANSPORTS. (3) (3 hours lectures) (Prerequisite:189-222) The role of the atmosphere and oceans in redistributing chemical, physical and biological quantities such as heat, nutrients and pollutants. Overview of flow regimes, from global to turbulence scales, advection and diffusion processes; Reynolds averaging and turbulence; the effect of the Earth`s rotation, stratospheric transport of pollutants, oceanic CO_2 transports.

195-414B APPLICATIONS OF REMOTE SENSING. (3) (3 hours lectures) (Prerequisite: 195-308 or 183-308.) A more quantitative version of some topics covered in 195-308 with emphasis on the contribution of remote sensing to atmospheric and oceanic sciences. Basic notions of radiative transfer and applications of satellite and radar data to mesoscale and synoptic-scale systems are discussed.

★**195-419B ADVANCES IN CHEMISTRY OF THE ATMOSPHERE.** (3) (3 hours lectures) (Prerequisites: 180-213, 180-273, 189-222 and 189-315 or equivalents, or permission of instructor.) (Not open to students who have taken 180-419, 180-619, and 195-619.) (Offered in odd years. Students should register in 180-419 in even years.) Selected areas of atmospheric chemistry from field and laboratory to theoretical modelling are examined. The principles of atmospheric reactions (gas, liquid and heterogeneous phases in aerosols and clouds) and issues related to chemical global change will be explored.

195-480A,B HONOURS RESEARCH PROJECT. (3) (Restricted to U3 Honours students.) The student will carry out a research project under the supervision of a member of the staff. The student will be expected to write a report and present a seminar on the work.

195-512A ATMOSPHERIC AND OCEANIC DYNAMICS. (3) (3 hours lectures) (Prerequisite: Permission of instructor.) Introduction to the fluid dynamics of large-scale flows of the atmosphere and oceans. Stratification of atmosphere and oceans. Equations of state, thermodynamics and momentum. Kinematics, circulation, and vorticity. Hydrostatic and quasi-geostrophic flows. Brief introduction to wave motions, flow over topography, Ekman boundary layers, turbulence.

195-513B WAVES AND STABILITY. (3) (3 hours lectures) (Prerequisite: Permission of instructor.) Linear theory of waves in rotating and stratified media. Geostrophic adjustment and model initialization. Wave propagation in slowly varying media. Mountain waves; waves in shear flows. Barotropic, baroclinic, symmetric, and Kelvin-Helmholtz instability. Wave-mean flow interaction. Equatorially trapped waves.

● **195-515B TURBULENCE IN THE ATMOSPHERE AND OCEANS.** (3) (3 hours lectures) (Prerequisite: 195-512A or permission of instructor.)

195-530A* CLIMATE DYNAMICS I. (3) (3 hours lectures) (Prerequisite: Permission of instructor.) Introduction to the components of the climate system. Review of paleoclimates. Physical processes and models of climate and climate change.

195-531B* CLIMATE DYNAMICS II. (3) (3 hours lectures) (Prerequisite: Permission of instructor.) The general circulation of the atmosphere and oceans. Atmospheric and oceanic general circulation models. Observations and models of the El Niño and Southern Oscillation phenomena.

● **195-540A SYNOPTIC METEOROLOGY I.** (3) (2 hours lectures; 2 hours laboratory) (Prerequisite: Permission of instructor.)

● **195-541B SYNOPTIC METEOROLOGY II.** (3) (2 hours lectures; 2 hours laboratory) (Prerequisite: 195-512A and -540A or permission of instructor.)

195-546B* CURRENT WEATHER DISCUSSION. (1) (2 hours) (Prerequisite: 195-540A or permission of instructor.) Half-hour briefing on atmospheric general circulation and current weather around the world using satellite data, radar observations, conventional weather maps, and analyses and forecasts produced by computer techniques.

195-550A* SPECIAL TOPICS IN METEOROLOGY AND OCEANOGRAPHY I. (1) (1 hour lecture) (Prerequisite: Permission of instructor.) Lectures and seminars on special topics such as hydrology, agricultural meteorology, the limits of predictability, planetary atmospheres, atmospheric and oceanic pollution, coastal currents, and research reviews.

● **195-551B* SPECIAL TOPICS IN METEOROLOGY AND OCEANOGRAPHY II.** (1) (1 hour lecture) (Prerequisite: Permission of instructor.)

● **195-558B* NUMERICAL METHODS AND LABORATORY.** (3) (1 hour lecture; 4 hours laboratory) (Prerequisite: Permission of instructor)

● **195-568B OCEAN PHYSICS.** (3) (3 hours lectures) (Prerequisite: 195-512A or permission of instructor.)

*Restricted to Graduate students and final-year Honours Atmospheric Science students. Others by special permission.

11.3 Biochemistry (507)

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Chair — T.B.A.

Emeritus Professors
Angus F. Graham; M.Sc.(Tor.), Ph.D., D.Sc.(Edin.), F.R.S.C.
Rose M. Johnstone; B.Sc., Ph.D.(McG.), F.R.S.C.
Samuel Solomon; M.Sc., Ph.D.(McG.), F.R.S.C.
Theodore L. Sourkes; M.Sc.(McG.), Ph.D.(Corn.), F.R.S.C.
Leonhard S. Wolfe; M.Sc.(N.Z.), Ph.D.(Cantab.), F.R.S.C.

Professors
Rhoda Blostein; B.Sc., M.Sc., Ph.D.(McG.)
Philip E. Branton; B.Sc., M.Sc., Ph.D.(Tor.) *(Gilman Cheney Professor of Biochemistry)*
Peter E. Braun; M.Sc.(U.B.C.), Ph.D.(Berk.)
Philippe Gros; B.Sc., M.Sc.(Montr.), Ph.D.(McG.)
Annette A. Herscovics; B.Sc., Ph.D.(McG.) *(joint appt. with Oncology)*
Robert E. MacKenzie; M.N.S., B.Sc.(Agr.)(McG.), Ph.D.(C'nell)
Edward A. Meighen; B.Sc.(Alta.), Ph.D.(Berk.)
Walter E. Mushynski; B.Sc., Ph.D.(McG.)
Gordon C. Shore; B.Sc.(Guelph), Ph.D.(McG.)
Joseph Shuster; B.Sc.(McG.), Ph.D.(Calif.), M.D.(Alta.)
John R. Silvius; B.Sc., Ph.D.(Alta.)
Nahum Sonenberg; M.Sc., Ph.D.(Weizmann Inst.), F.R.S.C.
Clifford P. Stanners; B.Sc.(McM.), M.A., Ph.D.(Tor.) *(joint appt. with Oncology)*
Maria Zannis-Hadjopoulos; B.Sc., M.Sc., Ph.D.(McG.) *(joint appt. with Oncology)*

Associate Professors
Nicole Beauchemin; B.Sc., M.Sc., Ph.D.(Montr.) *(joint appt. with Oncology)*
Vincent Giguère; B.Sc., Ph.D.(Laval) *(joint appt. with Oncology)*

Alain Nepveu; B.Sc., M.Sc.(Montr.), Ph.D.(Sher.) *(joint appt. with Oncology)*
Morag Park; B.Sc., Ph.D.(Glasgow) *(joint appt. with Oncology)*
Jerry Pelletier; B.Sc., Ph.D.(McG.)
Michel L. Tremblay; B.Sc., M.Sc.(Sher.), Ph.D.(McM.)

Assistant Professors
Kalle Gehring; M.Sc.(Mich.), Ph.D.(Berk.)
Alice Vrielink; B.Sc, M.Sc.(Cal.), Ph.D.(Lond.)

Associate Members
John J. Bergeron *(Anatomy & Cell Biology)*; Katherine Cianflone *(Exp. Medicine, RVH)*; L. Fernando Congote (*Exp. Medicine, RVH)*; Robert Dunn *(Exp. Medicine, MGH);* Mark S. Featherstone *(Oncology)*; William C. Galley *(Chemistry)*; Michael A. Parniak *(JGH, Lady Davis Inst.)*; Peter J. Roughley (*Shriners Hospital)*; Erwin Schurr *(Exp. Medicine, RVH)*; Charles Scriver *(Pediatrics, MCH);* Bernard Turcotte *(Exp. Medicine, RVH);* Simon Wing *(Medicine);* Xiang-Jiao Yang *(Molecular Oncology, RVH)*

Adjunct Professors
Michael Cordingley; B.A.(Cantab.), Ph.D.(Glasgow) *(Boehringer-Ingelheim)*
Mirek Cygler; M.Sc., Ph.D.(Poland)*(B.R.I.)*
Jacques Drouin; B.Sc., Ph.D.(Laval) *(Clin. Res. Inst.)*
Michael Gresser; B.A.(Kansas), Ph.D.(Brandeis) *(Merck Frosst)*
Feng Ni; B.A.(Lanzhou), M.Sc., Ph.D.(C'nell) *(B.R.I.)*
Donald Nicholson; B.Sc., Ph.D.(W.Ont.) *(Merck Frosst)*
Maureen D. O'Connor-McCourt; B.Sc.(Guelph), Ph.D.(Alta.) *(B.R.I.)*
Andrew C. Storer; B.Sc., Ph.D.(Birm.) *(B.R.I.)*
Marc Therrien; B.Sc., Ph.D.(Montr.) *(Clin. Res. Inst.)*
Andre Veillette; B.Sc., M.D.(Laval *(Clin. Res. Inst.)*
Lee A. Wall; B.Sc., Ph.D.(McG.) *(U. de Montr., CHUM, L'Inst. du cancer)*

Biochemistry is the application of chemical, genetic, and biophysical approaches to the study of biological processes at the cellular and molecular level. Biochemists are interested in the dynamic events that occur in cells, for example, in mechanisms of brain function; cellular differentiation; energy utilization by animals and microorganisms and in the molecular basis of inheritance and disease. The biochemist seeks to determine how specific molecules such as proteins, nucleic acids, lipids, vitamins and hormones function in various cellular processes. Biochemists place particular emphasis on the regulation of reactions in living cells. The knowledge and methods developed by biochemists are applied in all fields of medicine, in agriculture and in many chemical and health related industries. Biochemistry is unique in providing basic theoretical training as well as basic practical laboratory training and research in both enzymology and genetic engineering, the two basic components in the rapidly expanding field of Biotechnology.

Three programs are offered by the Department of Biochemistry. The Honours and Major programs provide a sound background for students who wish to have a professional career in biochemistry and can lead to post graduate studies and research careers in hospital, university or industrial laboratories. The Faculty program is less specialized offering students opportunities to select courses in other fields of interest.

During the first year, each program provides basic training in organic, physical and analytical chemistry as well as in biology and physiology. The Honours and Major programs become more specialized in biochemistry during the following two years with additional work in chemistry and biology. The rigorous training in chemistry, which distinguishes the Biochemistry program from Biological Sciences, can lead to admission to the Professional Order of Chemists – a requirement needed to function as a recognized chemist in the Province of Québec.

Students interested in pursuing an *ad hoc* Joint Major or Joint Honours degree between Biochemistry and a second discipline may consult with our Chief Adviser.

The increasing involvement of complex technology in modern society requires personnel trained in both chemistry and biology. With the advent of biotechnology, the combination of chemistry, molecular biology, enzymology and genetic engineering found in the biochemistry program provides the essential background and training in this area as well. The biochemist is in an advantageous position to fulfil this role and assume a wide variety of positions in industry and the health field. These range from research and development in the chemical and pharmaceutical industries to testing as well as research in government and hospital laboratories to management. Many graduates take higher degrees in research and attain academic positions in universities and colleges.

PRE-PROGRAM REQUIREMENTS
Entrance requirements for the Faculty, Major and Honours programs are: 6 credits in elementary biology, 6 credits in general chemistry, 3 credits in organic chemistry, 6 credits in calculus, 8-9 credits in physics.

FACULTY PROGRAM IN BIOCHEMISTRY (55 credits)
[MARS Program Code 4-142000]

U1 Required Courses (16 credits)

507-212B	(3)	Molecular Mechanisms of Cell Function
177-200A	(3)	Molecular Biology
177-202B	(3)	Basic Genetics
180-204A,B	(3)	Physical Chem./Biol. Sci. I
180-222A,B	(4)	Organic Chemistry II

U1 Complementary Courses (9 credits)
6 credits selected from:

552-209A	(3)	Mammalian Physiology I
552-210B	(3)	Mammalian Physiology II
528-211A	(3)	Biology of Microorganisms
177-205B	(3)	Biology of Organisms

3 credits selected from:

177-373A	(3)	Biostatistical Analysis
308-202A,B	(3)	Introduction to Computing I
204-204A,B	(3)	Introduction to Psychological Statistics
189-222A,B	(3)	Calculus III

U2 Required Courses (15 credits)

507-300D	(6)	Laboratory in Biochemistry
507-311A	(3)	Metabolic Biochemistry
507-312B	(3)	Biochemistry of Macromolecules
180-302A,B	(3)	Organic Chemistry III

U2 Complementary Courses (3 credits)
3 credits selected from:

177-303B	(3)	Developmental Biology
177-313B	(3)	Structure and Function of Cells
180-352B	(3)	Structural Organic Chemistry
180-382B	(3)	Organic Chemistry of Natural Products
528-314B	(3)	Immunology
504-262B	(3)	Introductory Molecular and Cell Biology

U3 Complementary Courses (12 credits)
at least 3 credits selected from:

507-450A	(3)	Protein Structure and Function
507-454A	(3)	Nucleic Acids

the remaining credits selected from the following list or the above:

507-404B	(3)	Biophysical Chemistry
507-455B	(3)	Neurochemistry
507-458B	(3)	Membranes and Cellular Signaling
504-261A	(4)	Introduction to Dynamic Histology
177-205B	(3)	Biology of Organisms
177-300A	(3)	Molecular Biology of the Gene
177-303B	(3)	Developmental Biology
177-304A	(3)	Evolution
177-314A	(3)	Molecular Biology of Oncogenes
180-214B	(3)	Physical Chem./Biol. Sci. II
180-257D	(4)	Analytical Chemistry
180-352B	(3)	Structural Organic Chemistry
180-362A,B	(2)	Advanced Organic Chemistry Lab.
180-382B	(3)	Organic Chemistry of Natural Products
180-402B	(3)	Advanced Bio-organic Chemistry
180-572B	(3)	Synthetic Organic Chemistry
528-211A	(3)	Biology of Microorganisms
528-314B	(3)	Immunology
549-300A	(3)	Drug Action

549-301B (3) Drugs and Disease
552-209A (3) Mammalian Physiology I
552-210B (3) Mammalian Physiology II

MAJOR PROGRAM IN BIOCHEMISTRY (67 or 70 credits)
[MARS Program Code 1-142000]

Students may transfer into the Major program at any time provided they have met all course requirements.

U1 Required Courses (20 credits)
507-212B (3) Molecular Mechanisms of Cell Function
177-200A (3) Molecular Biology
177-202B (3) Basic Genetics
180-204A,B (3) Physical Chem./Biol. Sci. I
180-222A,B (4) Organic Chemistry II
180-257D (4) Analytical Chemistry

U1 Complementary Courses (9 credits)
6 credits, selected from:
552-209A (3) Mammalian Physiology I
552-210B (3) Mammalian Physiology II
528-211A (3) Biology of Microorganisms
177-205B (3) Biology of Organisms
3 credits selected from:
177-309A (3) Math. Models in Biology
177-373A (3) Biostatistical Analysis
308-202A,B (3) Intro to Computing I
189-203A,B (3) Principles of Statistics
189-222A,B (3) Calculus III
204-204A,B (3) Intro to Psychological Stats

U2 Required Courses (23 credits)
all Faculty Program U2 Required Courses, plus:
180-214B (3) Physical Chem./Biol. Sci. II
180-362A,B (2) Advanced Organic Chemistry Lab.
504-262B (3) Intro. Molecular & Cell Biology

U2 Complementary Courses (3 credits)
3 credits selected from:
177-303B (3) Developmental Biology
177-313B (3) Structure and Function of Cells
180-352B (3) Structural Organic Chemistry
180-382B (3) Organic Chemistry of Natural Products
528-314B (3) Immunology

U3 Required Courses (6 credits)
507-450A (3) Protein Structure and Function
507-454A (3) Nucleic Acids

U3 Complementary Courses (6 or 9* credits)
at least 3 credits selected from:
507-404B (3) Biophysical Chemistry
507-455B (3) Neurochemistry
507-458B (3) Membrames and Cellular Signalling
507-460A* (6) Advanced Lab in Biochemistry
507-503B (3) Immunochemistry

the remainder, if any, to be selected from the following list:
177-300A (3) Molecular Biology of the Gene
177-303B (3) Developmental Biology
177-304A (3) Evolution
177-313B (3) Structure and Function of Cells
177-314A (3) Molecular Biology of Oncogenes
180-352B (3) Structural Organic Chemistry
180-382B (3) Organic Chemistry of Natural Products
180-402B (3) Advanced Bio-organic Chemistry
180-552B (3) Physical Organic Chemistry
180-572B (3) Synthetic Organic Chemistry
516-502A (3) Advanced Endocrinology I
516-503B (3) Advanced Endocrionology II
528-314B (3) Immunology
528-324A (3) Fundamental Virology
549-300A (3) Drug Action
549-301B (3) Drugs and Disease
552-311A (3) Intermediate Physiology I
552-312B (3) Intermediate Physiology II

* Students who are given special permission to take 507-460A are required to complete 9 credits of complementary courses in U3.

HONOURS PROGRAM IN BIOCHEMISTRY (76 credits)
[MARS Program Code 2-142000]

Admission to the Honours program will not be granted until U2. Students who wish to enter the Honours program in U2 should follow the U1 Major program. Those who satisfactorily complete the U1 Major program with a GPA of at least 3.20 and a mark of B or B- or better in every required course are eligible for admission to the Honours program.

Students seeking admission to the Honours program must obtain permission from the Student Affairs Officer during the Add/Drop period in September of their second year.

Promotion to U3 year is based on satisfactory completion of U2 courses with a GPA of at least 3.20 and a B in every required course. In borderline cases, the marks received in 507-311A and 507-312B will be of particular importance for continuation in the U3 Honours year.

For graduation in the Honours program, the student must complete a minimum of 90 credits, pass all required courses with no grade less than B, and achieve a CGPA of at least 3.20.

U1 Required Courses (20 credits)
as for the Major Program U1

U1 Complementary Courses (9 credits)
as for the Major Program U1

U2 Required Courses (23 credits)
as for the Major Program U2

U2 Complementary Courses (3 credits)
as for the Major Program U2

U3 Required Courses (15 credits)
507-404B (3) Biophysical Chemistry
507-450A (3) Protein Structure & Function
507-454A (3) Nucleic Acids
507-460A (6) Advanced Lab in Biochemistry

U3 Complementary Courses (6 credits)
3 - 6 credits must be selected from:
507-455B (3) Neurochemistry
507-458B (3) Membranes and Cellular Signaling
507-491B (6) Independent Research
507-503B (3) Immunochemistry
the remainder, if any, to be selected from the following list:
177-300A (3) Molecular Biology of the Gene
177-303B (3) Developmental Biology
177-304A (3) Evolution
177-313B (3) Structure and Function of Cells
177-314A (3) Molecular Biology of Oncogenes
180-352B (3) Structural Organic Chemistry
180-382B (3) Organic Chemistry of Natural Products
180-402B (3) Advanced Bio-organic Chemistry
180-552B (3) Physical Organic Chemistry
180-572B (3) Synthetic Organic Chemistry
516-502A (3) Advanced Endocrinology I
516-503B (3) Advanced Endocrinology II
528-314B (3) Immunology
528-324A (3) Fundamental Virology
549-300A (3) Drug Action
549-301B (3) Drugs and Disease
552-311A (3) Intermediate Physiology I
552-312B (3) Intermediate Physiology II

ADVISERS

New students interested in Biochemistry should call (514) 398-7266 for information regarding academic advising.

Returning Students must schedule an advising appointment directly with the academic adviser assigned to them in their first year in Biochemistry. Students should check the advisers' schedule which will be posted on the 8th floor of the McIntyre Medical Sciences Building in mid-March or early April 2001.

INTERDEPARTMENTAL HONOURS PROGRAM IN IMMUNOLOGY The Departments of Biochemistry, Microbiology and Immunology, and Physiology offer an Immunology Interdepartmental Honours Program, see section 11.13.

COURSE DESCRIPTIONS

The course credit weight is given in parentheses (#) after the course title.

▭ Denotes courses with limited enrolment

507-212B Molecular Mechanisms of Cell Function. (3) (Prerequisite: 177-200A) (A non-terminal course intended to be followed by 507-311A; 507-312B in the U2 year. Not open to students who have taken or are taking 177-201B.) An introductory course describing the biochemistry and molecular biology of selected key functions of animal cells, including: gene expression; mitochondrial production of metabolic energy; cellular communication with the extra-cellular environment; and regulation of cell division.

Professor Branton (Coordinator) and Staff

507-300D LABORATORY IN BIOCHEMISTRY. (6) (1 lecture and one 6-hour lab per week) (Prerequisites: 177-200A and 177-201B, or 507-212B, 180-222A,B; 180-257D recommended. Corequisites: 507-311A and 507-312B. Not open to students who have taken or are taking 177-301.) (For students in Biochemistry programs, others with permission of instructor.) A comprehensive course in modern biochemical techniques involving properties of enzymes, metabolism, fractionation of organelles from mammalian cells and molecular biology. **Professors Tremblay and Gros**

507-311A METABOLIC BIOCHEMISTRY. (3) (Prerequisites: 177-200A, 177-201B, or 507-212B, 180-222A,B) The generation of metabolic energy in higher organisms with an emphasis on its regulation at the molecular, cellular and organ level. Chemical concepts and mechanisms of enzymatic catalysis are also emphasized. Included: selected topics in carbohydrate, lipid and nitrogen metabolism; complex lipid and biological membranes; hormonal signal transduction. **Professor Mushynski**

507-312B BIOCHEMISTRY OF MACROMOLECULES. (3) (Prerequisites: 507-311A, 177-200A, 177-201B or 507-212B) Gene expression from the start of transcription to the synthesis of proteins, their modifications and degradation. Topics covered: purine and pyrmidine metabolism; transcription and its regulation; mRNA processing; translation; targetting of proteins to specific cellular sites; protein glycosylation; protein phosphorylation; protein turn-over; programmed cell death (apoptosis). **Professor Nepveu**

507-404B BIOPHYSICAL CHEMISTRY. (3) (Prerequisites: 180-204A,B, 180-214B or equivalent. (Not open to students who have taken 180-404B.) Hydrodynamic and electrophoretic methods for separation and characterization of macromolecules. Optical and magnetic resonance spectroscopy of biopolymers, and applications to biological systems. **Professor Silvius**

507-450A PROTEIN STRUCTURE AND FUNCTION. (3) (Prerequisites: 507-311A, 507-312B and/or sufficient organic chemistry. Intended primarily for students at the U3 level.) Primary, secondary, tertiary and quaternary structure of enzymes. Active site mapping and site-specific mutagenesis of enzymes. Enzyme kinetics and mechanisms of catalysis. Multienzyme complexes.

Professors Meighen (Coordinator), Gehring and Vrielink

507-454A NUCLEIC ACIDS. (3) (Prerequisites: 507-311A, 507-312B or permission of instructor.) Chemistry of RNA and DNA, transcription and splicing of RNA and their control; enzymology of DNA replication. Special topics on transgenics, genetic diseases and cancer. **Professor Shore and Staff**

507-455B NEUROCHEMISTRY. (3) (Prerequisites: 507-311A, 507-312B or permission of instructor) Covers biochemical mechanisms underlying central nervous system function. Introduces basic neuroanatomy, CNS cell types and morphology, neuronal excitability, chemically mediated transmission, glial function. Biochemistry of specific neurotransmitters, endocrine effects on brain, brain energy metabolism and cerebral ischemia (stroke). With examples, where relevant, of biochemical processes disrupted in human CNS disease.

Professors Boksa, Srivastava (Coordinators), Walker and Young (Psychiatry Dept.)

507-458B MEMBRANES AND CELLULAR SIGNALING. (3) (Prerequisites: 507-212B, 504-262B; one of 552-201A,552-209A or 177-205B; one of 507-312B or 504-365A; and 507-311A or permission of instructors.) (This course is also listed as 504-458B. Not open to students who have taken or are taking 504-458B or 507-456B.) An integrated treatment of the properties of biological membranes and of intracellular signaling, including the major role that membranes play in transducing and integrating cellular regulatory signals. Biological membrane organization and dynamics: membrane transport; membrane receptors and their associated effectors; mechanisms of regulation of cell growth, morphology, differentiation and death. **Professors Silvius and Greenwood (Anatomy Dept.)**

▭ **507-460A ADVANCED LAB IN BIOCHEMISTRY.** (6) (Enrolment limit) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) Students will select one project, employing advanced as well as standard biochemical techniques, to be performed in a research laboratory in the Department. Each student will also write a research-review paper with the advice of a professor and perform student projects in the teaching laboratory. **Professor Pelletier and Staff**

507-491B INDEPENDENT RESEARCH. (6) (Registration by departmental permission only) (Prerequisite: 507-460A) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) Individual work on a project to be performed in a research laboratory.

Professor Shore and Staff

507-503B IMMUNOCHEMISTRY. (3) (Prerequisites: 507-311A, 507-312B) This course, presented in lecture format, emphasizes the molecular, genetic and structure function events that occur in the humoral immune response. Interleukins and other mediators of inflammation, a field in which rapid changes are occurring, are discussed. The clinical significance of fundamental biochemical findings is described. **Professor Shuster**

11.4 Biology (177)

Stewart Biology Building, Room W4-7
1205 Avenue Docteur Penfield
Montreal, QC H3A 1B1
Telephone: (514) 398-6400
Website: http://www.mcgill.ca/Biology/biology1.htm

Chair — Donald L. Kramer

Emeritus Professors

Clark Fraser; O.C., B.Sc.(Acadia), M.Sc., Ph.D., M.D.(McG.), D.Sc.(Acadia), F.R.C.P.(C), F.R.S.C. *(Molson Emeritus Professor of Genetics) (joint appt. with Human Genetics)*
Sarah P. Gibbs; A.B., M.S.(C'nell), Ph.D.(Harv.), F.R.S.C. *(Macdonald Emeritus Professor of Botany)*
John B. Lewis; B.Sc., M.Sc., Ph.D.(McG.)
Gordon A. Machlaughlin; B.Sc.(Sask.), Ph.D.(Manit.), F.R.S.C. *(Macdonald Emeritus Professor of Botany)*
Joan R. Marsden; M.Sc.(McG.), Ph.D.(Calif.), D.Sc.(Queen's) *(Strathcona Emeritus Professor of Zoology)*
Rolf Sattler; B.Sc.(Tubingen), Ph.D.(Munich), F.R.S.C.

Professors

Graham A.C. Bell; B.A., D.Phil.(Oxon.), F.R.S.C. *(Molson Professor of Genetics)*
Gregory G. Brown; B.Sc.(Notre Dame), Ph.D.(N.Y.)
A.Howard Bussey; B.Sc., Ph.D.(Brist.), F.R.S.C.
Robert L. Carroll; B.S.(Mich.), M.A., Ph.D.(Harv.), F.R.S.C. *(Strathcona Professor of Zoology)*
Ronald Chase; A.B.(Stan.), Ph.D.(M.I.T.) *(on leave fall term)*
Rajinder S. Dhindsa; B.Sc., M.Sc.(Punj.), Ph.D.(Wash.)
Jacob Kalff; M.S.A.(Tor.), Ph.D.(Ind.) *(on leave)*

Donald L. Kramer; B.Sc.(Boston Coll.), Ph.D.(U.B.C.)*(on leave winter term)*
Paul F. Lasko; A.B.(Harv.), Ph.D.(M.I.T.) *(joint appt. with Anatomy & Cell Biology)*
Martin Lechowicz; B.A.(Mich. State), M.S., Ph.D.(Wis.)
Barid B. Mukherjee; B.Sc.(Calc.), M.S.(Brig.Young), Ph.D.(Utah) *(joint appt. with Human Genetics)*
Ronald J. Poole; B.Sc., Ph.D.(Birm.)
Derek A. Roff; B.Sc.(Sydney), Ph.D.(U.B.C.)
Rima Rozen; B.Sc., Ph.D.(McG.)
Daniel J. Schoen; B.Sc., M.Sc.(Mich.), Ph.D.(Calif.) *(Macdonald Professor of Botany)*

Associate Professors
Peter Hechtman; M.Sc.(Minn.), B.Sc., Ph.D.(McG.)
Siegfried Hekimi, M.Sc., Ph.D.(Geneva)
Louis Lefebvre; B.Sc., M.A., Ph.D.(Montr.)
Robert L. Levine; B.Sc.(Brooklyn), M.Sc., Ph.D.(Yale)
Yutaka Nishioka; B.A., M.A.(Tokyo), Ph.D.(Col.)
Valerie M. Pasztor; B.Sc.(Birm.), Ph.D.(McM.)
Gerald S. Pollack; M.A., Ph.D.(Prin.)
Catherine Potvin; B.Sc., M.Sc.(Montr.), Ph.D.(Duke)*(on leave)*
Neil M. Price; B.Sc.(New Br.), Ph.D.(Br.Col.)
Joseph Rasmussen; B.Sc., M.Sc.(Alta.), Ph.D.(Calg.)
Beat Suter; Dip., Ph.D.(Zür)

Assistant Professors
Thomas Bureau; B.Sc.(Calif.), Ph.D.(Texas)
Joseph A. Dent; B.Sc., Ph.D.(Colo.)
Kevin McCann; B.A.(Dart), M.Sc., Ph.D.(Guelph)
Richard Roy; B.Sc.(Bishop's), Ph.D.(Laval)
Amanda Vincent; B.Sc.(W.Ont.), M.Sc.(Br.Col.), Ph.D.(Cantab.)
Candace S. Waddell; B.A.(Virginia), Ph.D.(UCSF)

Associate Members
Sal Carbonetto *(MGH),* Hugh J. Clarke *(RVH.),* Pierre Drapeau *(MGH),* Robert Dunn *(Neuroscience),* Michael Ferns *(Neurology & Neurosurgery),* William F. Grant *(Plant Science),* David Green *(Redpath Museum) (on leave),* Kenneth Hastings *(MNI)*, Paul Holland *(MNI)*, Roberta Palmour *(Allan Memorial Institute)*, Leonard Pinsky *(Lady Davis Institute),* Henry Reiswig *(Redpath Museum),* David Rosenblatt *(Paediatrics),* Guy Rouleau *(MGH),* Charles R. Scriver *(Paediatrics),* Teruko Taketo *(RVH),* Harriet S. Tenenhouse *(Paediatrics)*

Adjunct Professors
Wing Cheung *(DNA Landmarks)*
Wayne Hunte *(U. West Indies)*
Benoit S. Landry *(DNA Landmarks)*
William C. Leggett; B.A., M.Sc.(Wat.), Ph.D.(McG.), F.R.S.C. *(Queen's)*
David Y. Thomas *(NRC Lab),*
Malcolm S. Whiteway; B.Sc.(Dal.), Ph.D.(Alta.) *(NRC Lab)*

Biology is the study of living beings at the molecular, cellular and organismal levels. It deals with fundamental questions such as the origin and evolution of plants and animals, interactions between living organisms and their environment, mechanisms of embryonic development, structure and function of the living cell and its organelles, molecular basis of inheritance, biochemical and genetic basis of human diseases, and the operation of the brain and the nervous system. The study of biology also has vast practical applications. The knowledge, methods and concepts developed through research in the various fields of biology are applied extensively in agriculture, medicine, biotechnology, genetic engineering, environmental protection and wildlife management.

The Department of Biology offers two Faculty Programs, a Major Program, an Honours Program, a Minor Program and a Minor Concentration in Science for Arts students. The details of these programs are given below. The pre-requisites for Biology programs are those of CEGEP profile 10.11 and include, in addition to the minimum requirement for admission to the Faculty, CEGEP Biology 401 or equivalent (Biology 177-112B) and one course in Organic Chemistry, CEGEP Chemistry 202 or equivalent (Chemistry 180-212A,B). Students who have a DEC in Science but lack either of these courses must take them as extra requirements. It is advisable to take CEGEP Biology 401 in advance, if possible, since it is a strict prerequisite to the basic courses in Cell and Molecular Biology (177-200A and -201B) which are normally taken in the first year.

The programs in Biology offer students an opportunity to specialize in more than one area of biology and provide them with a broad training in biology as compared to the more specialized programs in Biochemistry, Microbiology, Physiology and Anatomy. A B.Sc. degree in Biology, therefore, prepares students for a wide range of employment opportunities, including entry to professional schools in medicine, veterinary science, dentistry, agriculture, nursing, education and library science. It also provides solid background for those interested in careers related to environmental protection, wildlife management, biotechnology and genetic engineering. A B.Sc. degree in Biology can also lead to post-graduate studies and research careers in universities, research institutes, hospitals, and industrial or governmental laboratories.

The Department of Biology has well-equipped teaching and research laboratories and its academic staff members, research associates, post-doctoral fellows and graduate students carry out research in areas of molecular biology, human genetics, ecology, animal behaviour, developmental biology, neurobiology, marine biology, plant biology, and evolution. Its teaching and research resources are extended by the Redpath Museum; the Montreal Children's, Jewish General, Montreal General, Royal Victoria and Shriners Hospitals; Macdonald Campus; Montreal Neurological Institute; and the Sheldon Biotechnology Centre. For courses taught in the field, the stations at Mont St. Hilaire, the Morgan Arboretum, the Bellairs Research Institute in Barbados, and the Huntsman Marine Science Centre in New Brunswick are used. In addition, field stations near Lake Memphremagog and at Schefferville in northern Quebec are available for research projects.

The courses listed below are not described in any great detail. To provide more information, the Department has prepared a "Blue Book" (sold in the Biology Department, Room W4/8), entitled (Department of Biology Undergraduate Programs 2000-2001), which describes in detail the content of each course and the level at which it is given, the aims and methods used, lectures, references, grading procedures, etc. The book also contains more information on registration, counselling, committee structure and the research interests and facilities which are represented in the Department.

Inquiries about undergraduate programs should be directed to the Undergraduate Affairs Office, in Room W4/8, Stewart Biology Building, telephone (514) 398-7045.

MINOR PROGRAM IN BIOLOGY (24 credits)
[MARS Program Code TBA] (Awaiting Final Approval)

The Minor in Biology may be taken in conjunction with any primary program in the Faculty of Science (other than programs offered by the Department of Biology). Students are advised to consult the Undergraduate Advisor in Biology as early as possible (preferably during their first year), in order to plan their course selection.

Six credits of overlap are allowed between the Minor and the primary program.

Required Courses (18 credits)

177-200A	(3)	Molecular Biology
177-201B	(3)	Cell Biology and Metabolism
177-202B	(3)	Basic Genetics
177-205B	(3)	Biology of Organisms
177-208A	(3)	Ecology
177-304A	(3)	Evolution

Complementary Courses (6 credits)
6 credits to be chosen from the Biology Department's course offerings, at the 300 level or above.

FACULTY PROGRAMS

In view of the constantly changing job market for B.Sc. graduates in biology, the Department has designed Faculty Programs to allow students to prepare for a wide range of employment opportunities. The programs offer students an opportunity to specialize

in more than one area of biology, to broaden the scope of their scientific background. The programs can be tailored to provide a relatively broad spectrum of biology courses, or provide a degree of specialization in biology which approaches that of a Major Program (total 36 to 54 biology credits). The flexibility and scope of these programs will not only enhance the graduate's prospects for employment, but also entrance into graduate studies.

FACULTY PROGRAM IN BIOLOGY (54 credits)
[MARS Program Code 4-144500]

Required Courses (18 credits)
177-200A (3) Molecular Biology
177-201B (3) Cell Biology and Metabolism
177-202B (3) Basic Genetics
177-205B (3) Biology of Organisms
177-208A (3) Introduction to Ecology
177-304A (3) Evolution

Complementary Courses (36 credits)
18 credits of Biology courses, including 3 credits selected from:
177-206A (3) Methods in Biology of Organisms
or 177-301A,B (3) Cell and Molecular Laboratory
18 credits of Science courses including, at most, 3 credits of general interest Science courses (not listed in Science Major Programs).

Of the Complementary courses at least 6 of the 15 remaining Biology credits and 6 of the 18 Science credits must be above the 200-level, none may be at the 100-level; all are to be approved by the adviser.

FACULTY PROGRAM IN BIOLOGY AND MATHEMATICS
(57 credits) [MARS Program Code 4-144700]

Required Mathematics Courses (21 credits)
189-133A,B,C,L,T* (3) Vectors, Matrices and Geometry
189-222A,B* (3) Calculus III
189-223A,B* (3) Linear Algebra
189-315A,B (3) Ordinary Differential Equations
189-323A,B (3) Probability Theory
189-324A,B (3) Statistics
308-202A,B (3) Introduction to Computing I
* students with CEGEP equivalents of these courses must substitute other mathematics courses in consultation with the adviser

Complementary Courses (36 credits)
21 credits in Biology including
12 credits selected from:
177-200A (3) Molecular Biology
177-201B (3) Cell Biology and Metabolism
177-202B (3) Basic Genetics
177-205B (3) Biology of Organisms
177-206A (3) Methods in Biology of Organisms
177-304A (3) Evolution
552-209A (3) Mammalian Physiology I
552-210B (3) Mammalian Physiology II
and 9 credits selected from:
177-208A (3) Introduction to Ecology
or 177-307A (3) Behavioural Ecology/Sociobiology
177-303B (3) Developmental Biology
177-306A (3) Neurobiology and Behaviour
177-324A (3) Ecological Genetics
177-370B (3) Human Genetics Applied
177-420B (3) Gene Activity in Development
177-430B (3) Neural Basis of Behaviour
177-431A (3) Neurobiology of Learning & Memory
177-470B (3) Lake Management
177-473A (3) Ecology of Aquatic Invertebrates
6 credits of any other Biological Sciences courses
9 credits of mathematics
including at least 3 credits selected from:
177-309A (3) Mathematical Models in Biology
198-413A (3) The Physical Basis of Physiology
and at least 3 credits selected from:
189-314A,B (3) Advanced Calculus
189-317A,B (3) Numerical Analysis
189-319B (3) Partial Differential Equations
189-327B (3) Matrix Numerical Analysis
189-407B (3) Dynamic Programming
189-423A (3) Regression and Analysis of Variance
189-425A (3) Sampling Theory and Applications
189-447B (3) Stochastic Processes
or other suitable mathematics courses chosen in consultation with the adviser.

Advisers: Drs. M. Mackey and L. Glass (Department of Physiology)

MAJOR PROGRAM IN BIOLOGY (54 credits)
[MARS Program Code 1-144500]

The Major requires 54 credits comprising 33 as specified below and 21 additional credits which are to be chosen by students in consultation with their adviser.

U1 Required Courses (18 credits)
177-200A (3) Molecular Biology
177-201B (3) Cell Biology and Metabolism
177-202B (3) Basic Genetics
177-205B (3) Biology of Organisms
177-206A (3) Methods in Biology of Organisms
177-208A (3) Introduction to Ecology

U2 or U3 Required Courses (6 credits)
177-301A,B (3) Cell and Molecular Laboratory
177-304A (3) Evolution

U2 or U3 Complementary Courses (9 credits)
9 credits selected from:
177-300A (3) Molecular Biology of the Gene
177-303B (3) Developmental Biology
177-305B (3) Diversity of Life
177-306A (3) Neurobiology and Behaviour

Other Complementary Courses (21 credits)
To be selected in consultation with the student's adviser. All courses must be at the 300 level or higher; they are to include any seven Biology courses of which at most three may be substituted, given the adviser's consent, with science courses offered by other departments. Unless required by the Major Program, prerequisites for these courses must be taken as electives.

BIOLOGY CONCENTRATIONS

The concentrations set out below are only guidelines for specialized training. They do not constitute sets of requirements. Students interested in advanced studies in any biological discipline are strongly advised to develop their skills in computing as appropriate. As an aid to students wishing to specialize, the concentrations list key and other suggested courses by discipline.

MOLECULAR GENETICS AND DEVELOPMENT CONCENTRATION

The discoveries that have fuelled the ongoing biomedical and biotechnological revolution have arisen at the intersection of a number of fields of biological investigation, including molecular biology, genetics, cellular and developmental biology and biochemistry. A substantial and significant quantity of this research has been conducted upon model eukaryotic organisms, such as yeast, nematode, the fruit fly, and the mustard weed, Arabidopsis. In the molecular genetics and development concentration students will obtain a comprehensive understanding of how the "model eukaryotes" have advanced our knowledge of the mechanisms responsible for cellular function and organismal development. Graduates from this concentration will be well prepared to pursue higher degrees in the fields of basic biology, biotechnology, and biomedicine or to assume a wide variety of positions in government, universities, and medical and industrial institutions.

Key courses:
Biology 177-300A, -301A,B, -303B, -373A, -451A
Chemistry 180-222A,B, -203A or -204A,B and -214B

Other suggested courses:
Biology 177-313B, -314A, -416B, -420B, -444A, -471C,D, -477A, -478B,C, -518B or -524A

NEUROBIOLOGY CONCENTRATION

Nervous systems are perhaps the most complex entities in the natural world, being composed of up to trillions of interconnected cells that must operate in a coordinated manner to produce behaviour which can range from the mundane (e.g., regulation of heart rate) to the magnificent (e.g., musical composition). The discipline Neurobiology, one of the fastest growing areas of modern biology, seeks to understand the evolution, development, and operation of nervous systems. The Neurobiology concentration addresses these issues by examination of neural structure, function and development at levels of organization that range from the molecular to the organismal. As a result of exposure to a wide range of experimental and intellectual approaches, students receive a sound, broadly-based education in biology.

Key courses:
Biology 177-306A, -389B, -430B, -431A, -532B, -588A

Other suggested courses:
Anatomy and Cell Biology 504-321A, 322B
Biochemistry 507-455B
Biology 177-300A, -303B, -373A or equivalent, -471C,D, -477A, -478B,C
Neurology/Neurosurgery 531-310B
Pharmacology 549-562A
Physiology 552-451A, -520B, -556B
Psychiatry 555-500B
Psychology 204-311A, -318B, -342B, -410B, -422B, -470A

HUMAN GENETICS CONCENTRATION

The courses recommended for students interested in Human Genetics are designed to offer a broad perspective in this rapidly advancing area of biology. Genetics is covered at all levels of organization (the gene, the chromosome, the cell, the organism and the population), using pertinent examples from all species, but with special emphasis on humans.

Key courses:
Biology 177-301A,B, -370B, -373A, -416B or -420B, -468B, -475B

Other suggested courses:
Biology 177-314A, -451A, -471C,D, -477A or -478B,C
Chemistry 180-222A,B, -203A or -204A and -214B
Biochemistry 507-311A, -450A
Microbiology and Immunology 528-314B

EXPERIMENTAL PLANT BIOLOGY CONCENTRATION

Research interests span modern molecular genetics, plant physiology and biochemistry, plant ecology and genetics, plant morphogenesis, and the adaptation and evolution of plant form and function. Research is carried out in the field and in the Department's large, excellent controlled environment facilities. The importance of adaptation to climate and the use of plants for food, chemicals, pharmaceuticals and materials underlie research using biotechnology and quantitative methods to improve cultivated plants and understand natural plant populations.

Key courses:
Biology 177-300A, -303B, -305B, -333B, -357A, -358A

Other suggested courses:
Biology 177-365A, -373A, -471C,D, -477A, -478B,C, -522B, -526B, -555L

EVOLUTIONARY BIOLOGY CONCENTRATION

Evolutionary biology is the study of processes that change organisms and their characteristics through time. Evolutionary biologists are concerned with adaptations of organisms and the process of natural selection.

Key courses:
Biology 177-305B, -307B, -324A, -331A, -352B, -462B, -472A, -471C,D, -477A or -478B,C, -570B, -555L

Other suggested courses in Organismal Biology:
Biology 177-327A, -335T, -350A, -351B, -354B, -358A

Genetics and Development:
Biology 177-300A, -303B

Ecology and Behaviour:
Biology 177-309A, -337C, -345A, -473A, -483B

ANIMAL BEHAVIOUR CONCENTRATION

Understanding the diverse ways in which animals feed, mate, care for their offspring, avoid predators, select their habitats, communicate, and process information constitute the subject matter of behaviour. Several approaches are used to study these questions. Some focus on ecological consequences and determinants, some on physiological, genetic and developmental mechanisms, others on evolutionary origins.

Key courses:
Biology 177-305B, -306A, -307B, -331A or -334E or another field course with a significant behavioural component.

Other suggested courses: 177-377B,C, -471C,D, -477A, -478B,C
Since animal behaviour builds upon the fields of behaviour, ecology, and evolutionary biology, most courses from these fields will be relevant. Some courses that focus on a particular taxonomic group such as birds (177-354B), amphibians and reptiles (177-327A) and marine mammals (177-335T) include a significant amount of behaviour. Prof. A. Baker of the Psychology Department is willing to advise students on selection of relevant psychology courses on perception, learning, and motivation.

BIOLOGICAL DIVERSITY AND SYSTEMATICS

The study of biological diversity deals with the maintenance, emergence, and history of the inexhaustible variety of different kinds of organisms. It is deeply concerned with the particular characteristics of different organisms and therefore emphasizes the detailed study of particular groups and forms the basis of comparative biology. Our knowledge of diversity is organized through the study of systematics which seeks to understand the history of life and the phylogenetic and genetic relationships of living things. Appreciation and knowledge of diversity and systematics are essential in ecology and evolutionary biology and underlie all work in resource utilization and conservation biology.

Key course:
Biology 177-305B

Other suggested courses:
Biology 177-240T, -324A, -327A, -331A or -334E,C, -335T, -341B, -350A, -351B, -352B, -353A, -354B, -358A, -365A, -373A, -437A, -460A -462B, -471C,D, -473A, -477A or -478B,C, -483B, -555L

Macdonald Campus
Zoology 349-307A, -312A, -313B, -316A, -424A
Plant Science 367-356A, -451B
Entomology 350-440B
Renewable Resources 375-402B, -420A

CONCENTRATIONS AVAILABLE WITHIN THE AREA OF ECOLOGY

Ecology is the study of the interactions between organisms and environment that affect distribution, abundance, and other characteristics of the organisms. A strong analytical and quantitative orientation is common to all areas of ecology, and thus students wishing to specialize in these areas are strongly encouraged to develop their background in statistical analysis, computing, and mathematical modelling. Many of the ecology courses feature a strong analytical component, and students will find that background preparation in this area is very useful, if not essential. Ecology depends heavily on field research, and thus 177-331A and/or other field courses should be considered as vital to all concentrations in this area.

GENERAL AND APPLIED ECOLOGY CONCENTRATION

The concentration in general and applied ecology is designed to introduce the breadth of contemporary ecology, at the levels of the ecosystem, communities and populations, and at the level of the individual organism, with an accent on the application of this science to practical problems in environmental management, and the management of resources and pests. In addition to general courses dealing with general principles, there is a selection of courses dealing with particular groups of organisms. Since it is essential to know how knowledge is obtained, the concentration includes a field course in ecology.

Key courses:
Biology 177-305B, -331A or -334E,C or -336C, -350A, -470B
Computer Science 308-202A,B or -273A,B

Other suggested courses:
Biology 177-307B, -324A, -327A, -345A, -354B, -432A, -441B or -442B, -462B, -473A, -535B
Geography 183-302B
Plant Science 367-451A (Macdonald Campus)

AQUATIC ECOLOGY CONCENTRATION

This concentration is designed to introduce the principles of ecology as they pertain to aquatic ecosystems and aquatic biota. Since it is essential to know how knowledge is obtained, as well as what has been learned, three of the courses (limnology, fish ecology, and aquatic invertebrate ecology) involve field components that stress the techniques used to study aquatic ecology. In addition, the concentration includes a field course in ecology. There is also a variety of courses in aquatic disciplines offered in other departments that complement the aquatic ecology courses offered in Biology.

Key courses:
Biology 177-305B, -331A or another field course, -337C, -432A, -441B or -442B, -460A, -470B, -473A, -483B
Computer Science 308-202A,B or -273A,B

Other suggested courses:
Biology 177-307B
Geography 183-305A, -306B, -308A, -332A
Zoology 349-315A (Macdonald Campus)

MARINE BIOLOGY CONCENTRATION

This concentration is designed to offer students a broad introduction to Marine Biology and Marine Ecology which will form the basis for graduate studies in the fields, or to employment in Aquatic Biology and Oceanography.

Key courses:
Biology 177-305B, -335T or -336C, -337C, -351B, -437B, -441B, -442B

Other suggested courses:
Biology 177-331A, -334E,C -432A, 460A, -470B, -473A
Earth and Planetary Sciences 186-542A
Atmospheric and Oceanic Sciences 195-220A,B, -512A, -550A, -561B

For students intending to proceed to graduate work, one independent studies course (177-477A or -478B,C) is recommended. Because of the importance of numerical analyses in all fields of Ecology, courses in Biometry (e.g. -373A) and Computer Science (308-202A,B or -273A,B) are recommended.

HONOURS PROGRAM IN BIOLOGY (67 or 70 credits)

[MARS Program Code 2-144500]

The Honours program in Biology is designed expressly as a preparation for graduate studies and research, and provides students with an enriched training in biology and some research experience in a chosen area. Acceptance into the Honours Program at the end of U2 requires a CGPA of 3.20 and approval of a 9 or 12-credit Independent Studies proposal (see listing of 177-479D,G and 480D,G for details). For an Honours degree, a minimum CGPA of 3.20 in the U3 year and adherence to the program as outlined below are the additional requirements.

U1 Required Courses (18 credits)
as for the Major program

U2 and U3 Required Courses (9 credits)
177-301A,B (3) Cell and Molecular Laboratory
177-304A (3) Evolution
177-373A (3) Biostatistical Analysis

U2 and U3 Complementary Courses (27 credits)
9 credits selected from:
177-300A (3) Molecular Biology of the Gene
177-303B (3) Developmental Biology
177-305B (3) Diversity of Life
177-306A (3) Neurobiology and Behaviour
18 credits in Biology at the 300 level or higher

U3 Required Courses (13 or 16 credits)
177-499D (4) Honours Seminar in Biology
and 177-479D,G (9) Independent Studies in Biology
or 177-480D,G (12) Independent Studies in Biology

Courses Open to Non-Biologists

Many aspects of biology interest humanists and scientists specializing in other disciplines. Therefore, several courses are offered to students with little or no background in biology. These are either CEGEP equivalent courses (177-111A and 177-112B), service courses (177-373A), or general interest courses such as 177-115B and 177-210A.

COURSE DESCRIPTIONS

The course credit weight is given in parentheses (#) after the course title.

- ● Denotes courses not offered in 2000-01.
- ▭ Denotes Limited Enrolment
- ★ Denotes courses offered only in alternate years

177-101A ORGANISMAL BIOLOGY LAB. (1) (3 hours laboratory) (Exclusion: 177-111A) Laboratory component of 177-111A. May be taken only by transfer students who have completed elsewhere the lecture component but not the laboratory of 177-111A and only with permission of the Associate Dean of Science.
Professor Reiswig

177-102B CELL AND MOLECULAR BIOLOGY METHODS. (1) (3.5 hours laboratory) (Exclusion: 177-112B) The laboratory component of 177-112B. May be taken only by transfer students who have completed elsewhere the lecture component but not the laboratory of 177-112B and only with permission of the Associate Dean of Science. **Professor Poole**

▭ **177-111A PRINCIPLES OF ORGANISMAL BIOLOGY.** (3) (2 lectures and 3 hours laboratory) (Prerequisite: none. Exclusions: Biology 301 at CEGEP; 177-115B) An introduction to the structure, function and adaptation of plants and animals in the biosphere. Open to all students wishing introductory biology.
Professor Reiswig (Co-ordinator) and Staff

▭ **177-112B,L CELL AND MOLECULAR BIOLOGY.** (3) (2 lectures and 3.5 hours laboratory/seminar) (Prerequisite: none. Exclusions: Biology 401 at CEGEP; 177-115B.) The cell: ultrastructure, division, chemical constituents and reactions. Bioenergetics: photosynthesis and respiration. Principles of genetics and the molecular basis of inheritance. Serves as a prerequisite for 177-200A and 177-201B and as an alternative to CEGEP Cell Biology.
Professors Poole (Co-ordinator) and Dent

177-115B ESSENTIAL BIOLOGY. (3) (3 lectures) (Prerequisites: none. Restricted to non-Science astudents; not open to students who have had 177-111A, 177-112B, or equivalents.) An introduction to biological science that emphasizes the manner in which scientific understanding is achieved and evolves and the influence of biological science on society. Topics will include cell structure and function, genetics, evolution, organ physiology, ecology and certain special topics that change from year to year.
Professor Nishioka

177-200A MOLECULAR BIOLOGY. (3) (3 lectures, 1 hour tutorial) (Prerequisite: 177-112B or equivalent. Corequisite: 180-212A or equivalent.) The physical and chemical properties of the cell and its components in relation to their structure and function. Topics include: protein structure, enzymes and enzyme kinetics; nucleic acid replication, transcription and translation; the genetic code, mutation, recombination, and regulation of gene expression.
Professors Brown (Co-ordinator), Bureau and Dunn

177-201B CELL BIOLOGY AND METABOLISM. (3) (3 lectures, 1 hour tutorial) (Prerequisite: 177-200A. Exclusion: 507-212B) This course introduces the student to our modern understanding of cells and how they work. Major topics to be covered include: photosynthesis energy metabolism and metabolic integration; plasma membrane including secretion, endocytosis and contact mediated interactions between cells; cytoskeleton including cell and organelle movement; the nervous sytem; hormone signalling; the cell cycle. **Professor Levine (Co-ordinator) and Staff**

177-202B BASIC GENETICS. (3) (3 hours lecture, 1 hour conference optional) (Prerequisite: 177-200A. Exclusion: 177-274A.) Introduction to basic principles, and to modern advances, problems and applications in the genetics of higher and lower organisms with examples representative of the biological sciences.
Professors Suter (Co-ordinator) and Hechtman

177-205B BIOLOGY OF ORGANISMS. (3) (3 hours lecture, optional conference hour) (Prerequisites: 177-200A,177-208A/308B. Corequisite: 177-201B or 507-212B or permission of co-ordinator.) Unified view of form and function in organisms from all five kingdoms. Focus on the principal functions that all organisms must achieve to ensure their survival.
Professor Pasztor (Co-ordinator) and Staff

▭ **177-206A METHODS IN BIOLOGY OF ORGANISMS.** (3) (1 lecture and 4 hours laboratory) (Prerequisite: 177-111A or equivalent) Introduction to methods used in organismal biology, including ecological sampling, use of keys, measurements, use of statistics and computers in numerical analysis, microbiological methods, basic histological techniques, use of microscopes and library searching procedures. Lecture and Field trip in week one.
Professor Pasztor and Staff

177-208A INTRODUCTION TO ECOLOGY. (3) (2 hours lecture, 1 hour tutorial) (Prerequisite: 177-111A or CEGEP equivalent.) (Formerly 177-308B) This course introduces the basic principles and applications of population, community, and ecosystem ecology.
Professors Rasmussen (Co-ordinator) and Schoen

177-210A PERSPECTIVES OF SCIENCE. (3) (3 hours lecture) This course is an introduction to the thinking, language and practices of scientists. Its objective is to bridge the gap between science and the humanities, and in particular to allow students enrolled in the Minor Concentration in Science for Arts to pursue their interests in specific scientific disciplines. **Professor Lefebvre**

● **177-222T BASIC BIOTECHNOLOGY.** (3) (Prerequisite: CEGEP 301 and 401 or equivalent.)

177-240T MONTEREGIAN FLORA. (3) (Prerequisite: 177-111A or permission.) (Not open to students who have taken 177-358A or 367-358A) Field studies emphasizing sight-recognition of ferns, fern allies, conifers and flowering plants of the St. Lawrence River Valley, and the use of plant keys for species identification. Taught for two weeks at the Mont St. Hilaire Biosphere Reserve; contact instructor well in advance for specific dates, logistics.
Professor Lechowicz and Staff

177-300A MOLECULAR BIOLOGY OF THE GENE. (3) (3 hours lecture, optional conferences) (Prerequisites: 177-200A, 177-201B.) A survey of current knowledge and approaches in the area of gene structure and function. Topics include: gene isolation and characterisation, gene structure and replication, mechanism of gene expression and its regulation in pro- and eukaryotes.
Professors Nishioka (Co-ordinator) and Lasko

▭ **177-301A,B CELL AND MOLECULAR LABORATORY.** (3) (1 lecture and one 6-hour laboratory) (Prerequisites: 177-200A, 177-201B. 177-206A recommended. Exclusion: 507-300D. Password card required.) Focus is on the experimental methods used to develop the chemical and biological concepts introduced in first year courses. Techniques by which growth, metabolism and regulation of cell systems are analyzed and by which biological macromolecules are purified and characterized. **Professors Poole and Waddell**

177-303B DEVELOPMENTAL BIOLOGY. (3) (3 lectures and optional 1 hour conference) (Prerequisites: 177-200A and 177-201B. Corequisite: 177-202B) A consideration of the fundamental processes and principles operating during embryogenesis. Experimental analyses at the molecular, cellular, and organismal levels will be presented and analyzed to provide an overall appreciation of developmental phenomena. **Professors Lasko (Co-ordinator), Clarke and Rao**

177-304A EVOLUTION. (3) (3 hours lecture) (Prerequisite: 177-205B or 177-208A or MSE 170-202.) This course will show how the theory of evolution by natural selection provides the basis for understanding the whole of biology. The first half of the course describes the process of selection, while the second deals with evolution in the long term. (Prereq. changes Awaiting University Approval) **Professors Bell (Co-ordinator) and Carroll**

177-305B DIVERSITY OF LIFE. (3) (2 lectures and 1 three-hour laboratory) (Prerequisite: 177-205B or 177-208A or MSE 170-202.) This course will describe biological diversity in phylogenetic and ecological contexts, in populations and ecosystems, and from local to global scales. The practical classes will cover the relevant phylogenetic, ecological and statistical techniques needed to measure and analyze biodiversity. (Prereq. changes Awaiting University Approval) **Professor Bell and Staff**

177-306A NEUROBIOLOGY AND BEHAVIOUR. (3) (3 hours lecture) (Prerequisites: 177-201B, 177-205B.) Mechanisms of animal behaviour; ethology; cellular neurophysiology, integrative networks within nervous systems; neural control of movement; processing of sensory information. **Professors Pollack (Co-ordinator) and Lefebvre**

177-307B BEHAVIOURAL ECOLOGY/SOCIOBIOLOGY. (3) (2 hours lecture and 1 hour conference) (Prerequisites: 177-205B, 177-208A/308B or permission.) The relationship between animal behaviour and the natural environment in which it occurs. This course introduces the subject of ecology at the level of the individual organism. Emphasis on general principles which relate to feeding, predator avoidance, aggression, reproduction and parental care of animals including humans. **Professor Kramer**

177-309A MATHEMATICAL MODELS IN BIOLOGY. (3) (2 hours lecture) (Prerequisite: Elementary calculus. An additional course in calculus is recommended.) Application of finite difference and differential equations to problems in cell and developmental biology, ecology and physiology. Qualitative, quantitative and graphical techniques are used to analyze mathematical models and to compare theoretical predictions with experimental data.
Professor Glass (Physiology Department)

● **177-313B STRUCTURE AND FUNCTION OF CELLS.** (3) (2 hours lecture, 3 hours seminar) (Prerequisites: 177-200A; 177-201B or 507-212B.)

177-314A MOLECULAR BIOLOGY OF ONCOGENES. (3) (3 hours lecture per week) (Prerequisites: 177-200A; 177-201B or 507-212B) The genes that cause cancer are altered versions of genes present in normal cells. The origins of these oncogenes, their genetic structure, regulation, and the biochemical properties of the oncogene-encoded proteins will be analyzed in an attempt to understand the origins of human and animal cancers.
Professor Mukherjee

★**177-324A ECOLOGICAL GENETICS.** (3) (2 hours lecture, 1 seminar) (Prerequisite: 177-202B) This course presents evolutionary genetics within an ecological context. The course covers theoretical topics together with relevant data from natural populations of plants and animals. **Professor Schoen**

● **177-327A HERPETOLOGY.** (3) (2 hours lecture; 3 hours laboratory) (Prerequisite: 177-205B)

▭ **177-331A ECOLOGY/BEHAVIOUR FIELD COURSE.** (3) (Prerequisites: 177-206A; 177-208A/308B) (Preregistration in March and April. See Prof. Kalff.) A 12-day Field Course just before the fall term, with a project report to be prepared early in the fall term. Methods of sampling natural populations of animal and plant species in fresh water and terrestrial habitats. Estimating population size. Testing hypotheses in nature. Energy flow determinations and behavioural ecology. **Professor Kalff and Staff**

▭ **177-334E APPLIED TROPICAL ECOLOGY.** (3) (Prerequisites: 177-208A/308B and permission.) Aspects of tropical ecology relevant to agriculture, forestry, fisheries and conservation of natural resources. Taught at the University's Bellairs Research Institute in Barbados, for two weeks in early May. The course is organized in a series of small-group field projects of 2-3 days each. Interested students should contact the Undergraduate Office and fill out an application form. **Staff**

▭ **177-335T MARINE MAMMALS.** (3) (Prerequisites: 177-205B) Biology of marine mammals with special emphasis on seals and whales of the Bay of Fundy. Taught at the Huntsman Marine Science Centre, St. Andrews, N.B., for two weeks in August. The course combines lectures, laboratory exercises, field trips, and individual projects. Interested students should contact their adviser before enrolling in the course. See S. Gabe, W4/8. **Staff (HMSC)**

▭ **177-336C MARINE AQUACULTURE.** (3) (Prerequisites: 177-208A/308B) Principles of marine aquaculture with emphasis on theoretical and practical aspects of the cultivation of salmonids, invertebrates, and marine algae. Taught at the Huntsman Marine Science Centre, St. Andrews, N.B., for two weeks, usually in May. The course combines lectures, laboratory exercises, and field trips. Interested students should consult their adviser before enrolling in the course. See S. Gabe, W4/8. **Staff (HMSC)**

▭ **177-337C ECOLOGY AND BEHAVIOUR OF FISHES.** (3) (Prerequisites: 177-205B, 177-208A/308B) (Exclusion: 177-449A) Taught at Huntsman Marine Science Centre, St. Andrews, N.B.) Introduction to behaviour and ecology of marine and freshwater fishes. Topics include: morphology, mechanics of swimming, growth and reproduction, foraging and schooling behaviour, fisheries management. The course combines lectures, lab exercises, field trips, and individual research projects. See S. Gabe, W4/8. **Staff (HMSC)**

177-341B HISTORY OF LIFE. (3) (3 hours lecture) (Prerequisite: 177-204A/304A or permission.) The origin, history, and nature of life from 3.5 billion years ago to the present, within the context of physical and biological changes in the Earth's environment. Topics: origin of life, radiation of multicellular organisms; invasion of land by plants and animals; rise and extinction of dinosaurs; origin of modern biota. **Professor Carroll**

★**177-345A PARASITISM AND SYMBIOSIS.** (3) (2 hours lecture and eight 3-hour laboratories) (Prerequisite: 177-205B or permission.) The biology of parasites and host-parasite interactions are examined from the cellular, organismal and population perspective. Evolution of symbiosis in relation to life cycle patterns of major taxonomic groups is examined. Modern strategies for parasite control are discussed. **Professor Smith (Institute of Parasitology)**

177-350A INSECT BIOLOGY AND CONTROL. (3) (Exclusion: 350-330A) A lecture course designed to introduce insect structure, physiology, biochemistry, development, systematics, evolution, ecology and control. The course stresses interrelationships and integrated pest control. **Professor Dunphy (Dept. Nat. Res. Sci.)**

177-351B THE BIOLOGY OF INVERTEBRATES. (3) (2 hours lecture; 3 hours laboratory) (Prerequisites: 177-204A/304A, 177-205B or permission.) A survey of the metazoan invertebrates (excluding Protozoa) with emphasis on patterns of body organization, systematics, and presumed phylogenetic relationships among groups. Basic attributes such as feeding types, reproduction, skeletal systems, behaviour will be covered. Major as well as minor phyla will be considered. **Professor Reiswig**

● ★**177-352B VERTEBRATE EVOLUTION.** (3) (2 hours lecture, 3 hours laboratory) (Prerequisite: 177-204A/304A or permission)

● **177-354B BIOLOGY OF BIRDS.** (3) (2 hours lecture, 3 hours laboratory) (Prerequisite: 177-204A/304A; 177-206A recommended.)

177-357A PLANT PHYSIOLOGY. (3) (3 hours lecture) (Prerequisites: 177-200A and 177-201B or permission.) Advanced introduction to plant physiology. Study of processes that maintain day-to-day life of the plant and processes underlying plant development. Role of phytohormones, light and temperature on plant growth and development. Plant responses to environmental stresses. Application of modern techniques of tissue culture and molecular biology for agricultural benefits. **Professor Dhindsa**

177-358A CANADIAN FLORA. (3) (2 hours lecture, 3 hours laboratory) (Prerequisite: 177-111A or equivalent.) Practical training in plant identification combined with an emphasis on major plant families and species important in temperate boreal, and arctic regions. Four days of required, pre-semester field excursions; contact the instructor well in advance of the course. **Professor Lechowicz**

177-365A CONSERVATION BIOLOGY. (3) (3 hours lecture) (Prerequisite: 177-208A/308B) Discussion of relevant theoretical and applied issues in conservation biology. Topics: biodiversity, population viability analysis, community dynamics, biology of rarity, extinction, habitat fragmentation, ecological economics. Guest speakers discuss specific applied issues. **Professor Potvin**

177-370B HUMAN GENETICS APPLIED. (3) (3 hours lecture; 1 hour conference optional) (Prerequisites: 177-200A and 177-201B, 177-202B) A contemporary view of what genetics can do when applied to human beings. **Professor Palmour and Staff**

▭ **177-373A BIOSTATISTICAL ANALYSIS.** (3) (2 hours lecture and 2 hours laboratory per week) (Prerequisite: 189-112A,B or equivalent) (Note: 177-373 may preclude credit for other statistics courses. See "Course Overlap" on page 345.) Elementary statistical methods in biology. The aim of this course is to introduce students to the analysis of biological data. Emphasis is placed on the assumptions behind statistical tests and models. The course is designed to give a student the ability to intelligently use the statistical techniques typically available on computer packages such as SYSTAT or SPSS. Preference given to Biology students; laboratory sections assigned at term's start. **Professor Roff**

▭ **177-377B,C INDEPENDENT STUDIES IN BIOLOGY.** (3) (Open to U2 or U3 Biology students only.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) For course details, see 177-477A. **Staff**

▭ **177-389B LABORATORY IN NEUROBIOLOGY.** (3) (1 hour lecture; 5 hours laboratory) (Prerequisites: 177-306A or 552-311A or 204-308A or 531-310A or permission.) Provides experience in the methods of neurobiological research; experiments include extracellular and intracellular recording from nerve cells, electrical stimulation, and the study of neuro-behavioural problems. **Professors Pollack (Co-ordinator), Dent and Drapeau**

177-413 A,B,C,L,T READING PROJECT. (1) (3 hours independent work) (Prerequisites: 177-200A, 177-201B, 177-202B, 177-204A/304A, 177-205B, 177-208A/308B) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) Under the guidance of an instructor with the relevant expertise, the student explores the literature on a special topic and develops a written review in scientific format. Registration form required as for 177-477A. **Staff**

▭ **177-416B DEVELOPMENTAL MAMMALIAN GENETICS.** (3) (3 hours lecture) (Prerequisites: 177-202B or 177-274A, 177-300A, 177-303B; permission.) This course aims to examine problems, theories, and experimental evidence on several concepts of mammalian developmental processes at molecular to organogen-

esis levels. Most topics are in the mouse model system, where various techniques for genetic manipulation are available.
Professor Taketo

177-420B GENE ACTIVITY IN DEVELOPMENT. (3) (3 hours lecture and discussion) (Prerequisites: 177-300A and 177-303B or permission) An analysis of the role and regulation of gene expression in several models of eukaryotic development. The emphasis will be on critical evaluation of recent literature concerned with molecular or genetic approaches to the problems of cellular differentiation and determination. Recent research reports will be discussed in conferences and analyzed in written critiques. **Professor Roy**

● ▭ **★177-430B NEURAL BASIS OF BEHAVIOUR.** (3) (1 hour lecture, 2 hours seminar) (Prerequisite: 177-306A or 552-311A or 204-308A)

● ▭ **177-431A NEUROBIOLOGY LEARNING MEMORY.** (3) (3 hours lecture and discussion) (Prerequisite: 177-306A or permission.)

● **177-432A LIMNOLOGY.** (3) (2 hours lecture; 3 hours laboratory) (Prerequisites: 177-206A and/or permission.)

★177-437A ADVANCED INVERTEBRATE ZOOLOGY. (3) (Prerequisite: 177-351B or permission.) A survey of 1 or 2 selected invertebrate taxa. Functional morphology, feeding mechanisms, reproductive patterns, biotic interactions, habitat selection, general ecology and evolution. **Professor Reiswig**

● ▭ **★177-441B BIOLOGICAL OCEANOGRAPHY.** (3) (2 hours lecture, 3 hours laboratory/conference) (Prerequisite: 177-208A/308B or permission.)

▭ **★177-442B MARINE BIOLOGY.** (3) (2 hours lecture, 1 laboratory or conference) (Prerequisite: 177-208A/308B or permission) An introduction to marine benthic communities. Topics include structure and dynamics of hard and soft bottom communities; bioturbation, feeding strategies and trophodynamics; ecology of seagrass, mangrove and coral reef ecosystems; marine pollution.
Professor Price

● **★177-444A GENETIC BASIS OF LIFE SPAN.** (3) (1 hour lecture, 2 hours seminar) (Pre-requisites: 177-202B, 177-300A; 177-303B recommended or permission)

177-451A MOLECULAR BIOLOGY: CELL CYCLE. (3) (3 hours lecture) (Prerequisites: 177-200A, 177-201B, 177-300A.) Cytological studies, biochemical and genetical information are integrated to explain molecular form and function in the eukaryotic cell. The mitotic cell cycle and its coordination with cell growth and division; maintenance of cellular architecture, protein targeting, self-assembly of macromolecular complexes, organelle biogenesis, and DNA replication and segregation are examined.
Professors Bussy and Whiteway

▭ **177-453B NEOTROPICAL ENVIRONMENTS.** (3) (24 hours lecture and 36 hours field work over a 4-week period) Prerequisites: 144-218, 189-203, and 177-208A/308B, or equivalents, and permission of Program Coordinator. Corequisites: 170-451B, 183-498B and 336-450B) (Restriction: location in Panama. Students must register for a full semester of studies in Panama.) Ecology theory revisited in view of tropical conditions. Exploring species richness. Historical and contemporaneous factors structuring neotropical communities. Measuring biodiversity. Conservation status of ecosystems, communities and species. Guest Lecturers: Staff from Smithsonian Tropical Research Institute and Panamanian Universities. **Staff**

▭ **177-460A AQUATIC CONSERVATION.** (3) (2 lecture hours, 1 conference) (Prerequisites: 177-208A/308B and 177-365A or permission) An advanced conservation course, focused on marine and freshwater environments. Begins with the ultimate, distal and proximate processes that explain current global calamities. Then considers management responses such as fisheries modifications, protected areas, alternative livelihoods, and habitat restoration. Conferences include group work to produce real conservation action plans. **Professor Vincent**

★177-462B EVOLUTION OF LIFE CYCLES. (3) (2 hours lecture, 1 hour seminar) (Prerequisites: Core Program in Biology.) Evolutionary biology and analysis of the life history variation: optimality theory, game theory, and genetic analysis of growth, reproduction and survival. Course divided into two parts: theoretical foundations, and tests of theory using case studies. **Professor Roff**

177-468B TOPICS ON THE HUMAN GENOME. (3) (3 hours lecture) (Prerequisites 177-202B or 177-274A, 177-300A, 177-370B, or permission.) Cellular and molecular approaches to characterization of the human genome. **Professor Rozen and Staff**

177-471C,D INDEPENDENT STUDIES IN BIOLOGY. (6) (Open only to U3 Biology students.) (Prerequisite: 177-206A or 177-301A,B or other suitable laboratory course.) (Projects must be arranged individually with a staff member of the Biology Department and a form from Ms. A. Comeau, Room W4/8, Stewart Building, must be completed to receive credit for the course.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) Research or reading projects, permitting independent study under the guidance of a staff member in the Biology Department specializing in the field of interest. A written report is required and a copy must be submitted to Ms. Comeau.
Staff

● ▭ **★177-472A MOLECULAR EVOLUTION.** (3) (4 hours lecture/seminar) (Prerequisite: 177-300A)

177-475B HUMAN BIOCHEMICAL GENETICS. (3) (3 hours lecture) (Prerequisites: 177-202B and 177-300A) This "topics course" explores several major groups of human mutations through investigations of genes which affect collagen, globin function, immunity, etc. The course emphasizes the contribution of studies on humans to understanding of gene organization, expression and function.
Professor Hechtman and Staff

▭ **177-477A/177-478B,C INDEPENDENT STUDIES IN BIOLOGY.** (3 credits each) (Open only to U3 Biology students) (Prerequisite: 177-206A or 177-301A,B or other suitable laboratory course. Projects must be arranged individually with a staff member of the Biology Department and a form from Ms. Comeau, Room W4/8, Stewart Building, must be completed to receive credit for the course.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) Research or reading projects, permitting independent study under the guidance of a staff member in the Biology Department specializing in the field of interest. A written report is required and a copy must be submitted with the mark to Ms. Comeau. **Staff**

▭ **177-479D,G INDEPENDENT STUDIES IN BIOLOGY.** (9) (8-12 hours per week research project and related seminars) (Restricted to Biology Honours students. Projects must be arranged individually with, and accepted by a staff member of the Biology Department.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) The major objective of the course is to provide an introduction to the design, execution and reporting of research. The quality of projects is examined by at least two members of the Biology Department. **Staff**

▭ **177-480D,G INDEPENDENT STUDIES IN BIOLOGY.** (12) (10-15 hours per week research project and related seminars) (Restriction and course description: as for 177-479D,G.) (Please see regulations concerning Project Courses, section 2.6.2 in the Faculty Degree Requirements section.) **Staff**

177-499D HONOURS SEMINAR IN BIOLOGY. (4) (Weekly seminars) Honours students in Biology attend a selected series of guest speaker seminars of general interest-and prepare five reports. In addition, students give a seminar on their research.
Professor Hekimi

● **177-505B DIVERSITY AND SYSTEMATICS SEMINAR.** (3) (3 hours seminar) (Prerequisites: 177-204A/304A, 177-305B, or permission.)

177-518B EUKARYOTIC CELL GENETICS. (3) (2 hours seminar) (Prerequisite: 177-300A and permission.) This course is designed

for advanced undergraduate and graduate students. Readings from recent journal articles and reviews. Variable topics, including: cell differentiation, function of oncogenes and anti-oncogenes, growth regulation and cell cycle, gene transfer, recombination, mobile genetic elements, regulation of gene expression, cellular and viral replication, signal transduction. **Professor Nishioka**

★177-522B PLANT MOLECULAR BIOLOGY SEMINAR. (3) (2 hours seminar, 1 hour tutorial per week) (Prerequisite: 177-300A or permission.) This course deals with current topics in plant development, with particular emphasis on genetic and molecular approaches. This advanced course will include readings from the primary literature, as well as oral presentations and a written NSERC-styled grant proposal. **Professor Waddell**

▭ **177-524A TOPICS IN MOLECULAR BIOLOGY.** (3) (Prerequisite: 177-300A, 177-303B or permission.) Recent literature in the fields of molecular genetics and molecular biology. Topics include: signal transduction, cell function, genetic diseases in eukaryotes. **Professors Bussy and Thomas**

● ▭ **★177-526B PLANTS AND EXTREME ENVIRONMENTS.** (3) (1 hour lecture and 2 hours seminar/ discussion) (Prerequisites: 177-205B, 177-357A, or permission.)

177-532B DEVELOPMENTAL NEUROBIOLOGY SEMINAR. (3) (1 hour lecture, 2 hours seminar) (Prerequisites: 177-303B and 177-306A or permission.) Discussions of all aspects of nervous system development including pattern formation, cell lineage, pathfinding and targetting by growing axons, and neuronal regeneration. The basis for these discussions will be recent research papers and other assigned readings. **Professors Levine and Ferns**

▭ **177-535B POLITICAL ECOLOGY.** (3) (3 hour seminar) (Prerequisite: 177-208A/308B or permission of instructor.) This student-led seminar course will investigate the relationship between scientific understanding and political process, from the perspective of ecology. It will examine why policy decisions on environmental issues often fail to satisfy biological concerns, and what can be done to enhance scientific contributions. Students will each research one environmental policy (legal act and/or legislative decision) for group analysis. **Professor Vincent**

★177-555L FUNCTIONAL ECOLOGY OF TREES. (3) (Lectures and laboratory taught in residence at the Mont St. Hilaire Research Reserve) (Prerequisites: 177-204A/304A, 177-205B, 177-357A) Functional organization in trees: physiology, architecture, and life history. Emphasis on trees in natural habitats. **Professor Lechowicz**

177-570B ADVANCED SEMINAR IN EVOLUTION. (3) (3 hours seminar) (Open to undergraduates by permission.) Detailed analysis of a topic in evolutionary biology, involving substantial original research. **Professor Bell (Co-ordinator) and staff**

177-588A ADVANCES IN CELL/MOL NEUROBIOL. (3) (1½ hours lecture, 1½ hours seminar) (Prerequisite: 177-300A or permission.) Discussion of fundamental molecular mechanisms underlying the general features of cellular neurobiology. An advanced course based on lectures and on a critical review of primary research papers. **Professors Carbonetto and Hastings**

11.5 Biotechnology (202)

Sheldon Biotechnology Centre
Lyman-Duff Building
Telephone: (514) 398-3998

Program Supervisor
Professor Hugh P.J. Bennett; B.A.(York), Ph.D.(Brun.)

Biotechnology, the science of understanding, selecting and promoting useful organisms and specific gene products for commercial and therapeutic purposes, is the success story of this generation. It demands a broad comprehension of biology and engineering as well as detailed knowledge of at least one basic subject such as molecular genetics, protein chemistry, microbiology, or chemical engineering.

The Minor Program in Biotechnology is offered by the Faculties of Engineering and of Science, and students combine the Minor with the regular departmental Major (or Honours or Faculty) program. The Minor emphasises an area relevant to biotechnology which is complementary to the main program.

Students should identify their interest in the Biotechnology Minor to their departmental academic adviser and to the Program Supervisor of the Minor and, at the time of registration for the U2 year, should declare their intent to embark on the Minor. Before registering for the Minor, and with the agreement of the academic adviser, students must submit their course list to the Program Supervisor who will certify that the student's complete program conforms to the requirements for the Minor. Students should ensure that they will have fulfilled the prerequisite requirements for the courses selected.

GENERAL REGULATIONS

To obtain the Minor in Biotechnology the students must:

a) satisfy the requirements both for the departmental program and for the Minor.
b) complete 24 credits, 18 of which must be exclusively for the Minor program.
c) obtain a grade of C or better in the courses presented for the Minor.

MINOR PROGRAM IN BIOTECHNOLOGY (24 credits)

[MARS Program Code 6-146400]

PROGRAM FOR STUDENTS IN THE FACULTY OF SCIENCE*

Required Courses (15 credits)

177-200A	(3)	Molecular Biology
177-201B	(3)	Cell Biology and Metabolism
or 507-212B	(3)	Molecular Mechanisms of Cell Function
177-202B	(3)	Basic Genetics
528-211A	(3)	Biology of Microorganisms
202-505B	(3)	Selected Topics in Biotechnology

Complementary Courses (9 credits)
selected from courses outside the department of the main program, these may be taken from those listed as required courses for Engineering students. Alternatively, or in addition, courses may be taken from the lists below; in which case, at least three courses must be taken from one area of concentration as grouped.

* as 18 credits must be applied exclusively to the Minor, approved substitutions must be made for any of the specified courses which are part of the student's main program.

PROGRAM FOR STUDENTS IN THE FACULTY OF ENGINEERING*

Required Courses (12 credits)

302-200A	(3)	Intro to Chemical Engineering
302-204B	(3)	Chemical Manufacturing Processes
302-474A	(3)	Biochemical Engineering
202-505B	(3)	Selected Topics in Biotechnology

Complementary Courses (12 credits)
selected from courses outside the department of the main program, these may be taken from those listed as required courses for Science students. Alternatively, or in addition, courses may be taken from the lists below; in which case, at least three courses must be taken from one area of concentration as grouped.

* as 18 credits must be applied exclusively to the Minor, approved substitutions must be made for any of the specified courses which are part of the student's main program.

Biomedicine

504-541B	Cell and Molecular Biology of Aging
516-504A	Biology of Cancer
546-300B	Human Disease

Chemistry

180-382B	Organic Chemistry of Natural Products
180-402B	Advanced Bio-organic Chemistry
180-552B	Physical Organic Chemistry

Immunology
504-261A Introduction to Dynamic Histology
507-503B Immunochemistry
552-513B Cellular Immunology
528-314B Immunology
528-414A Advanced Immunology

Management*
154-208 Microeconomics Analysis and Applications
280-211 Introduction to Financial Accounting
280-341 Finance 1
280-352 Marketing Management I
280-472 Operations Management
* These courses may not also be used for a Management Minor, nor for complementary, by Engineering students

Microbiology
528-323A Microbial Physiology
528-324A Fundamental Virology
528-413B Parasitology
528-465A Bacterial Pathogenesis and Host Defenses
528-466B Viral Pathogenesis and Host Defenses

Molecular Biology (Biology)
177-300A Molecular Biology of the Gene
177-314A Molecular Biology of Oncogenes
177-420B Gene Activity in Development
177-451A Molecular Biology: Cell Cycle
177-524A Topics in Molecular Biology

Molecular Biology (Biochemistry)
507-311A Metabolic Biochemistry
507-312B Biochemistry of Macromolecules
507-450A Protein Structure and Function
507-454A Nucleic Acids
507-455B Neurochemistry

Physiology
552-517B Artificial Internal Organs
552-518A Artificial Cells and Biotechnology
549-562A General Pharmacology I
549-563B General Pharmacology II
516-401B Physiology and Biochemistry of Endocrine Systems
516-502A Advanced Endocrinology, Part I
516-503B Advanced Endocrinology, Part II

Plant Biology
177-357A Plant Physiology
177-526B Plants and Extreme Environments

Pollution*
303-225B Environmental Engineering
303-430A Water Treatment and Pollution Control
303-526B Solid Waste Management
303-553B Stream Pollution and Control
302-471B Industrial Water Pollution Control
* These courses may not also be used for a Environmental Engineering Minor by Engineering students.

General:
306-310A,B Engineering Economy

COURSE DESCRIPTION

The course credit weight is given in parentheses (#) after the course title.

202-505A SELECTED TOPICS IN BIOTECHNOLOGY. (3) (Restricted to U3 students) Current methods and recent advances in biological, medical, agricultural and engineering aspects of biotechnology will be described and discussed. An extensive reading list will complement the lecture material. **Professor Prichard**

11.6 Chemistry (180)

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Chair — David N. Harpp

Emeritus Professors
John F. Harrod; B.Sc., Ph.D.(Birm.)
(Tomlinson Emeritus Professor of Chemistry)
Alan S. Hay; B.Sc., M.Sc.(Alta.), Ph.D.(Ill.), D.Sc.(Alta.), F.R.S., F.N.Y., Acad.Sci.*(Tomlinson Emeritus Professor of Chemistry)*
Mario Onyszchuk, B.Sc.(McG.), M.Sc.(W.Ont.), Ph.D.(McG.), Ph.D.(Cantab,)
Donald Patterson; M.Sc.(McG.), Doc. Hon. Causa(St-Etienne)
(Otto Maass Emeritus Professor of Chemistry)
Arthur S. Perlin; M.Sc., Ph.D.(McG.), F.R.S.C.
(E.B. Eddy Emeritus Professor of Industrial Chemistry)
William C. Purdy; B.A.(Amherst), Ph.D.(M.I.T.), F.C.I.C.
(William C. Macdonald Emeritus Professor of Chemistry)
Leon E. St-Pierre; B.Sc.(Alta.), Ph.D.(Notre Dame, Ind.), F.C.I.C.
Michael A. Whitehead; B.Sc., Ph.D. D.Sc.(Lond.), F.C.I.C.

Professors
Ian S. Butler; B.Sc., Ph.D.(Brist.), F.C.I.C., C.Chem., F.R.S.C.(U.K.)
Tak-Hang Chan; B.Sc.(Tor.), M.A., Ph.D.(Prin.), F.C.I.C., F.R.S.C.
Adi Eisenberg; B.S.(Worcester Polytech.), M.A., Ph.D.(Prin.), F.C.I.C. *(Otto Maass Professor of Chemistry)*
Byung Chan Eu; B.Sc.(Seoul), Ph.D.(Brown)
Patrick G. Farrell; B.Sc., Ph.D., D.Sc.(Exe.)
Denis F.R. Gilson; B.Sc.(Lond.), M.Sc., Ph.D.(U.B.C.), F.C.I.C.
David N. Harpp; A.B.(Middlebury), M.A.(Wesleyan), Ph.D.(N.Carolina), F.C.I.C.
James J. Hogan; B.S.(Renss.), Ph.D.(Chic.)
George Just; Ing.Chem.(E.T.H. Zürich), Ph.D.(W.Ont.), F.C.I.C.
(William C. Macdonald Professor of Chemistry)
Robert H. Marchessault; B.Sc.(Loyola), Ph.D.(McG.), D.Sc.(C'dia), F.R.S.C. *(E.B. Eddy Professor of Industrial Chemistry)*
David Ronis; B.Sc.(McG.), Ph.D.(M.I.T.)
Eric D. Salin; B.Sc.(Calif.), Ph.D.(Oreg.St.)
Bryan C. Sanctuary; B.Sc., Ph.D.(U.B.C.)
Alan G. Shaver; B.Sc.(Car.), Ph.D.(M.I.T.)

Associate Professors
Mark P. Andrews; B.Sc., M.Sc., Ph.D.(Tor.)
David H. Burns; B.Sc.(Puget Sound), Ph.D.(Wash)
Masad J. Damha; B.Sc., Ph.D.(McG.)
William C. Galley; B.Sc.(McG.), Ph.D.(Calif.)
Ashok K. Kakkar; Ph.D.(Wat.)
Romas Kazlauskas; B.Sc.(Clev.St.), Ph.D.(M.I.T.)
R. Bruce Lennox; B.Sc., M.Sc., Ph.D.(Tor.)
Joan F. Power; B.Sc., Ph.D.(C'dia)
Linda Reven; B.A.(Car.), Ph.D.(Ill.)

Assistant Professors
Parisa Ariya; B.Sc., Ph.D.(York)
Bruce Arndtsen; B.A.(Car.), Ph.D.(Stan.)
Christopher J. Barrett; B.Sc., M.Sc., Ph.D.(Queen's)
James Gleason; B.Sc.(McG.), Ph.D.(Virginia)
Hanadi Sleiman; B.Sc.(A.U.B.), Ph.D.(Stan.)

Faculty Lecturers
John Finkenbine; B.S.(Capital), Ph.D.(McG.)
Grazyna Wilczek; M.Sc., Doctorate Chem. Sci.(Warsaw)

Associate Members
James A. Finch *(Mining & Metallurical Engineering),*
Orval A. Mamer *(University Clinic),* Barry I. Posner *(Medicine)*

Adjunct Professors
G Ronald Brown; B.Sc.(Man.), Ph.D.(McG.)
Ariel Fenster; L.ès S., D.E.A.(Paris), Ph.D.(McG.)
Joseph A. Schwarcz; B.Sc., Ph.D.(McG.)