MINOR CONCENTRATIONS
African Studies
Socio-Cultural Anthropology – see Anthropology
Anthropological Archaeology – see Anthropology
Art History
Canadian Ethnic Studies
Canadian Studies
Classics
East Asian Language and Literature
East Asian Cultural Studies
Advanced East Asian Studies – see East Asian Studies
Economics
English – Literature
English – Drama and Theatre
English – Cultural Studies
Langue et littérature françaises – Lettres
Langue et littérature françaises – Léttres et traduction
Langue et littérature françaises – Langue et traduction
Langue et littérature françaises – Théorie et critique littéraires
Geography
German Literature – see German Studies
German Literature and Culture in Translation – see German Studies
Hispanic Languages – see Hispanic Studies
Spanish Literature and Culture – see Hispanic Studies
Spanish-American Literature and Culture – see Hispanic Studies
History
History and Philosophy of Science
Humanistic Studies
International Development Studies
Italian Studies
Italian Civilization – see Italian Studies
Jewish Studies
Theoretical Linguistics – see Linguistics
Applied Linguistics – see Linguistics
Middle East Studies – see Middle East Studies
Middle East Languages – see Middle East Studies
North American Studies
Philosophy
Political Science
Political Science: Canada/Québec
Comparative Politics – see Political Science
International Relations – see Political Science
Political Economy – see Political Science
Politics, Law and Society – see Political Science
South Asia – see Political Science
Québec Studies
Religious Studies – World Religions
Religious Studies – Scriptural Languages
Russian – see Russian and Slavic Studies
Russian Civilization – see Russian and Slavic Studies
Social Studies of Medicine
Sociology
Women’s Studies

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.)
Donald Lawrence; B.Sc.(Bishop's), M.D., C.M.(McG.) (joint appt. with Neurology & Neurosurgery)
Charles P. Leblond; M.D.(Paris), Ph.D.(Montr.), D.Sc.(Acad.), 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)
Dennis G. Osmond; B.Sc., M.B., Ch.B., D.Sc.(Brist.), F.R.C.S.
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)
Eugenia Wang; B.Sc.(Taiwan), M.A.(N.Mich.), Ph.D.(Case Western Reserve) (joint appt. with Medicine)
Hershey Warshawsky; B.Sc.(Sir G.Wms.), M.Sc., Ph.D.(McG.)

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)
Michael F. Lalli; B.S., M.A.(Bowling Green), Ph.D.(McG.)
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.)
Hoijatolla Vali; B.Sc., M.Sc., Ph.D.(Munich) (joint appt. with Earth and Planetary Sciences)

Assistant Professors
Chantal Autexier; B.Sc.(C'dia), Ph.D.(McG.) (joint appt. with Medicine)
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)
Alfredo Riberio-da-Silva; M.D., Ph.D.(Oporto) (joint appt. with Pharmacology and Therapeutics)
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. Those 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 in 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, micro-injection 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) Genomic Human Anatomy
504-261A (4) Introduction to Dynamic Histology
must be taken in U1)
504-262B (3) Introductory Molecular & Cell Biology
504-321A (3) Circuity of the Human Brain
177-200A (3) Molecular Biology
177-202B,A (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

Complementary Courses (18 credits)

6 credits selected from:
504-322B (3) Neuroendocrinology
504-365A (3) Cell Biology of the Secretory Process
504-381B (3) Experimental Basis of Embryology

12 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; 362-307B;
504-322B, 504-365A, 504-381B, 504-432D, 504-541B;
528-314B, 528-323A, 528-324A, 528-386D, 528-387B, 528-413B,
528-414A, 528-465A, 528-466B, 528-509B;
531-301B; 546-300B;
549-300A, 549-301B, 549-562A, 549-563B;
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 (56 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
177-301A,B (3) Cell and Molecular Laboratory
528-314B (3) Immunology
552-212D (2) Introductory Physiology Lab

Complementary Courses (12 credits)

12 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]

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 3.0 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 3.2 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 3.2.

Required Courses (74 credits)

all Major Program required courses, plus:
504-322D,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 (6 credits)

6 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 1999-2000.
□ Denotes limited enrolment.
★ Denotes courses taught only in alternate years.

● 504-205A ASTROBIOLOGY. (3 hours lecture) (Not open to students who have taken or are taking 186-205A.)

504-212B MOLECULAR MECHANISMS OF CELL FUNCTION. (3) (Pre-requisite: 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 alsoOTE following Course Descriptions above.) Professor Hermo

504-261A INTRODUCTION TO DYNAMIC HISTOLOGY. (4) (3 hours lectures, 2 hours laboratory) (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) (1 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 audio-visual materials.

Professor Bennett

504-321A CIRCUITY 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 50-321A) A lecture course describing brain-endocrine relationships. Emphasis on modern experimental evidence and conceptual developments within the field.

Professor Brawer, Beaudet and Walker

504-365A CELL BIOLOGY OF THE SECRETORY PROCESS. (3) (2 hours lectures, 2 hours conference) (Prerequisites: 504-261A, 177-200A, 177-201B, or by special permission.) 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 Bennett 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.) This course will focus on the function of cell adhesion molecules as morphogenetic regulators. Modern techniques of molecular embryology will be discussed.

Professor Blaschuk

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 Blaschuk, Hermo and Morales

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 Wang and Staff

11.2 Atmospheric and Oceanic Sciences (195)

Burnside Hall, Room 705
605 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.)
R.Grant Ingram; B.Sc., M.Sc.(McG.), Ph.D.(M.I.T.) (on leave)
Lawrence A. Mysak; B.Sc.(Alta.), M.Sc.(Adel.), A.M., Ph.D.(Harv.), F.R.S.C. (Canada Steamsip Lines Professor of Meteorology)

Izisar 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.)
Charles A. Lin; B.Sc.(U.B.C.), Ph.D.(M.I.T.)
Thomas Wamb; B.Sc.(U.B.C.), M.Sc., Ph.D.(McG.)

Man Kong (Peter) Yau; S.B., S.M., Sc.D.(M.I.T.)

Assistant Professors
Parisa Ariya; B.Sc., Ph.D.(York) (joint actpt. with Chemistry)
David Straub; B.S., M.S.(SW Louisiana), Ph.D.(Wash)

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, 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.

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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 five 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 Minor program includes almost all the atmospheric science courses in the Major program, and when complemented by the right choice of elective courses also satisfies the requirements for a professional career in meteorology. 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. YES, the internship year program in Engineering and Science, is a pregraduate work experience program available to eligible students and normally taken between their U2 and U3 years. See Faculty of Engineering section 2.8 on page 219 for further information on YES.

MINOR PROGRAM IN ATMOSPHERIC SCIENCE (24 credits)  
[MARS Program Code 6-662000]

The Minor may be taken in conjunction with any program in the Faculty of Science, although it is most readily accessible to students enrolled in Physics programs. Other students who take the following courses in an appropriate sequence and achieve grades of C or better are also eligible: 189-222, 189-223, 189-314, 189-315, 198-230, 198-232, 198-259, 198-331, 198-333.

Required Courses (24 credits)

195-214A (3) Intro. to the Physics of the Atmosphere
195-215B (3) Weather Systems and Climate
195-310B (3) Physical Oceanography
195-330A (3) Physical Meteorology
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

MAJOR PROGRAM IN ATMOSPHERIC SCIENCE (64 credits)  
[MARS Program Code 1-662000]

Required Courses (55 credits)

all Minor Program required courses, plus:

195-546B (1) Current Weather Discussion
189-222A,B (3) Calculus III
189-223B,A (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
198-331B (3) Mechanics
198-333B (3) Thermal & Statistical Physics
or 188-340A (3) Electricity and Magnetism
308-206A,B (3) Computers in Engineering

Complementary Courses (9 credits)

3 - 6 credits to satisfy a statistics requirement, usually:
189-203A,B (3) Probability Theory
and 189-324A,B (3) Statistics

3 - 6 credits ordinarily selected from:
183-522A (3) Advanced Environmental Hydrology
189-317A (3) Numerical Analysis
189-319B (3) Partial Differential Equations
195-515B (3) Turbulence
198-241B (3) Signal Processing
198-248A (3) Physics of Energy
198-340A (3) Electricity and Magnetism
198-342B (3) Electromagnetic Waves
198-352B (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 1-720100]

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
195-310B (3) Physical Oceanography
195-330A (3) Physical Meteorology
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 & 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
198-314A,B (3) Advanced Calculus
198-315A,B (3) Ordinary Differential Equations

Complementary Courses (3 credits)

198-434A (3) Optics
or 198-439A (3) Laboratory in Modern Physics
HONOURS PROGRAM IN ATMOSPHERIC SCIENCE
(70 credits) [MARS Program Code 2662000]

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 3.3. 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 3.3 in the Honours Program courses (taken as a whole) is required to remain in the program. A CGPA of 3.3 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
195-310B (3) Physical Oceanography
195-330A (3) Physical Meteorology
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 (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
198-232A (3) Heat and Waves
198-259D (3) Lab in Mechanics, Heat & Optics
198-331B (3) Mechanics
198-333B (3) Thermal and Statistical Physics
or 198-340A (3) Electricity and Magnetism
308-208A,B (3) Computers in Engineering

Complementary Courses (12 credits)
12 credits taken from a list of courses approved by the Department; the selection must satisfy a requirement in statistics.

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. Students must fulfill 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 (24 credits)
195-310B (3) Physical Oceanography
195-330A (3) Physical Meteorology
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 (6 credits)
6 credits taken from a list of courses approved by the Department.

COURSE DESCRIPTIONS
The course credit weight is given in parentheses (#) after the course title.
* Denotes courses not offered in 1999-2000.
 Denotes limited enrolment.
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.


195-515B 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.) Analysis of current meteorological data. Description of a geostrophic, hydrostatic atmosphere. Ageostrophic circulations and hydrostatic instabilities. Kinematic and thermodynamic methods of computing vertical motions. Tropical and extratropical condensation rates. Barotropic and equivalent barotropic atmospheres.

195-541B Synoptic Meteorology II. (3) (2 hours lectures; 2 hours laboratory) (Prerequisite: 195-512A and -540A or permission of instructor) Analysis of current meteorological data. Quasi-geostrophic theory, including the omega equation, as it relates to extratropical cyclone and anticyclone development. Frontogenesis and frontal circulations in the lower and upper troposphere. Cumulus convection and its relationship to tropical and extratropical circulations. Diagnostic case study work.

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) Numerical simulation of atmospheric and oceanic processes. Finite difference, finite element, and spectral modelling techniques. Term project including computer modelling of convection or large-scale flows in the atmosphere or ocean.

195-568B Ocean Physics. (3) (3 hours lectures) (Prerequisite: 195-512A or permission of instructor.) Research methods in physical oceanography including data analysis and literature review. Course will be divided into five separate modules focussing on temperature-salinity patterns, ocean circulation, boundary layers, wave phenomena and tides.

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

11.3 Biochemistry (507)

McIntyre Medical Sciences Building, Room 802 3655 Drummond Street Montreal, QC H3G 1Y6

Telephone: (514) 398-7266
Fax: (514) 398-7384
Email: Caron@med.mcgill.ca
Website: http://www.biochem.mcgill.ca

Chair — Philip E. Branton

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. Sorkus; 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.(Ala.)
John R. Silvis; 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
Nico 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)

Monse 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.)
Une Veillette; B.Sc., M.D.(Laval), F.R.C.P.(C) (joint appt. with Oncology)

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 Congole (Exp. Medicine, RVH); Robert Dunn (Exp. Medicine, MGH); Mark S. Featherstone (Oncology); William C. Galley (Chemistry); Peter J. Roughley (Shriners Hospital); Erwinn Schurr (Exp. Medicine, RVH);

Charles Scriver (Pediatrics, MCH); Bernard Turcotte (Exp.
Biochemistry is the application of chemistry to the study of biological processes at the cellular level. Biochemists are interested in the chemical events that occur in cells, for example, in mechanisms of brain function; cellular differentiation; energy utilization by animals, plants and microorganisms and in the chemical 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 chemical 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 fulfill 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**

**U1 Required Courses** (55 credits)

**U1 Complementary Courses** (9 credits)

<table>
<thead>
<tr>
<th>Credits</th>
<th>Code</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>177-200B</td>
<td>(3)</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>180-204A,B</td>
<td>(3)</td>
<td>Physical Chem./Biol. Sci. I</td>
</tr>
<tr>
<td>180-222A,B</td>
<td>(4)</td>
<td>Organic Chemistry II</td>
</tr>
</tbody>
</table>

**MAJOR PROGRAM IN BIOCHEMISTRY** (70 credits)

**U1 Required Courses** (20 credits)

<table>
<thead>
<tr>
<th>Credits</th>
<th>Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>507-212B</td>
<td>(3)</td>
<td>Molecular Mechanisms of Cell Function</td>
</tr>
<tr>
<td>177-200A</td>
<td>(3)</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>177-200A,B</td>
<td>(3)</td>
<td>Basic Genetics</td>
</tr>
<tr>
<td>180-204A,B</td>
<td>(3)</td>
<td>Physical Chem./Biol. Sci. I</td>
</tr>
<tr>
<td>180-222A,B</td>
<td>(4)</td>
<td>Organic Chemistry II</td>
</tr>
</tbody>
</table>

**U1 Complementary Courses** (9 credits)

<table>
<thead>
<tr>
<th>Credits</th>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>552-209A</td>
<td>(3)</td>
<td>Mammalian Physiology I</td>
</tr>
<tr>
<td>552-210B</td>
<td>(3)</td>
<td>Mammalian Physiology II</td>
</tr>
</tbody>
</table>
U1 Major program with a GPA of at least 3.2 and a mark of B or B-
low the U1 Major program. Those who satisfactorily complete the
Admission to the Honours program will not be granted until U2.

U2 Required Courses (23 credits)
all Faculty Program U2 Required Courses, plus:
180-214B (3) Physical Chem./Biol. Sci. II
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

U2 Required Courses (3 credits)
9 credits must be selected from:
507-404B (3) Biophysical Chemistry
507-450A (3) Protein Structure & Function
507-455B (3) Neurochemistry
507-456B (3) Biochemistry of Membranes
507-491B (6) Independent Research
507-503B (3) Immunology
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

U2 Complementary Courses (3 credits)
9 credits must be selected from:
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
507-455B (3) Neurochemistry
507-456B (3) Biochemistry of Membranes
507-491B (6) Independent Research
507-503B (3) Immunology
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

U3 Required Courses (6 credits)
507-450A (3) Protein Structure & Function
507-455B (3) Neurochemistry
507-456B (3) Biochemistry of Membranes
507-491B (6) Independent Research
507-503B (3) Immunology
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

U3 Complementary Courses (9 credits)
9 credits must be selected from:
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
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180-552B (3) Physical Organic Chemistry
180-572B (3) Synthetic Organic Chemistry
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507-456B (3) Biochemistry of Membranes
507-491B (6) Independent Research
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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
All students (U1, U2, U3) must meet with an adviser prior to regist-
ration. For more information, telephone (514) 398-7266, McIntyre
Medical Sciences Building, Room 802.

INTERDEPARTMENTAL HONOURS PROGRAM IN
IMMUNOLOGY
The Departments of Biochemistry, Microbiology
and Immunology, and Physiology offer an Immunology Interde-
partmental Honours Program, see section 11.14.

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

Denotes courses not offered in 1999-2000.
Denotes courses with limited enrolment

507-212B Molecular Mechanisms of Cell Function. (3) (Pre-
require: 177-200A) (A non-terminal course intended to be fol-
lowed 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; mitochon-
drial 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, oth-
ers with permission of instructor.) A comprehensive course in mod-
ern biochemical techniques involving properties of enzymes, metabolism, fractionation of organelles from mammalian cells and metabolic,  

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 cellular, molecular 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 pyrimidine metabolism; transcription and its regulation; mRNA processing; translation; targeting 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) Hydrodynamic and electrophoretic methods for separation and characterization of macromolecules. Optical and magnetic resonance spectroscopy of biopolymers, and applications to biological systems.  

Professors Silvius and Gally (Chemistry Dept.)

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 Vrieland

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 excitation, chemically mediated transmission, gial 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 Boks, Srivastava (Coordinators), Walker and Young (Psychiatry Dept.)


Professors Silvius and Bielstein

507-460A ADVANCED LAB IN BIOCHEMISTRY. (6) (Enrolment limit) (Please see regulations concerning Project Courses, section 2.6.2 on page 339 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 on page 339 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)
Adjunct Professors

David Rosenblatt (Paediatrics),  Guy Rouleau (MGH),  Robert Dunn (Neuroscience),  Michael Ferns (Neurology & Neurosurgery),  William F. Grant (Plant Science),  Roy Gravel (Paediatrics),  David Green (Redpath Museum),  Kenneth Hastings (MNI),  Paul Holland (MNI),  Wayne Hunte (Bellairs Institute),  Roberta Palmour (Allan Memorial Institute),  Leonard Pinsky (Lady Davis Institute),  Henry Reiswig (Redpath Museum),  David Rosenblatt (Paediatrics),  Guy Rouleau (MGH),  Charles R. Scrivner (Paediatrics),  Teruko Taketo (RVH),  Harriet S. Tenenhouse (Paediatrics)

Faculty of Science

Undergraduate Programs, McGill University

[FACULTY PROGRAM IN BIOLOGY (54 credits)]

FACULTY PROGRAM IN BIOLOGY [MARS Program Code 4-144500]

Required Courses (18 credits)

- 177-200A (3) Molecular Biology
- 177-201B (3) Cell Biology and Metabolism
- 177-202A, B (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
  - 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 [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
    - 177-202A, B (3) Basic Genetics
    - 177-205B (3) Biology of Organisms
    - 177-206A (3) Methods in Biology of Organisms

Adjunct Professors

Wing Cheung (DNA Landmarks),  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. Whitley;  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 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 D.C.S. 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, 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/B), entitled (Department of Biology Undergraduate Programs 1999-2000), 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 Secretary, in Room W4/B, Stewart Biology Building, telephone (514) 398-7045.
MOLECULAR GENETICS AND DEVELOPMENT CONCENTRATION

The discoveries that have fuelled the ongoing biomedical and biotechnological revolution have derived from the fusion 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:

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, -477A, -478B,C
- Pharmacology 549-562A
- Psychiatry 555-500B
- Psychology 204-311A, -318B, -342B, -410B, -422B, -470B

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, -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 im-
portance 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:

**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:
- Other suggested courses in Organismal Biology:
  - Biology 177-327A, -335T, -350A, -351B, -353A -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, -377B,C or -477A and/or -478B,C, -593B
- Other suggested courses:
  - 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 is essential in ecology and evolutionary biology and underlie all work in resource utilization and conservation biology.

Key course:
- Biology 177-305B
- Other suggested courses:

Other suggested courses:
- 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:
  - 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, -493B
- 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, -353B, -437B, -441B, -442B
- Earth and Planetary Sciences 186-360A
- Other suggested courses:
  - Biology 177-331A, -334E,C -432A, 460A, -470B, -473A
  - Earth and Planetary Sciences 186-542A
  - Atmospheric and Oceanic Sciences 195-512A, -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 3.2 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 3.2 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
- 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 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.

**177-102B CELL AND MOLECULAR BIOLOGY METHODS.** (1) (3 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.

**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.

**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.

**Professors Nishioka**

- **177-199A SPECIES DIVERSITY.** (3) (3 hours seminar) (Pre- or Co-requisite: 177-111A) (FYS - for first year students only, maximum 25.)

**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 will include: protein structure, enzymes and enzyme kinetics; nucleic acid replication, transcription and translation; the genetic code, mutation, recombination, and regulation of gene expression.

**Professors Bureau, Dunn and Brown (Co-ordinator)**

**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 system; hormone signalling; the cell cycle.

**Professor Levine (Co-ordinator) and Staff**

**177-202A,B 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.

**Professor Hechtman (Co-ordinator) and Staff**

**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 Lemon 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.) The principles and practice of current biotechnology. Requirements for the transfer of genes between organisms by recombinant DNA; applications to therapy in humans and to improvements in plants and animals in agriculture. The culture of whole cells to generate antibodies, enzymes and growth factors. Biomining and bioremediation. Legal and ethical issues.

Professor Sinclair

177-240T MONTREALIAN FLORA. (3) (Prerequisite: 177-111A or permission) Field and laboratory investigations of fern allies, ferns, conifers and flowering plants. Field work will deal with sight-recognition of major plant groups, families and general characteristics of the St. Lawrence River Valley and the use of plant keys for species identification. Lectures and laboratory taught in residence at Mt. St. Hilaire Research Reserve. Professor Lechowicz and Staff

177-274A GENERAL GENETICS. (3) (3 lectures; 1 hour conference) (Prerequisite: 177-112B or equivalent; co-requisite 177-200A. Not open to students who have taken 177-202B.)

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 and Lasko (Co-ordinator)

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 macro-molecules are purified and characterized. Good data analysis and report preparation are strongly encouraged.

Professors Poole and Waddell

177-303B DEVELOPMENTAL BIOLOGY. (3) (3 lectures and optional 1 hour conference) (Prerequisites: 177-200A and 177-201B. Corequisites: 177-202A,B or 177-274A.) 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) (Prerequisites: 177-202A,B, 177-205B, 177-208A) (Formerly 177-204A) 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.

Professors Bell (Co-ordinator) and Carroll

177-305B DIVERSITY OF LIFE. (3) (2 lectures and 1 three-hour laboratory) This course describes the adaptations of the major groups of living and extinct organisms. It shows how diversity can be analyzed through systematics, phylogenetics and the comparative method.

Professors Bell (Co-ordinator), Green and Reiswig

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), Chase and Lefebvre

177-307B BEHAVIOURAL ECOLOGY/SOCIOBIOLOGY. (3) (2 hours lecture and 1 hour conference) (Prerequisites: 177-205B, 177-208A 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, 177-205B) The structure and function of whole cells to generate antibodies, enzymes and growth factors. Biomining and bioremediation. Legal and ethical issues.

Professor Schoen

177-327A HERPETOLOGY. (3) (2 hours lecture; 3 hours laboratory) (Prerequisite: 177-205B) Principles of biology as exemplified by amphibians and reptiles. Topics include: adaptation, social behaviour, reproductive strategies, physiology, biomechanics, ecology, biogeography and evolution. Laboratories will emphasize structure, systematics and identification of local and world herpetofauna as well as field methods.

Professor Green

177-331A ECOLOGY/BEHAVIOUR FIELD COURSE. (3) (Prerequisites: 177-206A, 177-206A/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

177-333B PLANT BIOTECHNOLOGY. (3) (3 hours lecture) (Prerequisites: 177-200A, 177-201B, 177-274A or 177-202B)

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 Dr. Roff at an information session held in November and fill out an application form.

Professors Hunt and Roff

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 consult their adviser before enrolling in the course. See A. Comeau, 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 A. Comeau, 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. See A. Comeau, W4/8) 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.

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

177-350A 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 and Staff (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) The origin and evolution of the major groups of vertebrates; their anatomy, phylogeny and zoogeography. Structural, behavioral and physiological adaptations to different environments and energetic requirements. Evolutionary theory as applied to major events in the history of vertebrates; the origin and radiation of major taxa, patterns and rates of evolution.

Professor Carroll

177-353A LOWER EUCARYA: PROTISTA AND FUNGI. (3) (3 hours lecture) (Prerequisites: 177-204A/304A, 177-205B or permission. Corequisite: 177-304A)

177-354B BIOLOGY OF BIRDS. (3) (2 hours lecture, 3 hours laboratory) (Prerequisite: 177-204A/304A; 177-206A recommended.) The adaptations of birds to their peculiar mode of life, including aspects of anatomy, plumages, behaviour (migration, flight, reproduction, vocalizations). Introduction to local and world avifaunas. Laboratory exercises, field trips, research paper.

Professor Lemon

177-357A PLANT PHYSIOLOGY. (3) (3 hours lecture) (Prerequisites: 177-200A and 177-208A 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) (Prerequisites: 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

177-363A CONSERVATION BIOLOGY. (3) (3 hours lecture) (Prerequisite: 177-208A/308B) (Exclusion: 367-358) 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 or 177-274A) 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 339) 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 on page 339 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 Chase (Co-ordinator), Drapeau and Pollack

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 on page 339 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: 177-202A,B 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 organismal 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) This course examines neural mechanisms underlying behaviour. Topics will be introduced by a lecture, supplemented by a review article. This will be followed by student seminars and/or discussions. Topics will vary according to current literature, but will likely include communication, visual behaviour, escape, orientation, neurogenetics and locomotion.

Professor Pollock

177-431A NEUROBIOLOGY OF LEARNING & MEMORY. (3) (3 hours lecture and discussion) (Prerequisite: 177-306A or 552-311B or 552-311A or permission.) Properties of nerve cells that are responsible for learning and memory. Recent advances in the under-
standing of neurophysiological, biochemical and structural processes relevant to neural plasticity. Emphasis on a few selected model systems involving both vertebrate and invertebrate animals.

Professor Chase

177-432A LIMNOLOGY. (3) (2 hours lecture; 3 hours laboratory) (Prerequisites: 177-206A and/or permission.) A study of the physical, chemical and biological properties of inland waters, with emphasis on their functioning as systems.

Professor Kalff

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.) An introduction to how the ocean functions biologically - biology and ecology of marine plankton; regulation, extent and fate of production in the sea.

Professor Price

177-442B MARINE BIOLOGY. (3) (2 hours lecture, 1 laboratory or conference) (Prerequisite: 177-208A/308B or permission)

177-451A MOLECULAR BIOLOGY: CELL CYCLE. (3) (3 hours lecture) (Prerequisites: 177-200A, 177-201B, 177-300A.) Cytological studies, biochemical and genetic 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.

Professor Whiteway and Staff

177-453B NEOTROPICAL ENVIRONMENTS. (3) (16 hours lecture for 4 weeks, 1 hour seminar, 8 hours field work) (Prerequisites: 144-218, 189-203, and 177-208A/308B, or equivalents, and permission of Program Coordinator. Corequisites: 170-451B, 183-498B and 336-450) (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. 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 seminar) (Prerequisites: Core Program in Biology.)

177-468B TOPICS ON THE HUMAN GENOME. (3) (3 hours lecture) (Prerequisites 177-228B or 177-274A, 177-300A, 177-370B, or permission.) Cellular and molecular approaches to characterization of the human genome.

Professor Rozen and Staff

177-470B LAKE MANAGEMENT. (3) (2 hours lecture, 2 hours laboratory) (Prerequisite: 177-208A/308B or permission.)

177-471C,D INDEPENDENT STUDIES IN BIOLOGY. (3) (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 on page 339 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.

Professor Hechtman and Staff

177-472A MOLECULAR EVOLUTION. (3) (4 hours lecture/seminar) (Prerequisite: 177-300A and 177-204A/304A recommended.)

177-473A ECOLOGY OF AQUATIC INVERTEBRATES. (3) (2 hours lecture, 2 hours laboratory) (Prerequisite: 177-208A/308B or permission.)

177-475B HUMAN BIOCHEMICAL GENETICS. (3) (3 hours lecture) (Prerequisites: 177-274A or 177-202A,B 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-177-477B,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 on page 339 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 on page 339 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) (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 on page 339 in the Faculty Degree Requirements section.)

Staff

177-483B STATISTICS IN POPULATION BIOLOGY. (3) (3 hours lecture) (Prerequisites: 177-201B, 177-202B, 177-205B, 177-208A/308B, 177-373A or permission.)

177-499D HONOURS SEMINAR IN BIOLOGY. (4) (Weekly seminars) Honours students in Biology attend a selected series of guest speaker seminars of general interest. In addition, groups of students participate in a chosen series of specialized seminars and present approximately two reports.

Professor Nishioka

177-505B DIVERSITY AND SYSTEMATICS SEMINAR. (3) (3 hours seminar) (Prerequisites: 177-204A/304A, 177-305B, or permission.) A course dealing in depth with a particular aspect of biological diversity and/or systematics. Topics may include the systematics of a particular taxon, issues in biodiversity, systematics theory and practice, etc. The class will discuss aspects of the chosen topic and prepare individual seminar reports.

Professor Green

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, mo-
bile genetic elements, regulation of gene expression, cellular and viral replication, signal transduction. 

Professors Mukherjee and Nishioka (Co-ordinator)

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. With the agreement of the academic adviser, students should 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 Dynamic Histology
- 507-503B Immunochrometry
- 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 I
- 280-352 Market 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**
- 177-333B Plant Biotechnology
- 177-357A Plant Physiology
- 177-526B Plants and Extreme Environments

**Pollution* **
- 303-225B Environmental Engineering
- 303-430A Water Treatment and Pollution Control
- 303-426B Solid Waste Management
- 303-555B 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

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**COURSE DESCRIPTION**

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

**202-505B SELECTED TOPICS IN BIOTECHNOLOGY.** (3) Restricted to US 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

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**11.6 Chemistry (180)**

Otto Maass Chemistry Building
801 Sherbrooke Street West
Montreal, QC H3A 2K6
Departmental Office: Room 322. Telephone: (514) 398-6999
Student Advisory Office: Room 309A. Telephone: (514) 398-6927
Website: http://www.mcgill.ca/chemistry

Chair — David N. Harpp

Emeritus Professors
- John F. Harrod; B.Sc., Ph.D. (Birm.) (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)
- Leon E. St-Pierre; B.Sc. (Alta.), Ph.D. (Notre Dame, Ind.), F.C.I.C.

Professors
- Tak-Hang Chan; B.Sc. (Tor.), M.A., Ph.D. (Prin.), F.C.I.C., F.R.S.C., B. Jik Chin; B.Sc., M.Sc., Ph.D. (Tor.)
- 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. (Eke)
- Denis F.R. Olson; 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.
- Alan S. Hay; B.Sc., M.Sc. (Alta.), Ph.D. (Ill.), D.Sc. (Alta.), F.R.S., F.N.Y., Acad.Sci. (Tomlinson Professor of Chemistry)
- James J. Hogan; B.S. (Renss.), Ph.D. (Chic.)
- Robert H. Marchessault; B.Sc. (Loyola), Ph.D. (McG.), D.Sc. (C'dia), F.R.S.C. (E.B. Eddy Professor of Industrial Chemistry)
- William C. Purdy; B.A. (Amherst), Ph.D. (M.I.T.), F.C.I.C. (William C. Macdonald Professor of 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.)
- David N. Harpp; A.B. (Middlebury), M.A. (Wesleyan), Ph.D. (N.Carolina), F.C.I.C.
- Mario Onyszchuk, B.Sc. (McG.), M.Sc. (W.Ont.), Ph.D. (McG.), D.Sc.
- John T. Edward; D.Phil. (Oxon.), Ph.D., D.Sc. (Dub.), F.C.I.C., F.R.S.C. (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)
- Leon E. St-Pierre; B.Sc. (Alta.), Ph.D. (Notre Dame, Ind.), F.C.I.C.

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.)
- Arthur E. Grosser; A.B. (Ch'nell), Ph.D. (Wis.)
- R. Bruce Lennox; B.Sc., M.Sc., Ph.D. (T or.)
- Denis F.R. Gilson; B.Sc. (Lond.), M.Sc., Ph.D. (U.B.C.), F.C.I.C.
- Patrick G. Farrell; B.Sc., Ph.D., D.Sc. (Exe.)
- B. Jik Chin; B.Sc., M.Sc., Ph.D. (T or.)
- Byung Chan Eu; B.Sc. (Seoul), Ph.D. (Brown)
- Adi Eisenberg; B.S. (Worcester Polytech.), M.A., Ph.D. (Prin.), F.C.I.C. (Otto Maass Professor of Chemistry)
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- Michael Anthony Whitehead; B.Sc., Ph.D., D.Sc. (Lond.), F.C.I.C.

Assistant Professors
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- James J. Hogan; B.S. (Renss.), Ph.D. (Chic.)
- Robert H. Marchessault; B.Sc. (Loyola), Ph.D. (McG.), D.Sc. (C'dia), F.R.S.C. (E.B. Eddy Professor of Industrial Chemistry)
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- 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.)
- Michael Anthony Whitehead; B.Sc., Ph.D., D.Sc. (Lond.), F.C.I.C.
Chemistry is both a pure science, offering a challenging intellectual pursuit and an applied science whose technology is of fundamental importance to the economy and society. Modern chemists seek an understanding of the structure and properties of atoms and molecules to predict and interpret the properties and transformations of matter and the energy changes that accompany those transformations. Many of the concepts of physics and mathematics are basic to chemistry, while chemistry is of fundamental importance to many other disciplines such as the biological and medical sciences, geology, metallurgy, etc.

A degree in chemistry leads to a wide variety of professional vocations. The large science-based industries (petroleum refining, plastics, pharmaceuticals, etc.) all employ chemists in research and testing laboratories. Such positions are expected to increase with the currently growing concern for the environment and for consumer protection. A background in chemistry is also useful as a basis for advanced study in other related fields, such as medicine and the biological sciences. For a business career, a B.Sc. in Chemistry can profitably be combined with a master’s degree in Business Administration, or a study of law for work as a patent lawyer or forensic scientist.

Chemistry courses at the university level are traditionally divided into four areas of specialization: 1) organic chemistry, dealing with the compounds of carbon; 2) inorganic chemistry, concerned with the chemistry and compounds of elements other than carbon; 3) analytical chemistry, which deals with the identification of substances and the quantitative measurement of their compositions; and 4) physical chemistry, which treats the physical laws and energetics governing chemical reactions. Naturally there is a great deal of overlap between these different areas, and the boundaries are becoming increasingly blurred. After a general course at the collegiate level, courses in organic, inorganic, analytical and physical chemistry are offered through the university years. Since chemistry is an experimental science, laboratory classes accompany most undergraduate courses. In addition, courses are offered in polymer, nuclear, theoretical, radio- and biological chemistry to upper year undergraduates.

There are two main programs in chemistry, Honours and Major. The Honours program is intended primarily for students wishing to pursue graduate studies in chemistry. While the Major program is somewhat less specialized, it is still recognized as sufficient training for a career in chemistry. It can also lead to graduate studies although an additional qualifying year may be necessary. There are also a number of Faculty programs available. Interested stu-

dents may inquire about these at the Student Advisory Office, Room 309A, Otto Maass Chemistry Building.

PRE-PROGRAM REQUIREMENTS

Students entering from the Freshman program must have included Mathematics 189-140/141, Chemistry 180-121/111 or -120/110, Biology 177-111, Physics 198-131/112, or their equivalents in their Freshman year. Québec students must have completed the DEC with appropriate science and mathematics courses.

REQUIRED COURSES IN CHEMISTRY PROGRAMS

The required courses in Chemistry programs consist of 57 credits in chemistry, physics and mathematics, listed below. The courses marked with an asterisk (*) are omitted from the program of students who have successfully completed them at the CEGEP level but the Chemistry courses must be replaced by courses in that discipline if students wish to be eligible for admission to the Ordre des chimistes du Québec. Students from outside Québec or transfer students should consult the academic advisor.

A computer science course, either 308-102 or -202, will be required during U1 for students who have no previous introduction to computer programming. Students are required to contact their advisor on this matter. Completion of Mathematics 189-222 and -315 during U1 is strongly recommended. Physics 198-242 should be completed during U-2.

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Physics 198</td>
<td>242(2)</td>
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<tr>
<td>Math 189</td>
<td>133(3)<em>, 222(3)</em></td>
</tr>
<tr>
<td>Chemistry 180</td>
<td>302(3), 345(3), 355(3), 363(2), 365(2), 367(3), 377(3), 381(3), 392(3), 393(2)</td>
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<tr>
<td>Math 189</td>
<td>315(3)</td>
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</tbody>
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HONOURS AND MAJORS

HONOURS

<table>
<thead>
<tr>
<th>Course + 18 additional complementary Chemistry credits:</th>
<th>Credits</th>
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<tbody>
<tr>
<td>6 credits: 480, 490 (research)</td>
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<tr>
<td>6 credits: 300 level or higher</td>
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<tr>
<td>6 credits: 400 level or higher</td>
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MAJORS

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<tr>
<th>Course + 6 additional complementary Chemistry credits:</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 credits: 300 level or higher</td>
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</tbody>
</table>

HONOURS IN CHEMISTRY [MARS Program Code 2-172200]

The Honours Program in Chemistry is the Core Curriculum, to which is added 18 complementary credits in Chemistry. Of these 18 credits, 6 must be the Research Project, 180-480 and 180-490. Of the remaining 12 credits, 6 must be at the 300 level or higher, and 6 must be at the 400 level or higher. Attainment of the Honours degree requires a CGPA of at least 3.00.

HONOURS WITH BIO-ORGANIC OPTION [MARS Program Code 2-172205]

The Bio-organic Option of Honours in Chemistry consists of the requirements for Honours in Chemistry with replacement of 198-242 by 177-200 and 177-201, and replacement of the 6 complementary credits of Chemistry at the 300 level with 6 credits chosen from the following: 177-202, 177-301, 180-402, 528-211, 528-314, 528-323, 552-201, 552-202, 552-209A, 552-210B. Attainment of the Honours degree requires a CGPA of at least 3.00.
HONOURS WITH ENVIRONMENTAL OPTION
[MARS Program Code 2-172206]
The Environmental Option of Honours in Chemistry consists of the requirements for Honours in Chemistry with replacement of 6 complementary credits of Chemistry at the 300 level or higher by seven specified courses: 183-203, 183-302, 182-451, 198-219 or equivalent, 180-307, 180-352, and one of the following: 180-511, 180-555, 180-577, 180-597. Attainment of the Honours degree requires a CGPA of at least 3.00.

HONOURS WITH MATERIALS OPTION
[MARS Program Code 2-172207]
Students with an interest in this option should consult their adviser. Attainment of the Honours degree requires a CGPA of at least 3.00.

MAJOR IN CHEMISTRY [MARS Program Code 1-172200]
The Major in Chemistry is the Core Curriculum, to which is added 6 complementary credits of Chemistry at the 300 level or higher. [Note: the Major program is the Honours program less the 6 credit Research Project and the 6 complementary credits at the 400 level or higher.] Attainment of the Major degree requires a CGPA of 2.00.

MAJOR WITH BIO-ORGANIC OPTION
[MARS Program Code 1-172205]
The Bio-organic Option of Major in Chemistry is the Honours program with Bio-Organic Option less the 6 credit Research Project and the 6 complementary credits at the 400 level or higher. Attainment of the Major degree requires a CGPA of 2.00.

MAJOR WITH ENVIRONMENTAL OPTION
[MARS Program Code 1-172206]
The Environmental Option of Major in Chemistry is the Honours program with Environmental Option less the 6 credit Research Project and the 6 complementary credits at the 400 level or higher. Attainment of the Major degree requires a CGPA of 2.00.

MAJOR WITH MATERIALS OPTION
[MARS Program Code 1-172207]
The Materials Option of Major in Chemistry is the Honours program with Materials Option less the 6 credit Research Project and the 6 complementary credits at the 400 level or higher. Attainment of the Major degree requires a CGPA of 2.00.

FACULTY PROGRAMS IN CHEMISTRY
Faculty programs in Chemistry are constructed from the U1 courses and the general courses of U2 and U3 intended for these students. Consult the Department of Chemistry Student Advisory Office for an adviser. A computer science course, either 302-494A,B,D or 302-495A,B,D.

FACULTY PROGRAM IN CHEMISTRY AND MATHEMATICS
(56 credits) [MARS Program Code 4-172900]

MINOR PROGRAM IN CHEMISTRY
[MARS Program Code 6-172200]
A Minor in Chemistry which comprises 18 credits of chemistry courses taken at McGill, including 180-203, 180-212, 180-222, 180-281 and 180-257. Substitutions for these by more advanced courses may be made at the discretion of the advisor.

MINOR IN CHEMICAL ENGINEERING
[MARS Program Code 6-163800]
A Chemical Engineering Minor will be of interest to Chemistry students who wish to study the problems of process engineering and its related subjects. A student completing this Minor will be able to make the important link between molecular sciences and industrial processing. This Minor will not provide Professional Engineering accreditation. The Minor requires 24 credits as follows: 7 credits in 302-200A and 302-204B; at least one of 302-220B or 302-314A; at least 13 credits from the following: 189-311, 302-230B, 302-315B, 302-351B, 302-370A, 302-380A, 302-438B, 302-392A and 393B, 302-452B, 302-471A, 302-472A, 302-481A, 302-487A, and either 302-494A,B,D or 302-495A,B,D.

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

- Denotes Limited Enrolment

180-110B GENERAL CHEMISTRY - BIOLOGICAL. (4) (3 lectures)
(Prerequisites/Corequisites: College level mathematics and physics or permission of instructor; 180-120 is not a prerequisite.) (Not open to students who have taken or are taking 180-111.) A study of the fundamental principles of atomic structure, valence theory and periodic table. 

TBA Laboratory: (2 1/2 hours.) Illustrative experiments. Lab section for students continuing from 180-120 will be the same. New students will be assigned lab sections in OM 1 on the first day of classes. 

NOTE: Each lab section is limited enrolment.

180-111B GENERAL CHEMISTRY – PHYSICAL & ENGINEERING. (4) (3 lectures) 
(Prerequisites/corequisites: College level mathematics and physics or permission of instructor: 180-121 is not a prerequisite.) (Not open to students who have taken or are taking 180-111.) A study of the fundamental principles of atomic structure, valence theory and periodic table. 

Professor Hogan Laboratory: (2 1/2 hours.) Illustrative experiments. Lab section for students continuing from 180-121 will be the same. New students will be assigned lab sections in OM 1 on the first day of classes. 

NOTE: Each lab section is limited enrolment.

180-112B GENERAL CHEMISTRY LABORATORY. (1) (2½ hours laboratory)
(Open only to entering students who have the lecture equivalent of 180-110B.) Illustrative experiments. Laboratory section of 180-110B. Lab section for students continuing from 180-120 will be the same. New students will be issued lab sections in OM 1 on the first day of classes. 

NOTE: Each lab section is limited enrolment.

TBA

180-113B GENERAL CHEMISTRY (PSE). (1) (2½ hours laboratory)
(Open only to entering students who have the lecture equivalent of 180-111B.) Illustrative experiments for physical sciences and engineering students (PSE). Lab section for students continuing from 180-121 will be the same. New students will be assigned lab sections in OM 1 on the first day of classes. 

NOTE: Each lab section is limited enrolment.
180-120A GENERAL CHEMISTRY – BIOLOGICAL. (4) (3 lectures) (Prerequisites/corequisites: College level mathematics and physics, or permission of instructor: 180-110 is not a prerequisite.) (Not open to students who have taken or are taking 180-121.) A study of the fundamental principles of physical chemistry. Laboratory: (2 1/2 hours). Illustrative experiments. NOTE: Each lab section is limited enrolment. Professor Sanctuary

180-121A GENERAL CHEMISTRY – PHYSICAL & ENGINEERING. (4) (3 lectures) (Prerequisites/corequisites: College level mathematics and physics, or permission of instructor: 180-111 is not a prerequisite.) (Not open to students who have taken or are taking 180-120.) A study of the fundamental principles of physical chemistry. Laboratory: (2 1/2 hours). Illustrative experiments. NOTE: Each lab section is limited enrolment. Professor Damha

180-122A GENERAL CHEMISTRY LABORATORY. (1) (2 1/2 hours laboratory) (Open only to entering students who have the lecture equivalent of 180-120A.) Illustrative experiments. Laboratory section of 180-120A.

180-123A GENERAL CHEMISTRY LABORATORY (PSE). (1) (2 1/2 hours laboratory) (Open only to entering students who have the lecture equivalent of 180-121A.) Illustrative experiments for physical sciences and engineering (PSE) students. Laboratory section of 180-121A.

180-150B THE WORLD OF CHEMISTRY: PART I. (3) (3 lectures) (No prerequisites) (Science students may take for credit only 2 of: 180-150, -160, -170. 180-150, -160 and -170 can be taken independently of each other.) A series of lectures on the historical, practical, and simple chemical aspects of: food, food additives; vitamins; minerals, diet and cancer; dieting; water. Professors Harpp, Fenster and Schwarcz

◆ 180-160B THE WORLD OF CHEMISTRY: PART II. (3) (3 lectures) (No prerequisites) (Science students may take for credit only 2 of: 180-150, -160, -170. 180-150, -160 and -170 can be taken independently of each other.)

◆ 180-170B THE WORLD OF CHEMISTRY: PART III. (3) (3 lectures) (No prerequisites) (Science students may take for credit only 2 of: 180-150, -160, -170. Cannot be taken if 180-150 was taken before 1993. 180-150, -160 and -170 can be taken independently of each other.)

180-199A WHY CHEMISTRY? (3) (2 lectures and 1 seminar) (FYS – for first year students only, maximum 25) A lecture/seminar course which is expected to deal with a) color, from gemstones to lasers; b) microscopes that see atoms – with demonstrations; c) the atmosphere: the greenhouse effect, and acid rain, and d) scientific ethics in research and publication. Professors Grosser, Hogan and Marchessault

180-201B MODERN INORGANIC CHEMISTRY. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. Not open to Honours or Majors in chemistry.) (Not open to students who have taken or plan to take 180-281.) Systematic survey of the chemistry of the main group elements and their compounds. Basic concepts of electronic structure, bonding and structure will be developed and applied to the understanding of common materials. Emphasis on elements such as oxygen, nitrogen, silicon and others in order to understand their role in our everyday lives. Professor Andrews

180-203A SURVEY OF PHYSICAL CHEMISTRY. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. Intended for students in biological science programs requiring only one course in physical chemistry.) (Not open to students who have taken or are taking 180-204 or 180-213.) A survey of the principles and methods of physical chemistry with emphasis on the use of biological examples. Topics will include thermodynamics, transport properties, kinetics, molecular structure and interactions, and spectroscopy. Professor Groesser

180-204A,B,L PHYSICAL CHEM./BIOL. SCI I. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent and one full course in calculus.) (Not open to students who have taken or are taking 180-203 or 180-213.) Similar to 180-213. Emphasis on the use of biological examples to illustrate the principles of physical chemistry. The relevance of physical chemistry to biology is stressed. Professors Galley (A) and Sanctuary (B)

180-212A,B,C ORGANIC CHEMISTRY I. (4) (3 lectures and Laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 or 122 or equivalent courses.) A survey of reactions of aliphatic and aromatic compounds including modern concepts of bonding, mechanisms, conformational analysis, and stereochemistry. NOTE: Each lab section is limited enrolment. Professors Harpp and Sleiman (A) and Gleason (B) and Mr. Daoust

180-213B PHYSICAL CHEMISTRY I. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent; Mathematics 189-139 and 141 or equivalent.) (Not open to students who have taken or are taking 180-203 or 180-204.) Gas laws, kinetic theory. First law of thermodynamics, enthalpy, thermochemistry, bond energies. Second law of thermodynamics; the entropy and the free energy functions. Chemical and thermodynamic equilibrium states. Phase rule. Colligative properties of ideal solutions. Topics may include: chemical kinetics, electrochemistry and others. Professor Ronis

180-214B PHYSICAL CHEM./BIOL. SCI. II. (3) (3 lectures) (Prerequisites: 180-213 or 180-204.) Emphasis is placed on the use of biological examples to illustrate the principles of physical chemistry. The relevance of physical chemistry to biology is stressed. Professor Gilson

180-217A,B GENERAL ANALYTICAL CHEM. LAB. I. (1) (3 hours) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent.) Laboratory portion of an individualized program in analytical chemistry. Professor Purdy

#180-219A INTRODUCTION TO ATMOSPHERIC CHEMISTRY. (3) (3 hours lecture) (Prerequisite: CEGEP DEC in Science or permission of instructor.) (Not open to students who have taken 195-219, 180-419, or 195-419.) (Offered in even years. Students should register in 195-219 in odd 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. (Awaiting University Approval) Professor Ariya

180-222A,B,T ORGANIC CHEMISTRY II. (4) (3 lectures and laboratory) (Prerequisite: 180-212.) Modern spectroscopic techniques for structure determination. The chemistry of alkyll halides, alcohols, ethers, carbonyl compounds and amines with special attention to mechanistic aspects. Special topics. NOTE: Each lab section is limited enrolment. Professors Chin (A) and Farrell (B) and Mr. Daoust

180-224A,B,C ORGANIC CHEMISTRY LABORATORY I. (1) (4 hours laboratory) (Open only to students who have the lecture equivalent of 180-212A,B,) Illustrative experiments in organic chemistry. Laboratory section of 180-212A,B.

180-237B GENERAL ANALYTICAL CHEM. LAB. II. (1) (3 hours) (Prerequisites: 180-217) Laboratory portion of an individualized program in analytical chemistry. Professor Purdy

180-244A,B,T ORGANIC CHEMISTRY LABORATORY II. (1) (4 hours laboratory) (Prerequisite: 180-234A,B or equivalent) Laboratory portion of Organic Chemistry II.

180-257D ANALYTICAL CHEMISTRY. (4) (1 lecture, 1 homework tutorial and 4 hours laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent.) (Not open to students who have taken or are taking 180-277.) A survey of analytical chemistry including the theory and practice of representative gravimetric, volumetric and instrumental methods. NOTE: Each lab section is limited enrolment. Professor Purdy
180-275B CHEMICAL KINETICS. (1) (1 lecture) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. For Honours and Major Chemistry students. Other students with permission of the lecturer.) Order, molecularity, reaction mechanisms and rate constants. Determination of order, effect of temperature on rate, activated state theory. Collision theory. Reactions in solution, homogenous catalysis, upper atmosphere kinetics, drug kinetics.

Professor Grosser

180-277D CLASSICAL METHODS OF ANALYSIS. (4) (2 lectures and 4 hours laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. For Chemistry Honours and Majors students only.) (Not open to students who have taken or plan to take 180-257D.) Qualitative and quantitative analysis. A survey of methods of analysis including theory and practice of semimicro qualitative analysis and representative gravimetric, volumetric and instrumental methods.

NOTE: Each lab section is limited enrolment. Professor Purdy

180-381A INORGANIC CHEMISTRY I. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent.) Basic concepts of electronic structure and molecular bonding will be developed and applied to the understanding of common materials. Acid-base chemistry. Survey of the chemistry of the main group elements. Introduction to coordination and organometallic chemistry.

Professor Andrews

180-301B MODERN INORGANIC CHEMISTRY II. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent.) (Not open to students who have taken or plan to take 180-381.)

180-302A,B ORGANIC CHEMISTRY III. (3) (3 lectures) (Prerequisites: 180-212 and 222.) Topics covered may include the following: aromatics and heterocyclics, carbamions, rearrangements, molecular orbital considerations, polymers and biomolecules.

Professors Lennox (A) and Farrell and Just (B)

180-307A ENVIRONMENTAL ANALYSIS. (3) (2 lectures and laboratory with field trips) (Prerequisites: One course in analytical chemistry.) Description of current analytical practices in air and water pollution; critical evaluation of the reliability of the methods, with particular emphasis on interfering substances; rudiments of automated instrumentation; toxicological analysis as it relates to pollution.

Professors Salin and Farant

180-313A INTERMEDIATE PHYSICAL CHEMISTRY I. (3) (3 lectures) (Prerequisite: 180-213 or 204)

180-345A MOLECULAR PROPERTIES & STRUCTURE I. (3) (3 lectures) (Prerequisites: 180-213, 189-315. For Chemistry Honours and Majors only.) An introduction to quantum chemistry covering the historical development, wave theory, methods of quantum mechanics, and applications of quantum chemistry.

Professor Whitehead

180-350A EARTH, AIR, FIRE, WATER. (3) (3 lectures) (Prerequisites: 180-212 or equivalent and 180-204 or equivalent.) The elements of chemistry are found in a wide range of modern technological advances and environmental concerns. The course will deal with topics ranging from atmospheric chemistry, to receptor chemistry, to atomic microscopy, to ceramic materials.

Professors Hogan and Lennox

180-352B STRUCTURAL ORGANIC CHEMISTRY. (3) (3 lectures) (Prerequisite: 180-302.) Modern methods of structure determination, employing spectroscopic techniques; stereochemistry.

Professor Kazlauskas

180-355B MOLECULAR PROPERTIES & STRUCTURE II. Spectroscopy and Statistical Mechanics (3) (3 lectures) (Prerequisite: 180-345.) A survey of the principles of electronic, vibrational and rotational spectroscopy. Magnetic resonance methods. The application of statistical mechanical methods to chemistry.

Professor Reven

180-362A,B ADVANCED ORGANIC CHEMISTRY LAB. (2) (4 hours) (Prerequisite or corequisite: 180-302) (Not open to Honours or Majors in Chemistry.) An advanced laboratory with experiments relat-ed to the theoretical principles and synthetic methods of modern organic chemistry.

Professor Farrell and Mr. Daoust

180-363A,B PHYSICAL CHEMISTRY LAB. (2) (3 hours) (Prerequisite: 180-213. Corequisite: 180-273.) Selected experiments to illustrate physico-chemical principles.

NOTE: Each lab section is limited enrolment. Professors Galley and Marchessault and Dr. Wilczek

180-365B STATISTICAL MECHANICS. (2) (2 lectures) (Prerequisite: 180-345.) Molecular basis of thermodynamics with applications to ideal gases and simple solids. Topics to be covered will include: calculation of thermodynamic functions, chemical equilibrium constants, Einstein and Debye models of solids, absolute reaction rate theory, Debye-Hückel theory of strong electrolytes.

Professor Ronis

180-367A INSTRUMENTAL ANALYSIS I. (3) (2 lectures and 4 hours of laboratory) (Prerequisite: 180-257 or 180-277.) An introduction to modern methods of instrumental analysis emphasizing chromatography and electrochemical methods. Analytical methods to be examined in detail include gas liquid chromatography, high performance liquid chromatography, flow injection analysis, and electrochemical methods. Laboratory exercises give the student practical exposure to these techniques.

NOTE: Each lab section is limited enrolment.

Lectures: Professor Power Laboratory: Dr. Wilczek

180-371A,B,D INORGANIC CHEM. LAB. (2) (4 hours) (Prerequisite: 180-362; prerequisite/corequisite: 180-381) (Not open to students who have taken 180-392.) Modular format incorporating self-paced and self-guided instructions. In consultation with the instructors, a program of experimental modules is chosen covering projects related to theoretical principles, synthetic techniques and those instrumental methods used in modern inorganic and organometallic chemistry.

Professor Arndtsen and Dr. Finkenbine

180-377B INSTRUMENTAL ANALYSIS II. (3) (2 lectures and 4 hours of laboratory) (Prerequisite: 180-257 or 180-277.) Spectroscopic methods of analysis will be studied with respect to fundamentals, operational aspects and instrument design. Topics will range from UV-visible to X-ray spectrometry. Methodologies will be evaluated with respect to their application in spectrometric systems. Laboratory automation will be studied and applied in the laboratory.

NOTE: Each lab section is limited enrolment.

Professor Salin and Dr. Wilczek

180-381A CHEMISTRY OF TRANSITION ELEMENTS. (3) (3 lectures) (Prerequisite: 180-281. For Honours and Major Chemistry students.) (Not open to students who have taken or plan to take 180-301.) The history of transition chemistry, coordination numbers and geometry, nomenclature and symmetry. Crystal field theory will be described and applied to problems in spectroscopy, magnetoochemistry, thermodynamics and kinetics. Several aspects of organometallic and bioinorganic chemistry are also discussed.

Professor Arndtsen

180-382B ORGANIC CHEMISTRY OF NATURAL PRODUCTS. (3) (3 lectures) (Prerequisite/corequisite: 180-302.) Structure, synthesis, stereochemistry and biosynthesis.

Professor Just

180-392A,B OR D INTEGRATED INORGANIC/ORGANIC LAB. (3) (4 hours) (Prerequisite: 180-302. Corequisites: 180-381 and 180-302, if not previously taken. Advanced laboratory for Chemistry Honours and Major students. Students enrolled in 180-392 are strongly advised to choose the D option.) (Not open to students presently or previously enrolled in 180-382.) Modular format of self-paced and self-guided instruction. A program of modules is selected in consultation with the laboratory staff. The experimental modules consist of projects related to the theoretical principles, synthetic techniques and instrumental methods used in modern organic, inorganic and organometallic chemistry.

Professors Arndtsen, Farrell and Dr. Finkenbine

180-393A,B PHYSICAL CHEMISTRY LAB II. (2) (3 hours) (Prerequisites: 180-273, 180-363.) Selected experiments to illustrate phys-
180-402B ADVANCED BIO-ORGANIC CHEMISTRY. (3) (2 hours lectures, 1 hour seminar per week) (Prerequisite: 180-302) The application of advanced concepts of organic and physical chemistry to biological systems. The properties of amino acids, peptides, proteins, enzymes, nucleosides, etc., will be discussed and their relationship to biochemical reactions, the origins of life, coenzymes, template syntheses, neurochemistry, etc. Professor Galley and Dr. Wilczek

180-404B BIOPHYSICAL CHEMISTRY. (3) (3 lectures) (Prerequisites: 180-204 and 214 or 213 and 355.) (Not open to students who are taking or have taken Biochemistry 507-404 or 507-451) Molecular weight determination, hydrodynamic and spectroscopic properties of biopolymers. The structure and dynamics of biopolymers and biological systems. Professors Galley and Silvius (Biochemistry)

180-419B ADVANCES IN CHEMISTRY OF THE ATMOSPHERE. (3) (3 hours lecture) (Prerequisite: 180-213, 180-273, 189-222 and 189-315 (or equivalents), or permission of instructor.) (Not open to students who have taken 195-419, 180-619, or 195-619.) (Offered in even years. Students should register in 195-419 in odd 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. (Awaiting University Approval) Professor Ariya

180-455A POLYMER CHEMISTRY. (3) (Prerequisite: 180-213. Corequisite 180-273.) A survey course on the structure of polymers, kinetics and mechanisms of polymer and copolymer synthesis; characterization and molecular weight distributions; polymer microstructure, the thermodynamics of polymer solutions; the crystalline and amorphous states, rubber elasticity and structure property relationships. Professors Marchessault and Eisenberg

180-480D, N RESEARCH PROJECT. (3) (Prerequisite or Corequisite: 180-480. Registration by departmental permission only.) (Please see regulations concerning Project Courses, section 2.6.2 on page 339 in the Faculty Degree Requirements section.) A course designed to give Honours students research experience. The student will be assigned a project supervisor and a research project at the beginning of the session. The project will consist of a literature survey, experimental or theoretical work, a written research report and an oral examination. Professor Whitehead (Coordinator) and Staff

180-490D, N RESEARCH PROJECT. (3) (9 hours laboratory) (Prerequisite or Corequisite: 180-480. Registration by departmental permission only.) (Please see regulations concerning Project Courses, section 2.6.2 on page 339 in the Faculty Degree Requirements section.) For description, see 180-480. Professor Whitehead (Coordinator) and Staff

180-511A RADIOCHEMISTRY. (3) (3 lectures) (Prerequisites: 180-204 and 214 or equivalents.) The basic concepts of nuclear chemistry described in a qualitative way. Topics include: forces within nuclei, theories of nuclear structure, radioactive decay, nuclear reactions and fission, particle accelerators and reactors, radiocarbon dating, and tracer technique. Professor Hogan

180-531B CHEMISTRY OF INORGANIC MATERIALS.. (3) (3 lectures) (Prerequisites: 180-201 or -281. Co-requisite: 180-381.) Structure, bonding, synthesis, properties and applications of covalent, ionic, metallic crystals, and amorphous solids. Defect structures and their use in synthesis of specialty materials such as electronic conductors, semiconductors, and superconductors, and solid electrolytes. Basic principles of composite materials and applications of chemistry to materials processing. Professor Andrews

180-543C CHEMISTRY OF PULP & PAPER. (2) (2 lectures) (Prerequisites: 180-302 or permission of instructor.) The processes for converting wood to paper are described with emphasis on the relevant organic, physical and surface chemistry. Professor Gray

180-547B LABORATORY AUTOMATION. (5) (Two 1.5 hour lectures, laboratory) (Prerequisite: 180-377B, equivalent or permission of instructor.) Automation and data handling with respect to modern chemical laboratory instrumentation. Basic electronics, data acquisition, evaluation of laboratory needs, data processing methodologies. Professor Salin

180-552B PHYSICAL ORGANIC CHEMISTRY. (3) (Prerequisite: 180-302.) The correlation of theory with physical measurements or organic systems; an introduction to photochemistry; solvent and substitution effects on organic reaction rates, etc.; reaction mechanisms. Professors Chin and Sleiman

180-555A NMR SPECTROSCOPY. (3) (3 lectures) (Prerequisite: 180-355 or equivalent.) Interpretation of proton and carbon-13 nuclear magnetic resonance spectroscopy in one dimension for structural identification. Professor Gilson

180-556A ADVANCED QUANTUM MECHANICS. (3) (3 lectures) (Prerequisites: 180-345, 198-242.)

180-557A INSTRUMENTAL METHODS OF ANALYSIS. (3) (2 lectures and 3 hours laboratory) (Prerequisites: linear algebra and experience in some computer programming language.) The course is designed to provide a background in mathematical methods for chemical experimental design, system optimization, and sensor calibration. Topics covered include: factorial analysis of chemical spectra, pattern recognition from multisensor data, linear and nonlinear optimization for the determination of optimal reaction conditions, molecular modelling, multisensor calibration, etc.

180-572B SYNTHETIC ORGANIC CHEMISTRY. (3) (3 lectures) (Prerequisite: 180-382.) Synthetic methods in organic chemistry and their application to the synthesis of complex molecules. Professor Just

180-575B CHEMICAL KINETICS. (3) (3 lectures) (Prerequisite: 180-273 and -213.)

180-576B QUANTUM CHEMISTRY. (3) (Lecture and/or reading course) (Prerequisite: 180-345) A survey of current theoretical approaches to relativistic quantum chemistry, molecular structure, spectroscopy and one electron properties. Professor Whitehead

180-577B ELECTROANALYTICAL CHEMISTRY. (3) (Prerequisite: 180-367 and 180-377.) The application of electroanalytical techniques including polarography, coulometry and chronopotentiometry, to inorganic, organic and biochemical analysis. Professor Purdy

180-581B INORGANIC TOPICS I. (3) (Prerequisite: 180-381. Not open to students who have taken 180-481.)

180-585C COLLOID CHEMISTRY. (3) (Prerequisites: 180-273 and -345, 189-223 and -315, 198-241 and -242.) Principles of the Physical Chemistry of phase boundaries. Electrical double layer theory; van der Waals forces; Brownian motion; kinetics of coagulation; electrokinetics; light scattering; solid/liquid interactions; adsorptions; surfactants; hydrodynamic interactions; rheology of dispersions. Professor van de Ven

180-587A SELECTED TOPICS IN MODERN ANALYTICAL CHEM. (3) (Prerequisite: 180-367 and 180-377) Current theories of aqueous and nonaqueous solutions, with application to analytical chemistry; recent advances in analytical techniques. Topics may include: chromatography; applications of kinetics, solvent extraction and thermal analysis with emphasis on their theoretical basis. Professor Purdy

180-591B ADVANCED COORDINATION CHEM. (3) (3 hours) (Prerequisite: 180-381.) (For Honours and Major Chemistry students or with permission.) In-depth treatment of advanced coordination chemistry, including bio-inorganic chemistry and transition metal catalysis and solid state inorganic chemistry. Professors Shaver and Butler

180-593B STATISTICAL THERMODYNAMICS. (3) (3 lectures; research project) (Prerequisite: 180-345. Recommended: 180-355.) Basic hypotheses of statistical thermodynamics; ideal monatomic,
diatomic and polyatomic gases; Einstein and Debye models of solids; statistical theory of black-body radiation; Debye-Huckel theory of electrolyte solutions; absolute reaction rate theory of rate processes; theories of solutions.

180-597A ANALYTICAL SPECTROSCOPY, (3) (2 lectures; 3 hours laboratory) (Prerequisite 180-367 and 180-377) The design and analytical use of spectroscopic instrumentation will be examined with respect to fundamental and practical limitations. Classical emission, fluorescence, absorption and chemical luminescence will be discussed. Contemporary topics may include photo-acoustic spectroscopy, multielement analysis, X-ray fluorescence and modern multichannel detector systems.

**Profs. Power and Salin**

### 11.7 Cognitive Science

Dr. Tom Shultz, Department of Psychology, Program Director

Cognitive Science is the multi-disciplinary study of cognition in humans and machines. The goal is to understand the principles of intelligence with the hope that this will lead to better understanding of the mind and of learning, and to the development of intelligent devices that constructively extend human abilities.

The Minor in Cognitive Science is intended to supplement and support Major or Honours programs in Computer Science, Linguistics, Philosophy, or Psychology. Students wishing to enrol in this Minor must register with the Program Director.

**MINOR PROGRAM IN COGNITIVE SCIENCE** (27 credits)

[MARS Program Code 6-265600]

**Required Course** (3 credits)

204-532 (3) Cognitive Science

**Complementary Courses** (24 credits) from outside of the student's home department, selected from the courses listed below.

#### Computer Science

308-424 (3) Topics in Artificial Intelligence I
308-426 (3) Automated reasoning

#### Educational Psychology

416-555 (3) Applied Cognitive Science

#### Linguistics

104-321 (3) Linguistics Applied to Language Learning
104-351 (3) Phonology I
104-360 (3) Syntax I
104-370 (3) Semantics I
104-440 (3) Morphology
104-491 (3) Linguistic Theory I
104-530 (3) Phonology II
104-555 (3) Linguistic Theory & Language Acquisition
104-571 (3) Syntax II
104-690 (3) Introduction to Neurolinguistics

#### Mathematics

189-318 (3) Mathematical Logic
189-328 (3) Computability and Mathematical Linguistics

#### Philosophy

107-210 (3) Introduction to Deductive Logic
107-306 (3) Philosophy of Mind
107-310 (3) Intermediate Logic
107-410 (3) Topics in Advanced Logic I
107-415 (3) Philosophy of Language
107-419 (3) Epistemology
107-506 (3) Seminar: Philosophy of Mind
107-507 (3) Seminar: Cognitive Science

#### Psychology

204-311 (3) Human Behaviour and the Brain
204-314 (3) Thinking and Concepts
204-335 (3) Formal Models of Psych. Processes
204-340 (3) The Psychology of Language

204-343 (3) Language Acquisition in Children
204-352 (3) Laboratory in Cognitive Psychology
204-353 (3) Laboratory in Human Perception
204-401 (3) Theories of Cognition
204-413 (3) Cognitive Development
204-470 (3) Memory and Brain
204-472 (3) Scientific Thinking and Reasoning
204-501 (3) Auditory Perception
204-540 (3) Computational Modelling of Reasoning

### 11.8 Computer Science (308)

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**Director** — Denis Thérien

**Emeritus Professor**

Christopher Paige

**Professors**

David M. Avis; B.Sc.(Wat.), Ph.D.(Stan.) (on leave Winter 2000)
Luc P. Devroey; M.S.(Louvain), Ph.D.(Texas)
Tim H. Merrett; B.Sc.(Queen's), D.Phil.(Oxon.)
Monroe M. Newborn; B.E.E.(R.P.I.), Ph.D.(Ohio St.), F.A.C.M.
Prakash Panangaden; M.Sc.(I.I.T Kanpur), Ph.D.(Wis.)
Gerald F.G. Ratzer; B.Sc.(Glasc.), M.Sc.(McG.)
Denis Thérien; B.Sc.(Montr.), M.Sc., Ph.D.(Wat.)
Godfried T. Toussaint; B.Sc.(Tulsa), Ph.D.(Br.Col.)

**Associate Professors**

Claude Crepeau; B.Sc., M.Sc.(Montr.) Ph.D.(M.I.T.)
Nathan Friedman; B.A.(W.Ont.), Ph.D.(Tor.)
Laurie Hendren; B.Sc., M.Sc.(Q.), Ph.D.(Chell)
Niazim Madhavji; B.Sc.(Essex), Ph.D.(Man.)
Carl Tropper; B.Sc.(McG.), Ph.D.(Polyonk)
Sue Whitesides; M.S.E.E.(Stan.), Ph.D.(Wis.)

**Assistant Professors**

Xiao-Wen Chang; B.Sc., M.Sc.(Nanjing), Ph.D.(McG.)
Gregory Dudek; B.Sc.(Queen's), M.Sc., Ph.D.(Tor.)
Kaleem Siddiqi; B.Sc.(Lafayette), M.Sc., Ph.D.(Brown)

**Lecturer**

Alan Greenberg; M.Sc.(McG.)

**Adjunct Professors**

Renato De Mori, Petre Dini, Guang R.Gao, Syed Hyder, Vincent Van Dongen

The study of computer science encompasses everything from pure theory to hands-on applications including the analysis of algorithms, the study of computer architectures, compilers, databases, operating systems, networks and the study of software engineering.

The School currently operates a general purpose computing facility to support teaching, a large undergraduate workstation laboratory and seven dedicated laboratories for research in computational geometry and robotics, parallel processing, compilers, concurrent programming, software engineering, database systems, mobile robotics, and cellular automata.

The teaching facility consists of a network of over 50 Pentium workstations running the Linux operating system, 25 Pentium workstations running Windows NT, 4 SGI graphics workstations and 3 Power PC Macs. The facility also includes several compute engines including 3 SUN sparc20 servers. Dialup access is provided through the Computing Centre along with PPP network connections. For introductory courses most work is completed using the NT workstations and compute engines. All other courses use UNIX as a development environment.