1. The Faculty

1.1 Location
Dawson Hall
853 Sherbrooke Street West
Montreal, QC H3A 2T6
Canada
Telephone: (514) 398-4210
Web: http://www.mcgill.ca/science

The Student Affairs Office and the Office of the Associate Dean of the Faculty of Science are located in Dawson Hall, Room 115.

The Student Affairs Office serves students in both the Faculty of Science and the Faculty of Arts.

1.2 Faculty Administrative Officers
ALAN G. SHAVER, B.Sc.(Car.), Ph.D.(M.I.T.)
Dean
T.B.A.
Associate Dean
JOSIE D'AMICO
Assistant to the Dean
SHARON BEZEAU, B.A.(Tor.), M.A.(C'dia)
Recorder
DONALD SEDGWICK, B.Sc., M.Sc.(McG.)
Senior Adviser

1.3 Programs and Teaching in Science

The Faculty of Science is committed to providing outstanding teaching and research facilities. The Faculty draws on its involvement in cutting-edge research to ensure teaching excellence at the undergraduate level. Professors who are spearheading projects that are changing people’s understanding of the world teach regularly at the undergraduate level. Also, research-based independent studies courses offer students the opportunity to contribute to their professors’ work, rather than just learn about it.

In an effort to supplement classroom learning with real life experience, the Faculty of Science has increased opportunities for undergraduate students to participate in fieldwork. This is on top of the many undergraduate students the Faculty hires for Work-Study projects and other research programs. McGill Science students have an opportunity to get involved in the structuring of their own education. A recent Science Undergraduate Society initiative launched Operation Open Access, a project that gives Science students universal access to email, the internet, and the latest in science software through computer ‘infopoints’ located in areas of the campus frequented by Science students.

The Faculty of Science offers programs leading to the degree of Bachelor of Science (B.Sc.). Admission is selective; fulfillment of the minimum requirements does not guarantee acceptance. Admission criteria are described in the General University Information section.

Admission to the Faculty of Science requires entrance to the University of Montreal, the Faculty of Arts, or the Faculty of Medicine prior to enrolment in Science. Additional Admission Requirements are as follows:

1.1 Programs and Courses

The Faculty of Science offers programs leading to the degree of Bachelor of Science (B.Sc.). Admission is selective; fulfillment of the minimum requirements does not guarantee acceptance. Admission criteria are described in the General University Information section.

There are also two Diploma programs offered in Science. The Diploma in Meteorology is a one-year program available to holders of a degree in Mathematics, Engineering, Physics and other appropriate disciplines who wish to qualify for a professional career in Meteorology, see Atmospheric and Oceanic Sciences.
2. Faculty Degree Requirements

Each student in the Faculty of Science must be aware of the Faculty Regulations as stated in this Calendar. While departmental and faculty advisers and staff are always available to give advice and guidance, the ultimate responsibility for completeness and correctness of course selection and registration, for compliance with and completion of program and degree requirements, and for the observance of regulations and deadlines rests with the student. It is the student’s responsibility to seek guidance if in any doubt; misunderstanding or misapprehension will not be accepted as cause for dispensation from any regulation, deadline, program or degree requirement.

To be eligible for a B.Sc. degree, students must fulfill all faculty and program requirements as indicated below:

- Minimum Credit Requirement (section 2.1)
- Residency (section 2.2)
- CGPA (section 2.3)
- Time Limit for the Completion of the Degree (section 2.4)
- Program Requirements (section 2.5)
- Course Requirements (section 2.6)

2.1 Minimum Credit Requirement

Each student’s minimum credit requirement for the degree is determined at the time of acceptance and is specified in the letter of admission. Normally, Quebec students who have completed the Diplôme d’études collégiales (DEC) or equivalent diploma are admitted to a three-year program requiring the completion of 90 credits. Students from outside Quebec are normally admitted to a four-year program requiring the completion of 120 credits, but advanced standing of up to 30 credits may be granted to students who obtain satisfactory results in International Baccalaureate, French Baccalaureate, and Advanced Placement tests.

Students who are readmitted after interrupting their studies for a period of five consecutive years or more may be required to complete a minimum of 60 credits and satisfy the requirements of a program. In this case, a new CGPA will be calculated. The Associate Dean in consultation with the appropriate department may approve a lower minimum for students who had completed 60 credits or more before interrupting their studies.

Students who are readmitted after a period of absence are subject to the program and degree requirements in effect at the time of readmission. The Associate Dean in consultation with the department may approve exemption from any new requirements.

2.2 Residency

To obtain a B.Sc. degree, students must satisfy the following residency requirement. A minimum of 60 credits of courses must be taken and passed at McGill, exclusive of any courses completed as part of the basic science requirements defined below. At least two-thirds of all departmental program requirements (Honours, Major, Faculty Program, Minor) must be completed at McGill. In addition, some departments may require that their students complete specific components of their program at McGill.

The residency requirement for Diplomas is specified in the relevant departmental sections of the Calendar.

2.3 Cumulative Grade Point Average (CGPA)

Each candidate for the degree must achieve a minimum cumulative grade point average (CGPA) of 2.0.

2.4 Time Limit for the Completion of the Degree

Students registered in 90-credit programs are expected to complete their program in no more than eight terms after their initial registration for the degree. Students who exceed these limits must receive permission from the Faculty to continue their studies. Permission for exceeding the time limits will normally be granted only for valid academic reasons, such as a change of program (approval of the department is required) and part-time status.

Students in the Freshman Program become subject to these regulations one year after their initial registration.

2.5 Program Requirements

2.5.1 Freshman Program and Basic Science Requirements

Students who need 97-120 credits (four years) to complete their degree requirements must register in the Science Freshman Program, which is designed to provide the basic science foundation for a student’s subsequent three-year Faculty, Major, or Honours program. The basic science requirements are as follows: two semesters of calculus, general chemistry and general physics, and one semester of biology.

Students who have completed Advanced Placement exams, Advanced Levels, the International Baccalaureate, the French Baccalaureate, or McGill placement examinations may receive exemption and/or credit for all or part of the basic science requirements. Similarly students who have completed courses at other universities or colleges may receive exemptions and/or credits.

For a more detailed description of the Science Freshman Program, students should consult the Arts and Science Freshman Student Handbook available from the Student Affairs Office, Dawson Hall, Room 110.

2.5.2 Faculty, Major, and Honours Programs

Science students who need 96 or fewer credits to complete their degree requirements (other than those registered in the Freshman Program) are required to have an approved degree program, and to select their courses in each term with a view to timely completion of their degree and program requirements. Students must register in one of the following departmental programs leading to the degree of Bachelor of Science:

A Faculty program is an approved coherent selection of courses giving students a useful concentration in a recognised area. Students in a Faculty program may choose a pattern of study, which can range from one yielding a broad education to one specialising in particular areas.

Major programs are more specialised than Faculty programs and are usually centred on a specific discipline or department. For prospective teachers, the Faculty also offers Major programs in two subjects that can constitute the Science component of the Concurrent B.Sc./B.Ed. Program. For more information about this program, please consult the Science for Teachers section.

Honours programs require students to maintain academic performance at a high standard in addition to involving a very high degree of specialisation. Although the Honours programs are specially designed to prepare students for graduate study, the graduates of the other degree programs are also normally admissible to most graduate schools.

2.5.3 Minor Programs

In addition to the above degree programs, students in the Faculty of Science may select a Minor program. These are coherent sequences of courses in a given discipline or interdisciplinary area which may be taken in addition to the courses required for the degree program.

Science Minors normally consist of 24 credits. No more than 6 credits of overlap with the degree program are normally allowed, and in some cases no overlap is permitted.

Arts Minors consist of 18 credits, with no overlap permitted.

2.5.4 Other Second Programs

In addition to a Faculty, Major or Honours program, students may pursue a second Faculty, Major or Honours program with the approval of the Associate Dean. A minimum CGPA of 2.7 is required for admission to a second program. A minimum of 36 new credits must be completed in the second program. Students who wish to...
apply can obtain the appropriate approval form from the Student Affairs Office.

2.5.5 Concurrent B.Sc./B.Ed. program

This program has been designed to provide students with the opportunity to attain a Bachelor of Science degree and a Bachelor of Education degree after 135 credits of study. In the B. Sc. component, students must major in one of the following subject combinations: Mathematics and Physics, Mathematics and Chemistry, Chemistry and Physics, Biology and Physics, Biology and Geography. For more information about this program, students should refer to the Faculty of Education section 6.1.4 and to the relevant departmental sections in the Faculty of Science section.

2.5.6 Internship Program for Engineering and Science (IYES)

Certain B.Sc. programs offered by the Department of Mathematics and Statistics, the Department of Physics, and the School of Computer Science can include an internship component. Students from other departments are also eligible to apply for an internship year, but this will not be part of their degree designation. For program details, students should refer to the IYES entry (Section 2.8) in the Faculty of Engineering section and to the relevant departmental sections in the Faculty of Science section.

2.5.7 McGill School of Environment

The Faculty of Science is one of the three faculties in partnership with the McGill School of Environment. Please see the School section on page 453 of this Calendar.

2.6 Course Requirements

All required and complementary courses used to fulfill program requirements, including the basic science requirements, must be completed with a grade of C or better. Students who fail to obtain a satisfactory grade in a required course must either pass the supplemental examination in the course or do additional work for a supplemental grade if these options are available, or repeat the course. Course substitution will be allowed only in special cases; students should consult their academic adviser.

Normally, students are permitted to repeat a failed course only once. If a required course is failed a second time, a student may appeal to the Associate Dean for permission to take the course a third time. If permission is denied by the Associate Dean and/or by the Committee on Student Standing, on appeal, the student must withdraw from the program. (Failure is considered to be a grade of less than C or the administrative failures of J and KF.) If the failed course is a complementary course required by the program, a student may choose to replace it with another appropriate complementary course. If a student chooses to substitute another complementary course for a complementary course in which a D was received, credit for the first course will still be given but as an elective.

Full details of the course requirements for all programs offered are given in each unit section together with the locations of departmental advisory offices, program directors, and telephone numbers should further information be desired.

2.6.1 Course Overlap

Students will not receive credit towards their degree for any course where the content overlaps substantially with any other course for which the student receives credit or which the student has already passed at CEGEP or another university or elsewhere. It is the student’s responsibility to consult the Office of the Associate Dean as to whether or not credit can be obtained.

Credit for statistics courses will be given with the following stipulations:

1) Credit will be given for only one of the following introductory statistics courses: 154-227D, 154-257D, 166-461, 183-351B, 189-204B, 204-435B, 280-272B.

2) Credit will be given for only one of the following intermediate statistics courses: 154-227D, 154-257D, 166-461, 183-351B, 189-204B, 204-435B, 280-272B.

3) Students who have already received credit for one of the courses listed in (2) above may not subsequently receive credit for 177-373A.

4) Credit will be given for only one of the following: 154-227D, 154-257D, 189-204B, 204-305A/B, 280-272B.

5) Students in mathematics or computer science programs or students who have already received credit for 189-324B may not subsequently receive credit for any of the following: 154-227D, 154-257D, 166-350A, 177-373A, 186-215B, 189-203A, 189-204B, 198-219A, 204-204A/B, 204-305A/B, 280-271A/B, 280-272B.

6) Credit for statistics courses offered by faculties other than Arts and Science requires the permission of the Associate Dean.

Credit for computer courses will be given with the following stipulations:

- Credit for courses offered by the School of Computer Science is governed by rules specified as "Notes" in the School’s section.
- Credit for computer courses offered by faculties other than Science requires the permission of the Associate Dean of Science.

2.6.2 Project Courses

No more than 9 credits of individual project or independent study courses may normally be credited toward the requirement for the B.Sc. degree. The exceptions are for students in Biology who register for 177-480D and for students in Microbiology and Immunology who register for 528-502D. These students will be allowed 12 credits.

2.6.3 Courses Outside the Faculties of Arts and Science

Students in the Faculty of Science should consult the statement of regulations and the list of approved elective courses outside the Faculties of Arts and of Science, which is posted in the Student Affairs Office, Dawson Hall. The regulations are as follows:

- students are allowed a maximum of 18 credits of approved courses in faculties outside the Faculties of Arts and of Science;
- students may take a maximum of 6 credits of elective courses per year from faculties other than Arts and Science;
- students must have the necessary prerequisites and permission of the instructor for such courses;
- for courses in Education and Continuing Education, students also require the permission of the Associate Dean of Science;
- credit for computer and statistics courses offered by faculties other than Arts and Science requires the permission of the Associate Dean;
- students who use MARS to register for a course which exceeds the specified limitations or which is not approved will have the course flagged for no credit; the grade may be computed into their grade point averages (GPA and CGPA); (for more information, see section 4.2)
- courses taught in other faculties and specifically listed in the Arts or Science section are considered as courses taught in Arts or Science;
- credit will not be given for any "how to" courses offered by other faculties, which are intended to provide students with only practical or professional training in specific applied areas. Examples include courses that teach the use of certain computer packages (databases, spreadsheets, etc.) or computer languages (SQL, COBOL, FORTRAN, etc.), machine shop or electronic shop courses, technical drawing courses, and professional practice courses. Further informa-
tion, clarification and a list of "how to" courses which are specifically allowed to Science students, is available from the Student Affairs Office.

2.6.4 Courses Taken Under the Satisfactory/Unsatisfactory Option

Students may take one elective course per term to be graded under the Satisfactory/Unsatisfactory Option, to a maximum of 10% of the students' credits taken at McGill to fulfill the degree requirements. The decision to have an elective course graded as Satisfactory/Unsatisfactory must be made by students before the end of the Drop/Add period. For more information, students should consult the General University Information section.

2.6.5 Courses in English as a Second Language (ESL)

ESL courses are open to students whose primary language is not English and whose secondary education has been in institutions in which the primary language of instruction was not English, or students whose instruction in English language secondary institutions has not exceeded four years. Students in the Faculty of Science may take a maximum of 6 credits, including academic writing courses for non-anglophones. Students who feel they need to take more than 6 credits of ESL courses must appeal to the Associate Dean of Science.

3. Advising

Fall-term advising for newly admitted students takes place during the week prior to the beginning of classes. Students who are newly admitted to the winter term should consult the Calendar of Dates section for exact advising dates.

Students who need 96 or fewer credits to complete their degree requirements must consult an academic adviser in their proposed department of study to obtain advice and approval of their course selection. To facilitate program planning, they must present their transcripts and letters of admission. For a detailed description of advising and registration procedures, students should refer to the Welcome booklet, which is available from the Admissions and Registrar's Office.

Students who need 97-120 credits to complete their degree requirements will normally be registered in a Freshman Program until they complete their first year. They must consult an adviser in the Student Affairs Office to obtain advice and approval of their course selection. For a detailed description of advising and registration procedures, students should refer to the Welcome booklet, which is available from the Admissions and Registrar's Office, as well as the Arts and Science Freshman Handbook, which students receive prior to the start of classes from the Student Affairs Office.

Advising for all returning students takes place in March for the coming academic year. For more information, students should refer to the Arts and Science Registration Handbook, which is distributed in March in the Arts Lobby and is available on the Internet, http://www.mcgill.ca/arts_science.

Advising is also available by e-mail. The address is advisor@artscl.mcgill.ca.

4. Registration

All students register by MARS, McGill's automated registration system.

New students register in August prior to the first day of classes. For detailed information about registration, students should refer to the General University Information section, as well as to the Welcome booklet.

Returning students register in March for the coming academic year. For detailed information about registration, students should refer to the General University Information section of this Calendar, as well as to the Arts and Science Registration Handbook.

Students who fall into unsatisfactory standing at the end of the academic year will have their registration cancelled. They may not reregister in the Faculty, but may be readmitted after appealing to the Committee on Student Standing. For more information, students should consult the Student Affairs Office, Dawson Hall.

Students who have an outstanding fee balance from a previous term or outstanding fines will not be permitted to register. In addition, students who have registered for the upcoming academic year, but then subsequently take summer courses without paying the fees, will have their registration cancelled. Registration on MARS will be denied until these debts are paid in full. Students with financial problems ought to consult the Student Aid Office, Powell Student Services Building.

Students who decide not to return to McGill after initiating registration through MARS must either complete a withdrawal form in person or write a letter addressed to the Student Affairs Office, Faculty of Science, Dawson Hall, Room 115, 853 Sherbrooke Street West, Montreal, Quebec, H3A 2T6. Scholarship students should note that scholarship money is deposited directly into their University fee account; the University requires a formal request for withdrawal before the scholarship money can be released from the fee account.

4.1 Program Registration

Students should refer to the Welcome booklet or the Arts and Science Registration Handbook for information on how to register for programs on MARS. See section 11 for a list of all Science program codes.

4.2 Course Registration

Students in the Faculty of Science may register for and take for credit any course, unless otherwise indicated, in the sections of the Calendar applicable to the Faculties of Arts and of Science, subject to the course restrictions listed in this section.

Since the MARS system is unable to verify whether or not Faculty regulations are respected, it is technically possible to register for courses which are closed to Science students. When students' records are manually verified, however, any "closed" courses will be flagged as "not for credit towards the B.Sc." As a result, the students' expected date of graduation may be delayed.

Students who have valid reasons to take a course that is normally closed to Science students must obtain permission from the Associate Dean of Science before registering for the course. Only the Associate Dean can make exceptions to the Faculty rules.

Some courses may require the permission of the instructor owning to space limitations or program requirements. Students should consult this Calendar and/or the timetable to determine if permission is required of the instructor, the department, or the Faculty for any course they wish to take, or if password cards must be obtained.

4.2.1 Registration for First Year Seminars

Registration for the First Year Seminars is limited to students in their first year of study at McGill. These courses are designed to provide a closer interaction with professors and better working relations with peers. These seminars endeavour to teach the latest scholarly developments and expose participants to advanced research methods. Registration is on a first-come, first-served basis through MARS. The maximum number of students in any seminar is 25. Students may take only one seminar. Please consult the departmental listings for course descriptions.

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Department</th>
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<tr>
<td>177-199A</td>
<td>Species Diversity</td>
<td>Biology</td>
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<td>169-199A</td>
<td>Why Chemistry?</td>
<td>Chemistry</td>
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<td>185-190A</td>
<td>Environmental Perspectives</td>
<td>Geography</td>
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<tr>
<td>189-199A</td>
<td>Chaos, Fractals and Complexity</td>
<td>Mathematics and Statistics</td>
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<td>198-199B</td>
<td>Physics and Biology</td>
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7. Supplemental Assessments

7.1 Supplemental Examinations
Students may apply for permission to write supplemental examinations for certain courses. The following conditions apply:

- students must be in satisfactory or probationary standing;
- students must have received a final grade of D, F, J or U in the course;
- students must avail themselves of this privilege at the time of the next supplemental examination period;
- special permission is required if a student wishes to write supplementals totalling more than 7 credits;
- only one supplemental examination is allowed in a course;
- the supplemental result may or may not include the same proportion of class work as did the original grade. The instructor will announce the arrangements to be used for the course by the end of the change of course period;
- the supplemental result will not erase the grade originally obtained, which is used in calculating the GPA. Both the original mark and the supplemental result will be calculated in the CGPA;
- additional credit will not be given for a supplemental exam where the original grade for the course was a D and the student already received credit for the course.

The supplemental examination period for A courses is during the months of April and May, and for B and D courses during the last week of August. Supplemental applications are available at the Student Affairs Office. The deadline for submission of applications is March 1 for A courses and July 15 for B and D courses. A non-refundable fee for each supplemental paper is payable at the time of application. Students should consult the Student Affairs Office for further information.

7.2 Additional Work
In courses which are assessed partially by written term work, the instructor may choose to provide all students who receive a final mark of D, F, J or U in the course, and who are eligible for supplemental privileges, with the option of revising a paper or papers previously submitted, or of submitting further work in replacement of the original paper(s). The instructor will announce the availability and terms of additional work at the beginning of the course. The following conditions apply:

- students must be in satisfactory or probationary standing;
- students must have received a final grade of D, F, J, or U in the course;
- the mark resulting from the revised or additional work will be recorded as a supplemental mark;
- both the original mark and the supplemental mark will count in calculating the CGPA;
- the weight of the additional work will be equal to the weight given the work revised or replaced when the original mark was submitted;
- in courses in which both a supplemental examination and additional work are available, the student may choose the additional work or the examination or both. Where both are written, only one supplemental mark will be submitted, reflecting marks for both the supplemental examination and the additional work.

Additional work applications are available in the Student Affairs Office. The deadline for submission of applications is March 1 for A courses, and July 15 for B and D courses. A non-refundable fee is payable for each course at the time of application. Students should consult the Student Affairs Office for further information.

5. Grading and Credit

Before the end of the course change (drop/add) period, each instructor will inform students of the following:

- whether there will be a final examination in the course;
- how term work will affect the final mark in the course;
- how term work will be distributed through the year;
- whether letter grades or percentages will be given in the course;
- whether there will be a supplemental examination in the course, and if so, whether term work will be included in the supplemental grade (courses normally have supplemental examinations, and courses with formal final examinations must have supplementals);
- whether students with marks of D, F, J or U will have the option of submitting additional work, and if so how the supplemental mark will be calculated.

5.1 Incomplete Grades
If, in the instructor’s opinion, there is sufficient reason to permit a delay in the submission of required term work, an extension of deadline after the end of the course may be granted the student. In this case, the instructor will submit a grade of K (incomplete). At the time of submission of the grade of K, the instructor will indicate the date by which the work is to be completed. The maximum deadline extensions for the submission of grades to the Student Affairs Office will be as follows:

- students graduating in June: A, B, D courses: April 23
- non-graduating students: A courses: April 30
- B, D courses: July 30

Please consult the General University Information section for more information about grading and credit.

6. Examinations

Students should refer to the General University Information section for information about final examinations and deferred examinations.

The First Year Seminars offered by the Faculty of Arts are also open to Science students. For a complete listing, please consult the Arts section, page 44.

4.3 Registration for Graduation

Students in their final year must indicate the expected date of graduation on MARS and verify this date on MARS and on verification forms. When final-year students change their expected date of graduation, they must notify the Student Affairs Office immediately.

Students who fail to graduate as expected and who do not reregister must apply to the Associate Dean to graduate. Application to graduate must be made sufficiently in advance of the expected graduation date to allow the faculty to verify the student’s record. For further information, students should contact the Student Affairs Office.

The First Year Seminars offered by the Faculty of Arts are also open to Science students. For a complete listing, please consult the Arts section, page 44.

308-199A Excursions in Computer Science, see Computer Science
552-198A Feedback & Rhythms in Physiology, see Physiology
552-199A History of Genetic Engineering, see Physiology
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7.3 Reassessments and Rereads
In accordance with the Charter of Student Rights, and subject to the conditions stated therein, students have the right to consult any written submission for which they have received a mark and the right to discuss this submission with the examiner.

If, after discussion with the instructor, students request a formal final examination re-read, they must apply in writing to the Student Affairs Office. The following conditions apply:
- requests for rereads in more than one course per term will not be permitted;
- grades may be either raised or lowered as the result of a re-read;
- rereads in courses not in the Faculty of Science are subject to the deadlines, rules and regulations of the relevant faculty.

Application for rereads must be made by March 31 for fall-term courses and by September 30 for winter and summer-term courses. Students are assessed a fee for formal rereads. Any request to have term work re-evaluated must be made directly to the instructor concerned. Students should consult the Student Affairs Office for further information.

8. Academic Standing
Academic standing is determined at the end of the academic year, immediately following the winter term examination period.

8.1 Satisfactory Standing
Conditions pertaining to satisfactory standing are as follows:
- new students, and students whose GPA and CGPA are both 2.0 or greater, are in satisfactory standing;
- students who were previously in probationary standing but whose GPA is 2.5 or greater should normally be placed in satisfactory standing;
- students who were previously in unsatisfactory standing and who were readmitted by the Associate Dean or the Committee on Student Standing must satisfy the conditions specified in the letter of readmission in order to be placed in satisfactory standing.

8.2 Probationary Standing
Conditions pertaining to probationary standing are as follows:
- students who were previously in satisfactory standing but whose GPA falls between 1.5 and 1.99 will be placed in probationary standing;
- students who were previously in probationary standing and whose GPA is 2.0 or higher will remain in probationary standing;
- students who were previously in unsatisfactory standing but who were readmitted by the Associate Dean or the Committee of Student Standing are readmitted to probationary standing.

8.3 Unsatisfactory Standing
Conditions pertaining to unsatisfactory standing are as follows:
- students whose GPA falls below 1.5 will be placed in unsatisfactory standing;
- students who were previously in probationary standing and whose GPA falls below 2.5 and whose CGPA is below 2.0 will be placed in unsatisfactory standing;
- students who were previously in unsatisfactory standing and who were readmitted to probationary standing by the Associate Dean or the Committee of Student Standing and who have not satisfied the conditions specified in the letter of readmission will be placed in unsatisfactory standing.

Students in unsatisfactory standing for the second time must withdraw permanently.

8.4 Incomplete Standing
Conditions pertaining to incomplete standing are as follows:
- students whose records in any year show a mark of K, K*, L, L*, or && will have no GPA or CGPA calculated for that year, and the record will show "Standing Incomplete";
- once the appropriate course requirements have been completed, the GPA and CGPA will be calculated and the students' standing will be determined as described above;
- students whose standing is still incomplete by the beginning of classes of the next academic year must obtain permission from the Office of the Associate Dean to continue their studies; otherwise, their registration will be cancelled.

9. Awards and Honourary Designations

9.1 Honours And First Class Honours
Departments may recommend to the Faculty that students registered in an Honours program be awarded Honours or First Class Honours under the following conditions:
- students must complete all requirements imposed by the department;
- for Honours, the CGPA at graduation must be at least 3.0 to 3.49;
- for First Class Honours, the CGPA at graduation must be at least 3.50;
- some departments may impose additional requirements, which must be met before students are recommended for Honours or First Class Honours. These will be found in the departmental descriptions of Honours programs.

Students in an Honours program whose GPA is below 3.0 or who did not satisfy certain program requirements must consult their advisor to determine whether they are eligible to graduate in a program other than Honours.

9.2 Distinction or Great Distinction
Students in Faculty or Major programs whose academic performance is appropriate may be awarded their degrees with Distinction or Great Distinction under the following conditions:
- students must have completed a minimum of 60 McGill credits to be eligible;
- for Distinction, the CGPA at graduation must be 3.30 to 3.49;
- for Great Distinction, the CGPA at graduation must be 3.50 or greater;
- these designations are based upon the cumulative academic record including, in the case of transfer students, their record in another faculty or at another university.

9.3 Dean's Honour List
The designation Dean's Honour List may be awarded to students under the following conditions:
- students must have completed a minimum of 60 McGill credits to be considered;
- students must be in the top 10% of the Faculty's graduating students;
- this honorary designation is based upon the cumulative academic record including, in the case of transfer students, their record in another faculty or at another university.
9.4 Medals and Prizes
Various medals, scholarships and prizes are open to graduating students. Full details of these are set out in the Undergraduate Scholarships and Awards Calendar, available in the Admissions and Registrar's Office. No application is required except in the case of the Moyse Travelling Scholarships.

10. Program Codes

FACULTY PROGRAMS
080100 Anatomy and Cell Biology
142000 Biochemistry
144500 Biology
144700 Biology and Mathematics – see Biology
172200 Chemistry
172500 Chemistry and Biological Sciences – see Chemistry
172900 Chemistry and Mathematics – see Chemistry
632500 Mathematics and Computer Science
635100 Mathematics, Statistics and Computer Science
631200 Mathematics, Chemistry and Physics
662800 Microbiology and Immunology
720000 Physics
750000 Physiology
810000 Psychology

MAJOR PROGRAMS
080100 Anatomy and Cell Biology
662000 Atmospheric Science
142000 Biochemistry
144500 Biology
148000 Biology and Chemistry for Teachers
148100 Biology and Geography for Teachers
172200 Chemistry
172205 Chemistry (Bio-organic option)
172206 Chemistry (Environmental option)
172207 Chemistry (Materials)
148200 Chemistry and Physics for Teachers
265700 Computer Science
480100 Earth and Planetary Sciences
450000 Geography
630000 Mathematics
148300 Mathematics and Chemistry for Teachers
148400 Mathematics and Physics for Teachers
662800 Microbiology and Immunology
720000 Physics
750000 Physiology
810000 Psychology

JOINT MAJORS
632500 Mathematics and Computer Science
720100 Atmospheric Science and Physics
720400 Physics and Geophysics
725500 Physiology and Physics
725400 Physiology and Mathematics

HONOURS PROGRAMS
080100 Anatomy and Cell Biology
630300 Applied Mathematics
662000 Atmospheric Science
142000 Biochemistry
144500 Biology
172200 Chemistry
172205 Chemistry (Bio-organic option)
172206 Chemistry (Environmental option)
172207 Chemistry (Materials)
265700 Computer Science
480200 Earth Sciences
480300 Planetary Sciences
450000 Geography
590500 Interdepartmental Honours in Immunology
630000 Mathematics
662800 Microbiology and Immunology
720000 Physics
750000 Physiology
630400 Probability and Statistics
810000 Psychology

JOINT HONOURS PROGRAMS
632500 Mathematics and Computer Science
634500 Mathematics and Physics

MINOR PROGRAMS
Atmospheric Science
Art History – see Faculty of Arts
Biotechnology
Canadian Ethnic Studies, see Faculty of Arts
Chemical Engineering – see Chemistry
Classics – see Faculty of Arts
Cognitive Science
Computer Science
Earth and Planetary Sciences
Electrical Engineering – see Physics
English (Literature, Drama and Theatre, Cultural Studies) – see Faculty of Arts
French Language and Literature (Lettres, Lettres et traduction, Langue et traduction, Théorie et critique littéraires) – see Faculty of Arts
Geochemistry – see Earth and Planetary Sciences
Humanistic Studies – see Faculty of Arts
Management – see Faculty of Science entry for Management
Mathematics
Music – see Faculty of Science entry for Music
Music Technology – see Faculty of Science entry for Music
Neuroscience
Pharmacology
Philosophy – see Faculty of Arts
Psychology
Socal Studies of Medicine – see Faculty of Arts
Sociology – see Faculty of Arts
Statistics – see Mathematics and Statistics
Women’s Studies – see Faculty of Arts

Note:
Other Minor programs in the Faculty of Arts may become available after publication of this Calendar. Please check with the Student Affairs Office, Dawson Hall.

The Minor in Computer Science is not available to students in the following programs: Honours in Computer Science; Honours in Mathematics and Computer Science; Faculty Program in Mathematics and Computer Science.

The Minor in Chemical Engineering is only available to students in Chemistry.

The Minor in Electrical Engineering is only available to students in the Major Program in Physics.

INTERNSHIP PROGRAMS - INTERNSHIP YEAR FOR ENGINEERING AND SCIENCE (IYES)
The following programs are also available with an Internship component. For more information, please see Section 2.8, in the Faculty of Engineering section of the calendar, and the relevant departmental section in the Faculty of Science.
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 Professors — YVES CLERMONT

Professors — ALAIN BEAUDET*, GARY C. BENNETT, JOHN J.M. BERGERON, JAMES R. BRAWER, LOUIS HERMO, CHARLES P. LEBLOND, DONALD LAWRENCE*, RICHARD MURPHY*, DENNIS G. OSMOND, BARRY I. POSNER*, CHARLES E. SMITH*, EUGENIA WANG*, HERSHEY WARSHAWSKY

Associate Professors — OREST W. BLASCHUK*, EUGENE DANIELS, SAMUEL DAVID*, MICHAEL F. LALL, PAUL LASKO*, MARILYN MILLER, SANDRA C. MILLER, CARLOS R. MORALES, HOJATOLLA VALI*

Assistant Professors — CHANTEL AUTHEXIER*, NATHALIE LAMARCHE, PHILIP BARKER*, TIMOTHY KENNEDY*, ANTONIS KORIMILAS*, PETER MCPHERSON*, ALFREDO RIBERIO-DA-SILVA*, WAYNE SOSSIN*, STEFANO STIFANI*, DOMINIQUE WALKER*, GARY WILD*

Adjunct Professors — DANIEL CYR*, SADAYUKI INOUE, DAVID Y. THOMAS

*Denotes cross or joint appointees.

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 Honours program is designed as the first phase in academic training and is a path for entry into graduate studies. 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 pursued. The Department is well equipped to perform cell fractionation, protein purification, recombinant DNA technology, microinjection of molecules into single cells, cytotoxicological, 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

Required Courses (39 credits)

504-212B (3) Molecular Mechanisms of Cell Function
504-214A (3) Systemic Human Anatomy
504-261A (4) Introduction to Dynamic Histology
504-262B (3) Introductory Molecular & Cell Biology
504-321A (3) Circuity of the Human Brain
177-200A (3) Molecular Biology
177-274A (3) General Genetics
180-212A,B (4) Organic Chemistry I
180-222A,B (4) Organic Chemistry II
189-203A (3) Principles of Statistics I or
204-204A,B (3) Introduction to Psychological Statistics or
177-373A (3) Biostatistical Analysis
552-209A (3) Mammalian Physiology I and
552-210B (3) Mammalian Physiology II or
552-201A (3) Human Physiology: Control Systems and
552-202B (3) Human Physiology: Body Functions

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:
any 300 level or higher biologically oriented courses (BOC) in Anatomy and Cell Biology (504-322B; 504-432D,A,B,L; 504-541B), Biochemistry, Biology, Experimental Medicine, Microbiology and Immunology, Neurology and Neurosurgery, Pathology, Pharmacology and Therapeutics, Physiology, Psychiatry or Psychology.

MAJOR PROGRAM IN ANATOMY AND CELL BIOLOGY

(68 credits)

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 selected from:
any 300 level or higher biologically oriented courses (BOC), as defined in the Faculty Program.

HONOURS PROGRAM IN ANATOMY AND CELL BIOLOGY

(80 credits)

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

Complementary Courses (6 credits)
6 credits selected from:
any 300 level or higher 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 1998-99
★★ Denotes courses taught only in alternate years

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

Professor Branton and Staff

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

Professor Hermo

504-261A INTRODUCTION TO DYNAMIC HISTOLOGY. (4) (3 hours lectures, 2 hours laboratory) (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 Hermo

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 Hermo

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

Professor Brawer

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

504-365A CELL BIOLOGY OF THE SECRETORY PROCESS. (3) (2 hours lectures, 2 hours conference) (Prerequisites: 504-261A, 177-200A, 177-201B, 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.)

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 Brawer, 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 models 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
805 Sherbrooke Street West
Montreal, QC H3A 2K6
Telephone: (514) 398-3764
Fax: (514) 398-6115
Internet: uginfo@zephyr.meteo.mcgill.ca
www: http://zephyr.meteo.mcgill.ca

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

The Department of Atmospheric and Oceanic Sciences offers four main programs in Atmospheric Science: Honours, Major, Minor, and a Joint Major in Physics and Atmospheric Sciences. 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, it is based on courses similar to those in the Major program, but provides the opportunity to take advanced optional courses. 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.

Some program requirements changed in 1996. Students who were registered in any department program prior to September 1996 should discuss changes in course requirements with the undergraduate adviser in the Department.

### MINOR PROGRAM IN ATMOSPHERIC SCIENCE (24 credits)

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)

1. **195-214A (3)** Intro. to the Physics of the Atmosphere
2. **195-215B (3)** Weather Systems and Climate
3. **195-310B (3)** Physical Oceanography
4. **195-330A (3)** Physical Meteorology
5. **195-512A (3)** Atmospheric and Oceanic Dynamics
6. **195-513B (3)** Waves and Stability
7. **195-540A (3)** Synoptic Meteorology I
8. **195-541B (3)** Synoptic Meteorology II
9. **195-546B (3)** Current Weather Discussion
10. **198-230A (3)** Dynamics of Simple Systems
11. **198-232B (3)** Heat and Waves
12. **198-241B (3)** Signal Processing

#### Complementary Courses (9 credits)

- 3 - 6 credits to satisfy a statistics requirement, usually: 189-203A,B (3) Principles of Statistics I
- or 189-322A,B (3) Probability Theory
- and 189-324A,B (3) Statistics
- 3 - 6 credits ordinarily selected from:
  - **189-315A,B (3)** Ordinary Differential Equations
  - **189-317A (3)** Numerical Analysis
  - **189-319B (3)** Partial Differential Equations
  - **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 (3)** Current Weather Discussion
  - **198-230A (3)** Dynamics of Simple Systems
  - **198-232B (3)** Heat and Waves
  - **198-241B (3)** Signal Processing
  - **305-331A,B (3)** Fluid Mechanics I

### MAJOR PROGRAM IN ATMOSPHERIC SCIENCE AND PHYSICS (70 credits)

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)

1. **195-214A (3)** Intro. to the Physics of the Atmosphere
2. **195-215B (3)** Weather Systems and Climate
3. **195-310B (3)** Physical Oceanography
4. **195-330A (3)** Physical Meteorology
5. **195-512A (3)** Atmospheric and Oceanic Dynamics
6. **195-513B (3)** Waves and Stability
7. **195-540A (3)** Synoptic Meteorology I
8. **195-541B (3)** Synoptic Meteorology II
9. **195-546B (1)** Current Weather Discussion
10. **198-230A (3)** Dynamics of Simple Systems
11. **198-232B (3)** Heat and Waves
12. **198-241B (3)** Signal Processing
198-259D (3) Lab. in Mechanics, Heat & Optics
198-331B (3) Mechanics
198-333B (3) Thermal and Statistical Physics
198-339B (3) Measurements Laboratory
198-340A (3) Electricity and Magnetism
198-342B (3) Electromagnetic Waves
198-446A (3) Quantum Physics
198-222A,B (3) Calculus III
198-223A,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)

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
198-222A,B (3) Calculus III
198-223A,B (3) Linear Algebra
198-314A,B (3) Advanced Calculus
198-315A,B (3) Ordinary Differential Equations
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, or who need to 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.

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 1998-99
- Denotes limited enrolment.

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

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

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

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

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

195-310B PHYSICAL OCEANOGRAPHY. (3) (3 hours lectures) (Prerequisite: 195-220, 189-141 or equivalent. Not open to students who have taken 186-360.) Wind driven and thermohaline ocean circulations, surface and internal waves, and tidal phenomena. Use of remote sensing techniques in oceanography. Applications of physical oceanography to other fields of ocean research.


195-400D INDEPENDENT STUDY OF AN ENVIRONMENTAL PROBLEM. (3) (Restricted to students taking a joint program in Atmospheric and Environmental Science or with permission of Department.) A reading or research project, conducted under the guidance of an instructor, on the meteorological processes related to an environmental problem. A written report will be required. Students should consult the departmental undergraduate student adviser for the names of available supervisors.
195-480A, 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.


195-515B 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. Atmospheic and oceanic general circulation models. Observations and models of the El Niño and Southern Oscillation phenomena.

195-540A SYNOPSIS 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 convection rates. Barotropic and equivalent barotropic atmospheres.

195-541B SYNOPSIS 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
Internet: Caron@medcor.mcgill.ca

Chair — PHILIP E. BRANTON
Emeritus Professors — ANGUS F. GRAHAM, ROSE M. JOHNSTONE, SAMUEL SOLOMON, THEODORE L. SOURKES, LEONHARD S. WOLFE

Professors — RHODA BLOSTEIN, PHILIP E. BRANTON, PETER E. BRAUN, PHILIPPE GROS, ANNETTE A. HERSCOVICS, ROBERT E. MACKENZIE, EDWARD A. MEIGHEN, WALTER E. MUSHINSKI, GORDON C. SHORE, JOSEPH SHUSTER, JOHN R. SILVIUS, NAHUM SONENBERG, CLIFFORD P. STANNERS, MARIA ZANNIS-HADJIOPOULOS

Associate Professors — NICOLE BEAUCHEMIN, VINCENT GIGUERE, ALAIN NEPVEU, MORAG PARK, JERRY PELLETIER, MICHEL L. TREMBLAY, ANDRE VEILLETTE

Assistant Professors — KALLE GEHRING, ALICE VRIELINK

Associate Members — JOHN J. BERGERON (ANATOMY & CELL BIOLOGY), KATHERINE CIANFLONE (RVH, CARDIOLOGY), L. FERNANDO CONGOTE (EXP. MEDICINE), ROBERT DUNN (MGH), MARK FEATHERSTONE (MCGILL CANCER CTR.), WILLIAM C. GALLEY (CHEMISTRY), PETER J. ROUGHLEY (SHRINERS HOSPITAL), ERWINN SCHURR (EXP. MEDICINE), CHARLES SCRIVER (PEDIATRICS), BERNARD TURCOTTE (MEDICINE)

Adjunct Professors — MICHAEL CORDINGLEY (BIO MEGA), MIKE CYGLER (B.R.I.), JACQUES DROUIN (CLIN. RES. INST.), JILLY EVANS (MERCK FROSST), MICHAEL GRESSER (MERCK FROSST), FENG NI (B.R.I.), DONALD NICHOLSON (MERCK FROSST), MAUREEN O’CONNOR-MCCOURT (B.R.I.), ANDREW STORER (B.R.I.)

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.

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.

Inquiries about programs should be directed to Maureen Caron, Student Affairs Officer in the Department of Biochemistry at (514) 398-7266.

PRE-PROGRAM REQUIREMENTS

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

FACULTY PROGRAM IN BIOCHEMISTRY (55 credits)

<table>
<thead>
<tr>
<th>U1 Required Courses (16 credits)</th>
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<tbody>
<tr>
<td>507-212B (3) Molecular Mechanisms of Cell Function</td>
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<tr>
<td>177-200A (3) Molecular Biology</td>
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<tr>
<td>177-202B (3) Basic Genetics</td>
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<tr>
<td>180-204A,B (3) Physical Chem./Biol. Sci. I</td>
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<tr>
<td>180-222A,B (4) Organic Chemistry II</td>
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<tr>
<th>U1 Complementary Courses (9 credits)</th>
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<tbody>
<tr>
<td>177-204A (3) Evolution</td>
<td></td>
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<tr>
<td>and 177-205B (3) Biology of Organisms</td>
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<tr>
<td>or 552-209A (3) Mammalian Physiology I</td>
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<tr>
<td>and 552-210B (3) Mammalian Physiology II</td>
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<tr>
<th>U2 Required Courses (15 credits)</th>
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<tbody>
<tr>
<td>507-300D (6) Laboratory in Biochemistry</td>
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<tr>
<td>507-311A (3) Metabolic Biochemistry</td>
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<tr>
<td>507-312B (3) Biochemistry of Macromolecules</td>
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<tr>
<td>180-302A (3) Organic Chemistry III</td>
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<tr>
<th>U2 Complementary Courses (3 credits)</th>
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<tbody>
<tr>
<td>177-303B (3) Developmental Biology</td>
<td></td>
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<tr>
<td>177-313B (3) Structure and Function of Cells</td>
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<tr>
<td>180-352B (3) Structural Organic Chemistry</td>
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<tr>
<td>180-382B (3) Organic Chemistry of Natural Products</td>
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<tr>
<td>528-314B (3) Immunology</td>
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<tr>
<td>504-262B (3) Introductory Molecular and Cell Biology</td>
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<tr>
<th>U3 Complementary Courses (12 credits)</th>
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<tbody>
<tr>
<td>at least 3 credits selected from:</td>
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<tr>
<td>507-404B (3) Biophysical Chemistry</td>
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<tr>
<td>507-450A (3) Protein Structure and Function</td>
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<tr>
<td>507-454A (3) Nucleic Acids</td>
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<tr>
<td>507-455B (3) Neurochemistry</td>
<td></td>
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<tr>
<td>507-456B (3) Biochemistry of Membranes</td>
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<tr>
<td>the remaining credits selected from the following list or the above:</td>
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<tr>
<td>504-261A (4) Introduction to Dynamic Histology</td>
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<thead>
<tr>
<th>U2 Required Courses (9 or 12* credits)</th>
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<tbody>
<tr>
<td>177-204A (3) Evolution</td>
<td></td>
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<tr>
<td>177-205B (3) Biology of Organisms</td>
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<tr>
<td>177-300A (3) Molecular Biology of the Gene</td>
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<tr>
<td>177-303B (3) Developmental Biology</td>
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<tr>
<td>177-314A (3) Molecular Biology of Oncogenes</td>
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<tr>
<td>180-257D (4) Analytical Chemistry</td>
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<tr>
<td>189-227A,B (3) Mathematics for Life Science Students</td>
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MAJOR PROGRAM IN BIOCHEMISTRY (70 credits)

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

<table>
<thead>
<tr>
<th>U1 Required Courses (23 credits)</th>
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<tbody>
<tr>
<td>507-212B (3) Molecular Mechanisms of Cell Function</td>
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<tr>
<td>177-200A (3) Molecular Biology</td>
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<tr>
<td>177-202B (3) Basic Genetics</td>
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<tr>
<td>180-204A,B (3) Physical Chem./Biol. Sci. I</td>
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<tr>
<td>180-222A,B (4) Organic Chemistry II</td>
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<tr>
<td>180-257D (4) Analytical Chemistry</td>
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<tr>
<td>189-227A,B (3) Mathematics for Life Science Students</td>
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<tr>
<th>U2 Required Courses (20 credits)</th>
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<tr>
<td>all Faculty Program U2 Required Courses, plus:</td>
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<tr>
<th>U2 Complementary Courses (6 credits)</th>
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<tbody>
<tr>
<td>3 credits selected from:</td>
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<tr>
<td>177-303B (3) Developmental Biology</td>
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<td>177-313B (3) Structure and Function of Cells</td>
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<tr>
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<tr>
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<tr>
<th>U3 Required Courses (6 credits)</th>
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<tr>
<td>507-450A (3) Protein Structure and Function</td>
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<td>507-454A (3) Nucleic Acids</td>
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<tr>
<th>U3 Complementary Courses (9 or 12* credits)</th>
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<td>507-404B (3) Biophysical Chemistry</td>
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<td>507-454A (3) Nucleic Acids</td>
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<tr>
<td>507-455B (3) Neurochemistry</td>
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<tr>
<td>507-456B (3) Biochemistry of Membranes</td>
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<tr>
<td>507-460A (6) Advanced Lab in Biochemistry</td>
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<tr>
<td>507-503B (3) Immunology</td>
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<tr>
<td>177-300A (3) Molecular Biology of the Gene</td>
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<tr>
<td>177-303B (3) Developmental Biology</td>
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<td>177-314A (3) Molecular Biology of Oncogenes</td>
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<tr>
<td>180-352B (3) Structural Organic Chemistry</td>
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<td>180-382B (3) Organic Chemistry of Natural Products</td>
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<tr>
<td>180-402B (3) Advanced Bio-organic Chemistry</td>
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<tr>
<td>180-572B (3) Synthetic Organic Chemistry</td>
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<td>528-314B (3) Immunology</td>
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<tr>
<td>180-552B (3) Physical Organic Chemistry</td>
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<tr>
<td>180-572B (3) Synthetic Organic Chemistry</td>
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1998/99 Undergraduate Programs – McGill University

Admissions and Registrar’s Home Page  Undergraduate Calendar - First Page  Chapter - First Page  Previous Page  Next Page
**INTERDEPARTMENTAL HONOURS PROGRAM IN IMMUNOLOGY**

The Departments of Biochemistry, Microbiology and Immunology, and Physiology offer an Immunology Interdepartmental Honours Program which is listed as a separate entry in this Calendar.

**COURSE DESCRIPTIONS**

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

- Denotes courses not offered in 1998-99
- Denotes courses with limited enrolment

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

- **Professor Branton (Coordinator) and Staff**

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

- **Professors Tremblay and Gros**

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

- **Professor Mushynski**

**507-312B BIOCHEMISTRY OF MACROMOLECULES.** (3) (Prerequisites: 507-311A, 177-200A, 177-201B or 507-212B) Gene expression from the start of transcription to the synthesis of proteins, their modifications and degradation. Topics covered: purine and 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. (This course is also listed as 180-404B, Not open to students who have taken or are taking 180-404B.) Hydrodynamic and electrophoretic methods for separation and characterization of macromolecules. Optical and magnetic resonance spectroscopy of biopolymers, and applications to biological systems.

- **Professors Silvis and Galley (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 complex.

- **Professors Meighen (Coordinator), Gehring and Vrielink**

**507-454A NUCLEIC ACIDS.** (3) (Prerequisites: 507-311A, 507-312B or permission of instructor.) Chemistry of RNA and DNA, transcription and splicing of RNA and their control; enzymology of DNA replication. Special topics on transgenic, 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 excita-
bility, chemically mediated transmission, gial function. Biochem-
istry of specific neurotransmitters, endocrine effects on brain, brain
energy metabolism and cerebral ischemia (stroke). With exam-
amples, where relevant, of biochemical processes disrupted in hu-
man CNS disease.

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

507-456B Biochemistry of Membranes. (3) (Prerequisites: 507-
311A, 507-312B, 180-214B or equivalent, or by consent of the in-
structors. Intended for U3 level students.) Composition, organiza-
tion and dynamics of biological membranes. Molecular
mechanisms of membrane receptor functions, membrane trans-
port and energy transduction. Membrane biogenesis and mem-
brane traffic in eukaryotic cells. Professors Silvius and Blostein

□ 507-460A Advanced Lab in Biochemistry. (6) (Enrolment
limit) Students will select one project, employing advanced as well
as standard biochemical techniques, to be performed in a re-
search 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 depart-
mental permission only) (Prerequisite: 507-460A) Individual work
on a project to be performed in a research laboratory.
Professor Shore and Staff

507-503B Immunology. (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 dis-
cussed. The clinical significance of fundamental biochemical
findings is described. Professor Shuster

11.4 Biology (177)
Stewart Biology Building, Room W4-7
1205 Avenue Docteur Penfield
Montreal, QC H3A 1B1
Telephone: (514) 398-6400

Chair — DONALD L. KRAMER

Emeritus Professors — F. CLARK FRASER (MOLSON EMERITUS
PROFESSOR OF GENETICS), JOHN M. MARSDEN (STRATHCONA
EMERITUS PROFESSOR OF ZOOLOGY)

Professors — GRAHAM BELL (MOLSON PROFESSOR OF GENETICS),
GREGORY G. BROWN, A.HOWARD BUSSEY, ROBERT L. CARROLL
(STRATHCONA PROFESSOR OF ZOOLOGY), RONALD CHASE,
RAJINDER DHINDSA, SARAH P. GIBBS, JACOB KALF,
DONALD L. KRAMER, MARTIN LECHEWICZ, ROBERT E. LEMON,
JOHN LEWIS, BAIRD B. MUKHERJEE, RONALD J. POOLE,
DEREK ROFF

Associate Professors — PETER HECHTMAN (ON LEAVE),
PAUL F.ASKO, LOUIS LEFEBVRE, ROBERT L. LEVINE,
YUTAKA NISHIOKA, VALETH M. PASZTOR, GERALD POLLACK,
CATHERINE POTVIN, JOSEPH RASMUSSEN, RIMA ROSEN,
DANIEL SCHOEN

Assistant Professors — THOMAS BUREAU, S. HEMIK,
REBECCA KELLUM, NEIL PRICE (ON LEAVE), LESLIE SEIBURTH,
BEAT SUTER, AMANDA VINCENT, CANDACE S. WADDELL

Associate Members — SAL CARBONETTO (MGH), HUGH CLARKE
(R.V.H.), PIERRE DRAPEAU (MGH), ROBERT DUNN
(NERSCIENCE), WILLIAM F. GRANT (AGRICULTURE, MACDONALD
CAMPUS), ROY GRAVEL (PAEDIATRICS), DAVID GREEN (REDPATH
MUSEUM), KENNETH H. HAMILTON (MNI), PAUL HOLLAND (MNI),
WAYNE HUNTE (BELLAIRS INSTITUTE), ROBERTA PALMOUR (ALLAN
MEMORIAL INSTITUTE), LEONARD PINSKY (LADY DAVIS INSTITUTE),
HENRY REISINGW (REDPATH MUSEUM), DAVID ROSENBLATT
(PAEDIATRICS), GUY ROULEAU (MGH), CHARLES R. SCRIVER

(PAEDIATRICS), TEREKO TAKETO (RVH), HARRIET S. TENENHOUSE
(PAEDIATRICS)

Adjunct Professors — WING CHEUNG (DNA LANDMARKS),
WILLIAM C. LEGGETT (QUEEN'S), DAVID Y. THOMAS (NRC LAB),
MALCOLM WHITNEY (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 or-
ganelles, 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 appli-
cations. The knowledge, methods and concepts developed
through research in the various fields of biology are applied exten-
sively in agriculture, medicine, biotechnology, genetic engineering,
environmental protection and wildlife management.

The Department of Biology offers two Faculty Programs, a Ma-
nor Program, an Honours Program and a Minor Program 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 (Bi-
ology 177-112B) and one course in Organic Chemistry, CEGEP
Chemistry 202 or equivalent (Chemistry 180-212A). 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 pre-
requisite 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 spe-
cialize in more than one area of biology and provide them with a
broad training in biology comparable to the most specialized pro-
grams 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 back-
ground for those interested in careers related to environmental
protection, wildlife management, biotechnology and genetic engi-
neering. 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,
organismal morphology and evolution of living beings, interactions
between the living cell and its environment, mechanisms of embryonic
development, structure and function of the living cell and its org-
nerelles, 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 appli-
cations. The knowledge, methods and concepts developed
through research in the various fields of biology are applied exten-
sively in agriculture, medicine, biotechnology, genetic engineering,
environmental protection and wildlife management.

The courses listed below are not described in any great detail.
To provide more information, the Department has prepared a "Blue
Book" (sold in the Biology Department, Room W4/8), entitled
(2006-2007 Undergraduate Programs 1998-99), 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
Student Affairs Secretary, in Room W4/8, Stewart Biology Build-
ing, telephone (514) 398-7045.
FACULTY PROGRAMS
In view of the constantly changing job market for B.Sc. graduates in biology, the Department has designed Faculty Programs to allow students to prepare for a wide range of employment opportunities. The programs offer students an opportunity to specialize in more than one area of biology, to broaden the scope of their scientific background. The program can be tailored to provide a relatively broad spectrum of biology courses, or provide a degree of specialization in biology which approaches that of a Major Program (total 36 to 54 biology credits). The flexibility and scope of these programs will not only enhance the graduate's prospects for employment, but also entrance into graduate studies.

FACULTY PROGRAM IN BIOLOGY (54 credits)
Required Courses (18 credits)
177-200A (3) Molecular Biology
177-201B (3) Cell Biology and Metabolism
177-202A,B (3) Basic Genetics
177-204A (3) Evolution
177-205B (3) Biology of Organisms
177-308B (3) Ecology

Complementary Courses (36 credits)
18 credits of Biology courses, including 3 credits selected from:
177-206A (3) Methods in Biology of Organisms
177-205B (3) Biology of Organisms
or 177-301A,B (3) Cell and Molecular Laboratory
18 credits of Science courses including, at most, 3 credits of general interest Science courses (not listed in Science Major Programs).

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

FACULTY PROGRAM IN BIOLOGY AND MATHEMATICS (57 credits)
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
177-204A (3) Evolution
177-205B (3) Biology of Organisms
177-206A (3) Methods in Biology of Organisms
552-209A (3) Mammalian Physiology I
552-210B (3) Mammalian Physiology II
and 9 credits selected from:
177-303B (3) Developmental Biology
177-306A (3) Neurobiology and Behaviour
177-307A (3) Behavioural Ecology/Sociobiology
or 177-308B (3) Ecology
177-324A (3) Ecological Genetics
177-370B (3) Human Genetics Applied
177-420B (3) Gene Activity in Development
177-430B (3) Neural Basis of Behaviour
177-431A (3) Neurobiology of Learning & Memory
177-470B (3) Lake Management
177-473A (3) Ecology of Aquatic Invertebrates
6 credits of any other Biological Sciences courses
9 credits of mathematics including at least 3 credits selected from:
177-309A (3) Mathematical Models in Biology
198-413A (3) The Physical Basis of Physiology
and at least 3 credits selected from:
189-314A,B (3) Advanced Calculus
189-317A,B (3) Numerical Analysis
189-319B (3) Partial Differential Equations
189-327B (3) Matrix Numerical Analysis
189-407B (3) Dynamic Programming
189-423A (3) Regression and Analysis of Variance
189-425A (3) Sampling Theory and Applications
189-447B (3) Stochastic Processes
or other suitable mathematics courses chosen in consultation with the adviser.

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

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

U1 Required Courses (18 credits)
177-200A (3) Molecular Biology
177-201B (3) Cell Biology and Metabolism
177-202A,B (3) Basic Genetics
177-204A (3) Evolution
177-205B (3) Biology of Organisms
177-206A (3) Methods in Biology of Organisms

U2 or U3 Required Courses (6 credits)
177-301A,B (3) Cell and Molecular Laboratory
177-308B (3) Ecology

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

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

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

MOLECULAR GENETICS AND DEVELOPMENT
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 organisational 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
Neurology/Neurosurgery 531-310B
Pharmacology 549-562A
Physiology 552-451A, -520B, -556B
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 importance of adaptation to climate and the use of plants for food, chemicals, pharmaceuticals and materials underlie research using biotechnology and quantitative methods to improve cultivated plants and understand natural plant populations.

Key courses:
Biology 177-300A, -303B, -305A, -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, -351A, -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 177-305A, -306A, -307B, -331A or -334E, C or another field course with a significant behavioural component, -377B,C or -477A and/or -478B,C, -593A

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.

BIOTICAL DIVERSITY AND SYSTEMATICS

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

Key course:
Biology 177-305A

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 other field courses should be considered as vital to all concentrations in this area.
GENERAL AND APPLIED ECOTLOGY 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. By appropriate selection of courses in consultation with advisers, it is possible to complement these courses with a Minor.

Key courses:
- Biology 177-305A, -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 ECOTLOGY 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. By appropriate selection of courses in consultation with advisers, it is possible to complement this concentration with a Minor.

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

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

MARINE BIOLOGY CONCENTRATION

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

Key courses:
- Biology 177-305A, -335T or -336C, -337C, -351A, -353B, -375B, -411B, -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 study 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)

The Honours program in Biology is designed expressly as a preparation for graduate studies and research, and provides students with a broad 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
- 177-308B (3) Ecology
- 177-373A (3) Biostatistical Analysis

U2 and U3 Complementary Courses (27 credits)
- 18 credits selected from:
  - 177-300A (3) Molecular Biology of the Gene
  - 177-303B (3) Developmental Biology
  - 177-305A (3) Diversity of Life
  - 177-306A (3) Neurobiology and Behaviour
- 9 credits selected from:
  - 177-300A
  - 177-303B
  - 177-305A
  - 177-373A
- or, general interest courses such as 177-115B and 177-115A and 177-112A.

U3 Required Courses (13 or 16 credits)
- 177-499D (4) Honours Seminar in Biology
- 177-499D (4) Honours Seminar in Biology

Courses Open to Non-Biologists

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

COURSE DESCRIPTIONS

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

Denotes courses not offered in 1998-99
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 component of 177-111A and only with permission of the Associate Dean of Science.

Professor Green

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 component of 177-112B and only with permission of the Associate Dean of Science.

Professor Poole

177-111A PRINCIPLES OF ORGANISMAL BIOLOGY. (3) (2 lectures and 3-hours laboratory) (Prerequisite: none. Exclusions: Biology 301 at CEGEP; 177-115B) An introduction to the structure, function and adaptation of plants and animals in the biosphere. Open to all students wishing introductory biology. Serves both as a prerequisite for 177-204A and 177-206A, and as an alternative to CEGEP Organismal Biology. Professor Reiswig (Co-ordinator) and Staff

177-111B.L. CELL AND MOLECULAR BIOLOGY. (3) (2 lectures and 3 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 177-204A and 177-206A and as an alternative to CEGEP Cell Biology. Professors Poole (Co-ordinator) and Kellum

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 sci-
entific 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.

**Staff**

**177-199A SPECIES DIVERSITY.** (3) (3 hours seminar) (Pre- or Co-requisite: 177-111A) (FYS - for first year students only, maximum 25.) Course is primarily about the biological nature of plant species diversity, and secondarily about the consequences for conservation biology of people’s aesthetic responses to species diversity. The course: 1) introduces the concept of species diversity and the basic mechanisms that regulate diversity; 2) compares plant diversity in a wide range of natural and managed ecosystems; and 3) considers problems in the conservation of species diversity.

**Professor Lechowicz**

**177-200A MOLECULAR BIOLOGY.** (3) (3 lectures, 1 hour tutorial) (Prerequisite: 177-112B or equivalent. Corequisite: 180-212A or equivalent.) The physical and chemical properties of the cell and its components in relation to their structure and function. Topics include: protein structure, enzymes and enzyme kinetics; nucleic acid replication, 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) Contemporary ideas in cell biology derived from studies at the cellular and subcellular level are presented. Topics include ultrastructure; cell synthetic processes; bioenergetics and intermediary metabolism, glycolysis, tricarboxylic acid cycle, electron transfer, oxidative phosphorylation, photosynthesis, metabolic regulation; membrane concept, transmembrane electrical potential, transport phenomena.

**Professors Levine (Co-ordinator) and Sieburth**

**177-202A,B BASIC GENETICS.** (3) (3 lectures, 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 Bussey (Co-ordinator) and Staff**

**177-204A EVOLUTION.** (3) (3 lectures, optional conference hour) (Prerequisite: 177-111A or equivalent.) This course will show how Darwin’s theory of natural selection provides the basis for understanding the rest of biology. The first half of the course describes the process of selection, while the second deals with evolution in the long term.

**Professors Roff and Carroll**

**177-205B BIOLOGY OF ORGANISMS.** (3) (3 lectures, optional conference hour) (Prerequisites: 177-204A, 177-200A. 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.

**Professors Pasztor (Co-ordinator) and Lechowicz**

**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**

**177-210A 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 in Science for Arts students to pursue their interests in specific scientific disciplines.

**Professor Lefebvre**

**177-222C BASIC BIOTECHNOLOGY.** (3) 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 use of whole cells in generating antibodies, enzymes and growth factors, in bioremediation, and as artificial cells. Biotechnology in the arts; and legal issues.

**Professor Sinclair**

**177-240T FIELD BOTANY.** (3) Field and laboratory investigations of bryophytes, 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. Observations of reproductive biology and ecology will also be emphasized. 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 optional) (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, 177-21B.) 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 Lasko and Nishioka (Co-ordinator)**

**177-301A,B CELL AND MOLECULAR LABORATORY.** (3) (1 lecture and one 6-hour laboratory) (Prerequisites: 177-204A, 177-201B. 177-206A recommended. Exclusion: 507-300D. Password card required.) Focus is on the experimental methods used to develop the chemical and biological concepts introduced in first year courses. Techniques by which growth, metabolism and regulation of cell systems are analyzed and by which biological macromolecules are purified and characterized. 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 177-21B.) Corequisite: 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 and Clarke**

**177-305A DIVERSITY OF LIFE.** (3) (2 lectures and 1 three-hour laboratory) This course describes the key 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 Green (Co-ordinator) and Reiswig**

**177-306A NEUROBIOLOGY AND BEHAVIOUR.** (3) (3 lectures) (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, Chase and Lefebvre**

**177-307B BEHAVIOURAL ECOLOGY/SOCIOBIOLOGY.** (3) (2 hours lecture and 1 hour conference) (Prerequisites: 177-204A and 177-205B 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**

**177-308B ECOLOGY.** (3) (2 hours lecture, 1 tutorial) (Prerequisite: 177-204A or permission) This course introduces the basic principles and applications of population, community, and ecosystem ecology.

**Professors Rasmussen and Schoen**

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

Professor Glass (Physiology Department)

177-313B STRUCTURE AND FUNCTION OF CELLS. (3) (2 hours lecture, 3 hours seminar) (Prerequisites: 177-200A; 177-201B or 507-212B) The functional organization of prokaryotic and eukaryotic cells. Topics include methods used for studying cells, evolution of the eukaryotic cell, structure and function of the major cellular organelles, and analysis of cellular processes such as cell motility, intracellular transport, secretion, endocytosis, mitosis, cell-to-cell communication and cell recognition.

Professor Gibbs

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

Professor Mukherjee

177-324A ECOLOGICAL GENETICS. (3) (2 hours lecture, 1 seminar) (Prerequisites: 177-200A, 177-204A, 177-205B, 177-267A, 177-277A) This course presents evolutionary genetics within an ecological context. The course covers theoretical topics together with relevant data from natural populations of plants and animals. Topics build upon material taught in 177-204A.

Professor Schoen

177-327A HERPETOLOGY. (3) (2 hours lecture; 3 hours laboratory) (Prerequisites: 177-204A, 177-205B, 177-206A) Principles of biology as exemplified by amphibians and reptiles. Topics include: adaptation, social behaviour, reproductive strategies, physiology, biomechanics, ecology, biogeography and evolution. Laboratory 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: 177-200A; 177-308B recommended) (Preregistration in March and April. See Prof. Kalf.) 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 Kalf 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: 177-308B 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. Kramer at an information session held each October and fill out an application form.

Professors Hunte and Kramer

177-335T MARINE MAMMALS. (3) (Prerequisite: 177-204A) Biology of marine mammals with special emphasis on seals and whales of the Bay of Fundy. Taught at the Huntsman Marine Science Centre, St. Andrews, N.B., for two weeks in August. The course combines lectures, laboratory exercises, field trips, and individual projects. Interested students should contact their adviser before enrolling in the course. See A. Comeau, W4/8.

177-336C MARINE AQUACULTURE. (3) (Prerequisite: 177-204A) 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: 177-204A, 177-205B) (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 or permission.) The origin, history, and nature of life from 3.5 billion years ago to the present, within the context of physical and biological changes in the earth's environment. Topics: origin of life, radiation of multicellular organisms; invasion of land by plants and animals; rise and extinction of dinosaurs; origin of modern biota.

Professor Carroll

177-345A PARASITISM AND SYMBIOSIS. (3) (2 hours lecture and eight 3-hour laboratories) (Pre- or Co-requisite: 177-204A or permission.) The biology of parasites and host-parasite interactions are examined from the cellular, organismal and population perspectives. Evolution of symbiosis in relation to life cycle patterns of major taxonomic groups is examined. Modern strategies for parasite control are discussed.

Professor Smith (Institute of Parasitology)

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

Professors Rau, Lewis, Stewart and Dunphy (Dept. Nat. Res. Sci.)

177-351B THE BIOLOGY OF INVERTEBRATES. (3) (2 hours lecture; 3 hours laboratory) (Prerequisites: 177-204A, 177-205B or permission)

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

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

177-354B BIOLOGY OF BIRDS. (3) (2 hours lecture, 3 hours laboratory) (Prerequisite: 177-204A; 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 177-201B) (Exclusion: 177-308B and 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: 177-204A, 177-205B or permission.) Practical training in plant identification combined with an emphasis on major plant families and species important in temperate boreal, and arctic regions.

Professor Lechowicz

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

Professor Potvin

177-370B HUMAN GENETICS APPLIED. (3) (3 hours lecture; 1 hour conference optional) (Prerequisites: 177-200A and 177-201B, 177-202B or 177-274A) A contemporary view of what genetics can do when applied to human beings.

Professor Pinsky and Staff
177-373A BIOSTATISTICAL ANALYSIS. (3) (2 hours lecture and 2 hours laboratory per week) (Prerequisites: 189-112A,B or equivalent) (Note: 177-373 may preclude credit for other statistics courses. See "Course Overlap" on page 335.) 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.

Doctoral Level Courses

Professor Roff

177-377B,C INDEPENDENT STUDIES IN BIOLOGY. (3) (Open to U2 or U3 Biology students only.) 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 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), Pollack, and Hekimi

177-413 A,B,C,L,T READING PROJECT. (1) (3 hours reading project) (Prerequisites: 177-200A, 177-201B, 177-202B, 177-204A, 177-205B, 177-308B) 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.

177-416B DEVELOPMENTAL MAMMALIAN GENETICS. (3) (2 hours lecture, 1 hour seminar) (Prerequisites: 177-202A,B or 177-274A, 177-300A, 177-303B or permission.) This course aims to examine problems, theories, and experimental evidence on several concepts of mammalian developmental processes at molecular to organogenesis 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) (2 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 Suter

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

177-431A NEUROBIOLOGY OF LEARNING & MEMORY. (3) (3 hours lecture and discussion) (Prerequisites: 177-306A or 531-310B or 552-311A or permission.) Properties of nerve cells that are responsible for learning and memory. Recent advances in the understanding of neurophysiological, biochemical and structural processes relevant to neural plasticity. Emphasis on a few select model systems involving both vertebrate and invertebrate animals.

Professor Chase

177-432A LIMNOLOGY. (3) (2 hours lecture; 3 hours laboratory) (Prerequisites: 177-204A and 177-206A and/or permission.) A study of the physical, chemical and biological properties of inland waters, with emphasis on their functioning.

Professor Kalf

177-437A ADVANCED INVERTEBRATE ZOOLOGY. (3) (Prerequisite: 177-351B or permission.)

177-441B BIOLOGICAL OCEANOGRAPHY. (3) (2 hours lecture, 3 hours laboratory/conference) (Prerequisite: 177-308B or permission.)

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

Professors Bussey and Whiteway

177-453B NEOTROPICAL ENVIRONMENTS. (3) (6 hours lecture for 4 weeks, 3 hours seminar, 2 hours laboratory, 6 hours conference) (Prerequisites: 144-218, 189-203, and 177-308, or equivalents, and permission of Program Coordinator) (Restriction: location in Panama. Students must register for a full semester of studies in Panama.) Ecology theory revisited in view of tropical conditions. Exploring species richness. Historical and contemporaneous factors structuring neotropical communities. Measuring biodiversity. Conservation status of ecosystems, communities and species. Guest Lecturers: Staff from Smithsonian Tropical Research Institute and Panamanian Universities. (Awaiting University Approval)

Staff

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

Professor Vincent

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

Professor RofT

177-466B TOPICS ON THE HUMAN GENOME. (3) (3 hours lecture) (Prerequisites 177-202B or 177-274A, 177-300A, 177-370B, or permission.) Cellular and molecular approaches to characterization of the human genome.

Professor Rozen and Staff

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

177-471C,D INDEPENDENT STUDIES IN BIOLOGY. (3) (Open only to U3 Biology students.) (Prerequisites: 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.) 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. (Awaiting University Approval)

Staff

177-472A MOLECULAR EVOLUTION. (3) (2 hours lecture, 4 hour lecture/seminar) (Prerequisite: 177-300A recommended.) This course is concerned with two aspects of molecular evolution—the evolution of macromolecules, in particular, rates and patterns of change occurring in the genetic material (e.g. DNA sequences) and its products (e.g. proteins), and the reconstruction of evolutionary history of both genes and organisms as inferred from molecular data.

Professor Bureau

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

177-475B HUMAN BIOCHEMICAL GENETICS. (3) (3 hours lecture) (Prerequisites: 177-274A or 177-202A, and 177-300A. Exclusion: 177-471 or 177-476.)

177-477A/478B,C INDEPENDENT STUDIES IN BIOLOGY. (3 credits each) (Open only to U3 Biology students) (Prerequisite: 177-206A or 177-301A,B or other suitable laboratory course.)
Projects must be arranged individually with a staff member of the Biology Department and a form from Ms. Comeau, Room W4/8, Stewart Building, must be completed to receive credit for the course. 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.

- **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.) 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.

- **177-480D, G INDEPENDENT STUDIES IN BIOLOGY.** (12) (10-15 hours per week research project and related seminars) (Restriction and course description: as for 177-479D,G.)

- **177-483B STATISTICS IN POPULATION BIOLOGY.** (3) (3 hours lecture) (Prerequisites: 177-201B, 177-202B, 177-205B, 177-308B, 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 seminars.

- **177-505B DIVERSITY AND SYSTEMATICS SEMINAR.** (3) (3 hours seminar) (Prerequisites: 177-204A, 177-305A, or permission.) A course dealing in depth with a particular aspect of biological diversity and/or systems. 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.

- **177-518B EUKARYOTIC CELL GENETICS.** (3) (2 hours seminar) (Prerequisite: 177-300A and permission.) This course is designed for advanced undergraduate and graduate students. Readings from recent journal articles and reviews. Variable topics, including: cell differentiation, function of oncogenes and anti-oncogenes, growth regulation and cell cycle, gene transfer, recombination, mobile genetic elements, regulation of gene expression, cellular and viral replication, signal transduction.

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

- **177-524A TOPICS IN MOLECULAR BIOLOGY.** (3) (Prerequisite: 177-300A, 177-303B or permission.) Recent literature in the fields of molecular genetics and molecular biology of development. Topics include: gene structure and the regulation of gene expression in eukaryotic organisms, especially during cellular differentiation.

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

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

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

- **177-570B ADVANCED SEMINAR IN EVOLUTION.** (3) (3 hours seminar) (Open to undergraduates by permission.)

- **177-588A MOLECULAR/CELLULAR NEUROBIOLOGY.** (3) (1 1/2 hours lecture, 1 1/2 hours seminar) (Prerequisite: 177-300A or permission.) A discussion of the fundamental molecular mechanisms underlying the general features of cellular neurobiology. This is an advanced course based on lectures and on a critical review of primary research papers. Intended for final-year undergraduates and for neuroscience graduate students interested in recent developments in molecular neurobiology.

- **177-593B BEHAVIOUR/SOCIOBIOLOGY SEMINAR.** (3) (3 hours seminar) (Prerequisites: 177-307B and 177-306A.)

### 11.5 Biotechnology (202)

Professor Hugh P.J. Bennett, Program Supervisor
Sheldon Biotechnology Centre
Lyman-Duff Building
Telephone: (514) 398-3998

**MINOR PROGRAM IN BIOTECHNOLOGY** (24 credits)

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 during their U1 year, 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.
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.

* These courses may not also be used for a Management 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 Immunochromatography
- 552-513A 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
- 177-402B Advanced Lab in Mol and Cell Biol (or 528-386B)
- 177-420B Gene Activity in Development

**Molecular Biology (Biochemistry)**
- 177-451A Molecular Biology: Cell Cycle
- 177-524A Topics in Molecular Biology

**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
- 303-553B Stream Pollution and Control
- 302-471B Industrial Water Pollution Control

* These courses may not also be used for a Environmental Engineering Minor by Engineering students.

**General**
- 306-310A.B Engineering Economy

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

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

**Professor Bussey**

**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

**Chair — IAN S. BUTLER**

**Emeritus Professors — JOHN T. EDWARD, (WILLIAM C. MACDONALD EMERITUS PROFESSOR OF CHEMISTRY), JOHN F. HARROD (TOMLINSON EMERITUS PROFESSOR OF CHEMISTRY), MARIO ONYSZCHUK, DONALD PATTERTON (OTTO MAASS EMERITUS PROFESSOR OF CHEMISTRY), ARTHUR S. PERLIN (E.B. EDDY EMERITUS PROFESSOR OF INDUSTRIAL CHEMISTRY), LEON E. ST.-PIERRE**

**Professors — IAN S. BUTLER, TAI-HANG CHAN, B. JIK CHIN, ADI EISENBERG (OTTO MAASS PROFESSOR OF CHEMISTRY), BYUNG CHAN EU, PATRICK G. FARRELL, DENIS F.R. GILSON, DAVID N. HARPP, ALAN HAY, JAMES J. HOGAN, GEORGE JUSTR, ROBERT H. MARCHEAULT (E.B. EDDY PROFESSOR OF INDUSTRIAL CHEMISTRY), LEON E. ST.-PETER, RICHARD H. VAUGHN (WILLIAM C. MACDONALD PROFESSOR OF CHEMISTRY), ROBERT H. MARCHEAULT (E.B. EDDY PROFESSOR OF INDUSTRIAL CHEMISTRY), WILLIAM C. PURDY (WILLIAM C. MACDONALD PROFESSOR OF CHEMISTRY), DAVID RONIS, RYAN C. SANCHEZ, ALAN G. SHAVER, MICHAEL ANTHONY WHITEHEAD**

**Associate Professors — MARK P. ANDREWS (ON LEAVE 1998), DAVID H. BURNS, MASAD J. DAMHA, WILLIAM C. GALLEY, ARTHUR E. GROSSER, ROMAS KAZLAUSKAS, R. BRUCE LENNOX, JOAN POWER**
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, development and quality control. Many federal and provincial departments and agencies 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 students 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 160-121/111 or -120/110, Biology 177-111, Physics 198-131/142, 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 56 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.

### CORE CURRICULUM OF REQUIRED COURSES

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<tr>
<th>Level</th>
<th>Course (department)</th>
<th>Credits</th>
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<tbody>
<tr>
<td>200 Level</td>
<td>Chemistry (180)</td>
<td>212(4)<em>, 213(3), 281(3), 222(4)</em>, 273(1), 277(3)</td>
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<tr>
<td></td>
<td>Physics (198)</td>
<td>242(2)</td>
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<td></td>
<td>Math (189)</td>
<td>133(3)<em>, 222(3)</em></td>
</tr>
<tr>
<td>300 Level</td>
<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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<td></td>
<td>Math (189)</td>
<td>315(3)</td>
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### HONOURS AND MAJORS

#### HONOURS

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

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

### HONOURS IN CHEMISTRY

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

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

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

The Materials Option of Honours in Chemistry is in the process of revision. 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**
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**
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**
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**
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 308-102 or 308-202, will be required during U1 for students who have no previous introduction to computer programming.

**FACULTY PROGRAM IN CHEMISTRY AND BIOLOGICAL SCIENCES** (56 credits)
Chemistry 180-212, 222 or equivalent, 180-204 and 214, or 213 and 355, 201 or 281, 277, 301 or 381, 345, 367 and 377, 302. Mathematics 189-222, 315. Physics 198-242. Nine additional credits from any of the following: Chemistry 180-331, 352, 363, 382, 355, 392, 393 and any 400-level courses in Chemistry for which the prerequisites are satisfied.

**FACULTY PROGRAM IN CHEMISTRY AND BIOLOGICAL SCIENCES** (56 credits)

**FACULTY PROGRAM IN CHEMISTRY AND MATHEMATICS** (55 credits)

Please refer to the Mathematics and Statistics section of this Calendar for the Faculty program in Mathematics, Chemistry and Physics.

**MINOR IN CHEMICAL ENGINEERING**
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: 189-314, 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 courses not offered in 1998-99.
- 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 180-110.) A study of the fundamental principles of atomic structure, valence theory and periodic table.

Professor Kakkar
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.

TBA

**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 180-110.) 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.

TBA

**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 180-120.) A study of the fundamental principles of physical chemistry. Laboratory: (2 1/2 hours). Illustrative experiments.

NOTE: Each lab section is limited enrolment.

Professor Sanctuary and Dr. Black

**180-121A GENERAL CHEMISTRY - PHYSICAL & ENGINEERING.** (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 180-120.) 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 and Dr. Black

**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.)

**180-160B THE WORLD OF CHEMISTRY: PART II.** (3) (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 aspects of chemical technology including publishing of scientific articles, rocketry, chemistry of space travel; materials (metals, ceramics, wood, plastic); household chemistry; cosmetics, energy including nuclear; water (acid rain; pollution); plastics; genetic engineering chemistry; forensic science. Professors Harpp, Fenster and Schwarz

**180-170B THE WORLD OF CHEMISTRY: PART III.** (3) (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 at-
mosphere: the greenhouse effect, and acid rain, and d) scientific ethics in research and publication. Professors Butler, Harpp, Hogan and Lennox

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.

Dr. Lebuis

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 Grosser

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 ORGANIC CHEMISTRY I. (4) (3 lectures and Laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 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 (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 189-190 or 191-192 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 other topics.

Professor Ronis

180-214B PHYSICAL CHEM./BIOL. SCI. II. (3) (3 lectures) (Prerequisites: 180-212 or 180-213 or 180-214.) 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 Wilson

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

180-222A,B,T ORGANIC CHEMISTRY II. (4) (3 lectures and laboratory) (Prerequisite: 180-212.) Modern spectroscopic techniques for structure determination. The chemistry of alkyl halides, alcohols, ethers, carbonyl compounds and amines with special attention to mechanistic aspects. Special topics.

Registrar

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

Professor Purdy

180-257D 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 and Ms. Foz

180-273B 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.) (Prerequisite: 180-212.) Order, molecularity, reaction mechanisms and rate constants. Determination of order, effect of temperature on rate, activated state theory. Collision theory. Reactions in solution, homogeneous catalysis, upper atmosphere kinetics, drug kinetics.

Professor Grosser

180-277B CLASSICAL METHODS OF ANALYSIS. (3) (2 lectures and 4 hours laboratory) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. For Chemistry Honours and Majors only.) Qualitative and quantitative analysis. A survey of classical methods of analysis including theory and practice of semimicro qualitative analysis and representative gravimetric and volumetric methods.

NOTE: Each lab section is limited enrolment.

Professor Purdy and Ms. Foz

180-281A INORGANIC CHEMISTRY I. (3) (3 lectures) (Prerequisites: 180-110 or 111 and 120 or 121 or equivalent. For Honours and Major Chemistry students.) (Not open to students who have taken or plan to take 180-210.) 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 Kakkar

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.) The chemistry of the transition metals and the properties of coordination compounds from the viewpoint of structural, bonding, chemical, mechanistic and spectroscopic behaviour. The biochemical and pollution aspects of transition metal chemistry.

Dr. Lebuis

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

Professor Lennox

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 Major in chemistry.) An advanced laboratory with experiments related 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

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 instructor, 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 Arndt 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.) 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 Arndt

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 180-362.) 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 Arndt, Farrell and Dr. Finkenbine

180-393A,B PHYSICAL CHEMISTRY LAB II. (2) (3 hours) (Prerequisites: 180-273, 180-363.) Selected experiments to illustrate physico-chemical principles more advanced than those of 180-363. NOTE: Each lab section is limited enrolment.

Professor Galley and Dr. Wilczek

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 Damha and Dr. Gour

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)

180-455A POLYMER CHEMISTRY. (3) (Prerequisites: 180-213. Corequisite 180-273. For Honours and Major students.) 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: 180-490. Registration by departmental permission only.) 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.) 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

180-531AChemistry 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 taken. Advanced course in 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. Primarily for Honours Chemistry students. Not open to students who have taken 180-452.) The correlation of theory with physical measurements or organic systems; an introduction to photochemistry; solvent and substituent effects on organic reaction rates, etc.; reaction mechanisms. 

Professor Chin

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) (Prerequisite: 180-367 and 180-377)

180-572B SYNTHETIC ORGANIC CHEMISTRY. (3) (3 lectures) (Prerequisite: 180-381) 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.) Kinetic laws, measurement of reaction rates, transition state and collision theory. Elementary reactions in gas, solution and solid phases and on surfaces. Reaction mechanisms, laser techniques, molecular beams, chemiluminescence, explosions. Extensive use of computers to simulate the kinetic behaviour of chemical systems. 

Professor Grosser

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 AND DISPERSED SYSTEMS. (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; adsorptants; 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 CHEMISTRY. (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

Inorganic Chemistry Staff

180-593B STATISTICAL THERMODYNAMICS. (3) (3 lectures; research project) (Prerequisite: 180-345. Recommended: 180-355.)

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 multiwavelength detector systems. 

Professors Power and Salin

11.7 Cognitive Science

Dr. Tom Shultz, Program Director

Telephone: (514) 398-6139/6150

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)

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

104-590 (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)

McConnell Engineering Building, Room 318
3480 University Street
Montreal, QC H3A 2A7
Telephone: (514) 398-7071
Fax: (514) 398-3883

Director — DENIS THÉRIEN
Emenius Professor — CHRISTOPHER PAIGE

Professors — DAVID AVIS (ON LEAVE, WINTER 1999), LUC DEVROYE, TIM H. MERRETT, MONROE M. NEWBORN (ON LEAVE), PRAKASH PANANGADEN, DENIS THÉRIEN, GODFREY T. TOUSSAINT

Associate Professors — NATHAN FRIEDMAN, LAURIE HENDREN, NAZIM MADHAVJI, GERALD RATZER, CARL TROPPER, SUE WHITESIDES

Assistant Professor — GREGORY DUDEK

Lecturer — ALAN GREENBERG

Adjunct Professors — RENATO DE MORI, 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 and operating systems, the simulation of 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, parallel computer systems (ACAPS), software engineering, database systems, mobile robotics, and cellular automata.

The teaching facility consists of a network of over 30 Pentium workstations running the Linux operating system, 25 Pentium workstations running Window/NT, 4 SGI graphics workstations and 8 IBM RS/6000 workstations. 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.

The School of Computer Science offers a Majors program and an Honours program through the Faculty of Science, and a Minor program through the Faculties of Arts, Science, and Engineering. In conjunction with the Department of Mathematics and Statistics, the School offers a Joint Honours program, a Joint Majors program and two Faculty programs through the Faculty of Science. Special programs involving Computer Science are also available in the Faculties of Management, Engineering, and Music. For further details, consult the sections in the Graduate Studies Calendars of these Faculties.

The School's courses are available as electives to Engineering students. Engineering students interested in a Minor in Computer Science should consult "Minor Programs and Choice of Electives or Complementary Courses" which can be found in the Faculty of Engineering section.

An industrial internship year is available to Computer Science students. IYES, the Internship Year Program for Engineering and Science, is a pre-graduate work experience program for Computer Science students normally between their U2 and U3 years. See the Faculty of Engineering section for further information on IYES.

MINOR PROGRAM IN COMPUTER SCIENCE (24 credits)

The Computer Science Minor may be taken in conjunction with any program in the Faculties of Science and Engineering (with the exception of the other programs based on Computer Science) with the approval of the Adviser of the student's main program and the School of Computer Science. At the time of registration in the penultimate year, students must declare their intent to receive a Computer Science Minor and approval must be given by the School for the particular sequence of courses the student wishes to call the Computer Science Minor. All courses must be passed with a grade of C or better.

Students may receive credit towards their Computer Science Minor by taking certain approved courses outside the School of Computer Science. These courses must have a high computer science content. A student will not be permitted to receive more than six credits from such courses. These courses must be approved by the School of Computer Science in advance.

If a student's Major program requires Computer Science courses, up to six credits of Computer Science courses may be used to fulfill both Major and Minor requirements.

Required Courses (12 credits)

308-202A,B (3) Introduction to Computing I
308-203A,B (3) Introduction to Computing II
308-273A,B (3) Principles of Assembly Languages
308-302A,B (3) Programming Languages and Paradigms

Complementary Courses (12 credits)

selected from:

308-305A (3) Computer System Architecture
308-310B (3) Computer Systems and Organization
308-335B (3) Software Engineering Methods
308-350A (3) Numerical Computing
or 189-317A (3) Numerical Analysis

308-360A (3) Algorithm Design Techniques
308-420A (3) Files and Databases
308-421B (3) Introduction to Database Systems
308-424A (3) Topics in Artificial Intelligence I
308-426B (3) Automated Reasoning
308-433A (3) Personal Software Engineering
308-505A (3) High-Performance Computer Architecture
308-506B (3) Advanced Analysis of Algorithms
308-507A (3) Computational Geometry
308-520B (3) Compiler Design
308-524B (3) Theoretical Found. of Prog. Languages
308-530A (3) Formal Languages
308-534B (3) Team Software Engineering
308-535A (3) Computer Networks
308-538B (3) Person-Machine Communication
308-540B (3) Matrix Computations
308-557B (3) Fundamentals of Computer Graphics
308-560A (3) Graph Algorithms and Applications
308-566A (3) Computer Methods in Operations Research
308-573A,B (3) Microcomputers
308-575A (3) Fundamentals of Distributed Algorithms

or from courses outside of the School approved by the adviser, to a maximum of 6 credits.

FACULTY PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE

See the Mathematics and Statistics section of this Calendar for complete program information.

FACULTY PROGRAM IN MATHEMATICS, STATISTICS AND COMPUTER SCIENCE

See the Mathematics and Statistics section of this Calendar for complete program information.

MAJOR PROGRAM IN COMPUTER SCIENCE (60 credits)

To enter the program, students must have completed 189-140 and 189-141, or their equivalents. 189-133, or its equivalent, may be taken prior to entry or concurrently with 308-250 during the first semester in the program. Freshman Program students interested
in Computer Science should also take 308-102. A student entering with insufficient programming background may take 308-202 but it will not count for program credit.

**Required Courses** (42 credits)

- 308-250A (3) Introduction to Computer Science
- 308-251A,B (3) Data Structures and Algorithms
- 308-273A,B (3) Principles of Assembly Languages
- 308-302A,B (3) Programming Languages and Paradigms
- 308-305A (3) Computer System Architecture
- 308-310B (3) Computer Systems and Organization
- 308-330A (3) Theoretical Aspects of Computer Science
- 308-350A (3) Numerical Computing
- 308-360A (3) Algorithm Design Techniques
- 189-222A,B (3) Calculus III
- 189-223A,B (3) Linear Algebra
- 189-240A (3) Discrete Structures and Computing
- 189-323A,B (3) Probability Theory
- 189-340B (3) Abstract Algebra and Computing

**Complementary Courses** (18 credits)

15 credits from:
- 308-335B (3) Software Engineering Methods
- 308-420A (3) Files and Databases
- 308-421B (3) Introduction to Database Systems
- 308-424A (3) Topics in Artificial Intelligence I
- 308-426B (3) Automated Reasoning
- 308-433A (3) Personal Software Engineering
- 308-505A (3) High-Performance Computer Architecture
- 308-506B (3) Advanced Analysis of Algorithms
- 308-507A (3) Computational Geometry
- 308-520B (3) Compiler Design
- 308-524B (3) Theoretical Foundations of Prog. Languages
- 308-531B (3) Theory of Computation
- 308-534B (3) Team Software Engineering
- 308-535A (3) Computer Networks
- 308-538B (3) Person-Machine Communication
- 308-540B (3) Matrix Computations
- 308-557B (3) Fundamentals of Computer Graphics
- 308-560A (30) Graph Algorithms and Applications
- 308-566A (3) Computer Methods in Operations Research
- 308-573A,B (3) Microcomputers
- 308-575A (3) Fundamentals of Distributed Algorithms
- 304-323A,B (3) Digital System Design
- 304-426A,B (3) Microprocessor Systems
- 304-531B (3) Real Time Systems
- 304-548A (3) Introduction to VLSI Systems

3 credits from Mathematics selected from:
- 189-314A,B (3) Advanced Calculus
- 189-315A,B (3) Ordinary Differential Equations
- 189-322B (3) Dynamical Systems, Fractals and Chaos
- 189-324A,B (3) Statistics
- 189-348A (3) Topics in Geometry
- 189-407B (3) Dynamic Programming
- 189-417A (3) Mathematical Programming
- 189-591B (3) Mathematical Logic I

**JOINT MAJOR PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE**

See the Mathematics and Statistics section of this Calendar for complete program information.

**HONOURS PROGRAM IN COMPUTER SCIENCE** (72 credits)

Honours students must maintain a CGPA of 3.0 and must have at least this average upon graduation as well.

**Required Courses** (45 credits)

all Major Program required courses, plus

- 308-400A,B (3) Technical Project and Report

**Complementary Courses** (27 credits)

24 credits from Major Program complementary courses

3 credits from Major Program complementary courses in Mathematics

**JOINT HONOURS PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE**

See the Mathematics and Statistics section of this Calendar for complete program information. Students must consult an Honours adviser in both departments.

**MINOR IN COGNITIVE SCIENCE**

Students following Major or Honours programs in Computer Science may want to consider the Minor in Cognitive Science.

**COURSE DESCRIPTIONS**

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

- Denotes courses not offered in 1998-99
- Denotes courses with limited enrolment

**Notes:**

A. A student cannot receive credit for both 308-202 and 308-208.
B. 308-203 and 308-250 are considered to be equivalent from a prerequisite point of view, and may not both be taken for credit.
C. A student cannot receive credit for both 308-330 and 308-530.
D. 308-203 and 308-250 are considered to be equivalent from a prerequisite point of view, and may not both be taken for credit.
E. A student who does well in 308-102 then has the background to do 308-250.
F. Management students may not receive credit for both 308-202 and 635-300. Likewise, they may not receive credit for both 308-202 and 635-301.

**308-102A COMPUTERS AND COMPUTING.** (3) (2 hours lectures; 2 hours laboratory) (Prerequisite: high school level mathematics course on functions.) (For restrictions, see Note D.) A course for students with no previous knowledge of computer science who may be interested in further study. The structure of a computer; methodologies for problem solving – algorithm design and data structures, the limitations of computers. An introduction to programming in a high level language. **Professor Friedman**

**308-199A EXCURSIONS IN COMPUTER SCIENCE.** (3) (3 hours) (Prerequisite: high school mathematics) (FYS - for first year students only, maximum 25.) This is a seminar format course intended for freshman and other beginning students. The topics are chosen to encourage critical discussion of fundamental ideas. Possible topics are computability, complexity, geometry, vision, AI, patern recognition, machine models, cryptography and security and social implications of computing. **Professor Toussaint**

**308-202A,B INTRODUCTION TO COMPUTING I.** (3) (3 hours) (Prerequisite: a CEGEP level mathematics course.) (For restrictions, see Notes A and F.) Overview of components of microcomputers, the internet, design and implementation of programs using a modern high-level language, and introduction to modular software design and debugging. Programming concepts are illustrated using a variety of application areas. **Professor Hendren**

**308-203A,B INTRODUCTION TO COMPUTING II.** (3) (3 hours) (Prerequisite: 189-133 and 308-202.) (For restrictions, see Notes B and F.) Basic data structures. Representation of arrays, stacks, and queues. Linked lists and their applications to binary trees.
308-206A PROGRAMMING TECHNIQUES. (1) (3 hours) (Corequisite: 308-203 or 308-250) Brief but comprehensive overview of programming in C. Language constructs, systems programming.

Staff

308-208A,B COMPUTERS IN ENGINEERING. (3) (3 hours) (Prerequisite: differential and integral calculus. Corequisite: linear algebra: determinants, vectors, matrix operations.) (For restrictions, see Note A.) Introduction to computer systems. Concepts and structures for high level programming. Elements of structured programming using FORTRAN 90 and "C". Assignments in both mainframe and microcomputer environment. Numerical algorithms such as root finding, numerical integration and differential equations. Non-numerical algorithms for sorting and searching.

Professors Avis and Friedman

308-250A INTRODUCTION TO COMPUTER SCIENCE. (3) (3 hours) (Prerequisites: Familiarity with a high level programming language and CEGEP level Math.) (For restrictions, see Note B.) An introduction to the design of computer algorithms, including basic data structures, analysis of algorithms, establishing correctness of programs and program testing. Overview of topics in computer science.

Professor Friedman and Panangaden

308-250A INTRODUCTION TO COMPUTER SCIENCE. (3) (3 hours) (Prerequisites: Familiarity with a high level programming language and CEGEP level Math.) (For restrictions, see Note B.) An introduction to the design of computer algorithms, including basic data structures, analysis of algorithms, establishing correctness of programs and program testing. Overview of topics in computer science.

308-273A,B PRINCIPLES OF ASSEMBLY LANGUAGES. (3) (3 hours) (Prerequisite: 308-250 or 308-203.) (For restrictions, see Notes B and E.) Design and analysis of algorithms. Complexity of algorithms. Data structures. Introduction to graph algorithms and their analysis.

Professor Devroye

308-273A,B PRINCIPLES OF ASSEMBLY LANGUAGES. (3) (3 hours) (Prerequisite: 308-202 or equivalent, or 308-250.) Computer structure, machine instruction execution, addressing techniques, digital representation of data. Assemblers, cross-assemblers and simulators. Interrupts. Input and output programming and devices. System support macros and software. Program segmentation and linkage.

Professor Friedman and Panangaden

308-302A,B PROGRAMMING LANGUAGES AND PARADIGMS. (3) (3 hours) (Prerequisite: 308-250 or 308-203) Programming language design issues and programming paradigms. Binding and scoping, parameter passing, lambda abstraction, data abstraction, type checking, Functional and logic programming.

Professors Friedman and Panangaden

308-305A COMPUTER SYSTEM ARCHITECTURE. (3) (3 hours) (Prerequisite: 308-273) A functional description of computer hardware. Hardware concepts and current issues. Memories, memory hierarchies and dynamic address translation. CPU characteristics, performance factors, overlap, parallel and pipeline systems. Microprogramming. Interrupt mechanism and clocks. Input/Output devices including telecommunications.

Mr. Greenberg

308-310B COMPUTER SYSTEMS AND ORGANIZATION. (3) (3 hours) (Prerequisite: 308-305) Control and scheduling of large information processing systems. Operating system software – resource allocation, dispatching, processes, access methods, job control languages, main storage management. Batch processing, multiprogramming, multiprocessor, time sharing.

Professor Tropper

308-330A THEORETICAL ASPECTS OF COMPUTER SCIENCE. (3) (3 hours) (Prerequisite: 308-251. For Major and Honours students.) (For restrictions, see Note C.) Mathematical models of computers, finite automata, Turing machines, counter machines, push-down machines, computational complexity.

Professor Thérien

308-335B SOFTWARE ENGINEERING METHODS. (3) (3 hours) (Pre/co-requisite: 308-302A.) This course in software engineering teaches basic concepts and methods for software development. The focus is on engineering and analysing requirements, design and code. Small software development exercises will be given where students would learn how to apply different methods.

Professor Gao


Professor Whitesides

308-400A,B TECHNICAL PROJECT AND REPORT. (3) (3 hours) (Prerequisites: 15 Computer Science credits. For Honours students.) A computer related project, typically a programming effort, along with a report will be carried out in cooperation with a staff member in the School of Computer Science.

Staff

308-420A FILES AND DATABASES. (3) (3 hours) (Prerequisite: 308-302.) Language essentials for file processing; sequential files; sorting, updating, tree files; direct files; files of structured data; basics of relational databases.

Professor Merrett

308-421B INTRODUCTION TO DATABASE SYSTEMS. (3) (3 hours) (Prerequisite: 308-420.) Database concepts. The relational, hierarchical and network models of data. Uses of implementations of the three data models. Data description languages. Data manipulation languages. Security, integrity and concurrency problems in databases.

Staff

308-424A TOPICS IN ARTIFICIAL INTELLIGENCE I. (3) (3 hours) (Prerequisite: 308-203 or -250 or equivalent.) Introduction to search methods in AI problems. Mechanical theorem-proving techniques, game playing by computers, the minimax and alpha-beta algorithms, and heuristic approaches to state space search problems.

Professor Newborn

308-426B AUTOMATED REASONING. (3) (3 hours) (Prerequisites: 308-424; or 308-302 with 189-340.) Representing and reasoning with knowledge. The case for logics. Introduction to Logic Programming and, for example, PROLOG. Introduction to some Artificial Intelligence applications of Logic Programming: Meta-interpreters, Expert Systems and their implementation, Planning, Natural Language Processing, Machine Learning.

Staff


Staff

308-433A PERSONAL SOFTWARE ENGINEERING. (3) (3 hours) (Prerequisite: 308-335B.) This software engineering course teaches students how to develop, manage and improve their personal processes for developing software. Selected software development practices are introduced through 10 small programming exercises. The students then use these programs to analyse data on their personal performance, plan homework projects, and guide their process improvement.

Professor Madhavji

308-505A HIGH-PERFORMANCE COMPUTER ARCHITECTURE. (3) (3 hours) (Prerequisites: 308-302 and 308-305 or equivalent.) Basic principles and techniques in the design of high-performance computer architecture. Topics include memory architecture; cache structure and design; virtual memory structures; pipelined processor architecture; pipeline control and hazard resolution; pipelined memory structures, interrupt, evaluation techniques; vector processing; RISC vs. CISC architectures; general vs. special purpose architectures; VLSI architecture issues.

Professor Gao
308-506B ADVANCED ANALYSIS OF ALGORITHMS. (3) (3 hours) (Prerequisite: 308-330 or 308-360 or 308-405 or 308-431.) The study of computational complexity and intractability: Cook's Theorem, NP-completeness, oracles, the polynomial hierarchy, lower bounds, heuristics, approximation problems.

Professor Whitesides

308-507A COMPUTATIONAL GEOMETRY. (3) (3 hours) (Prerequisite: 308-360 or 308-405 or equivalent or co-requisite 506.) Problems in computational geometry; worst-case complexity of geometric algorithms; expected complexity of geometric algorithms and geometric probability; geometric intersection problems; nearest neighbor searching; point inclusion problems; distance between sets; diameter and convex hull of a set; polygon decomposition; the Voronoi diagram and other planar graphs; updating and deleting from geometric structures.

Professor Toussaint

308-520B COMPILER DESIGN. (3) (3 hours) (Prerequisites: 308-273 and 308-302.) The structure of a compiler. Lexical analysis. Parsing techniques. Syntax directed translation. Run-time implementation of various programming language constructs. Introduction to code generation for an idealized machine. Students will implement parts of a compiler.

Professors Friedman and Hendren

308-524B THEORETICAL FOUNDATIONS OF PROG. LANGUAGES. (3) (3 hours) (Prerequisite: 308-302.) Operational and denotational semantics of programming languages. Equivalence theorems for first-order languages. Lambda calculus. Type inference, typed lambda calculus. Polymorphism. Elements of domain theory and fixed-point induction.

Professors Friedman and Panangaden

308-530A FORMAL LANGUAGES. (3) (3 hours) (Prerequisite: 308-203.) (For restrictions, see Note C.) The definition of a language. Grammars. Finite automata and regular languages. Context-free languages. Pushdown automata. Turing machines and undecidable problems. Context sensitive and phrase-structure languages.

Professor Thérien


Professor Thérien

308-534B TEAM SOFTWARE ENGINEERING. (3) (3 hours) (Prerequisite: 308-433 or equivalent.) Team-work and team-processes for evolving software systems. Guided by defined processes, project teams will elicit new requirements, design code and test an enhanced software system. Team members will play various technical and managerial roles in carrying out their software project.

Professor Madhavji

308-535A COMPUTER NETWORKS. (3) (3 hours) (Prerequisite: 308-310,) Exposition of the first four layers of the ISO model for computer network protocols, i.e., the physical, data, network, and transport layers. Basic hardware and software issues with examples drawn from existing networks, notably SNA, DECnet, and ARPA.net.

Professor Tropper

308-538B PERSON-MACHINE COMMUNICATION. (3) (3 hours) (Prerequisite: 308-424 or -425 or -426)

308-540B MATRIX COMPUTATIONS. (3) (3 hours) (Prerequisite: 189-327 or 308-350)

308-557B FUNDAMENTALS OF COMPUTER GRAPHICS. (3) (3 hours) (Prerequisites: 189-223, and 308-251 or -302.) The study of fundamental mathematical, algorithmic and representational issues in computer graphics. The topics to be covered are: overview of graphics process, projective geometry, homogeneous coordinates, projective transformations, quadtrees and tensors, line-drawing, surface modelling and object modelling reflectance models and rendering, texture mapping, polyhedral representations, procedural modeling, and animation.

Professor Dudek

308-560A GRAPH ALGORITHMS AND APPLICATIONS. (3) (3 hours) (Prerequisite: 308-360 or 308-405 or 308-341 or 389-343) Algorithms for connectivity, partitioning, clustering, colouring and matching, isomorphism testing. Algorithms for special classes of graphs. Layout and embeddings algorithms for graphs and networks. (Awaiting University Approval)

Professor Whitesides

308-566A COMPUTER METHODS IN OPERATIONS RESEARCH. (3) (3 hours) (Prerequisites: 308-360 or 308-405 and 189-223) Use of the computer in solving deterministic problems in operations research. Linear programming and extensions. Efficient methods for large problems. Transportation problems. Network models. Integer programming.

Professor Avis

308-573A,B MICROCOMPUTERS. (3) (3 hours) (Prerequisite: 308-305,) Characteristics and internal structure of microcomputers and workstations. Architectures of current CISC and RISC microprocessors. Assembler and machine languages for microcomputers. System software. Applications for single and networked microcomputers. Students will be assigned "hands-on" projects.

Professor Ratzer

308-575A FUNDAMENTALS OF DISTRIBUTED ALGORITHMS. (3) (3 hours) (Prerequisite: 308-310.) Study of a collection of algorithms which are basic to the world of concurrent programming. Distinction of algorithms from the following areas: termination detection, deadlock detection, global snapshots, clock synchronization, fault tolerance (byzantine and self-stabilizing systems).

Students will implement algorithms on the BBN butterfly and will present papers on topics in these areas.

Professor Tropper

11.9 Dietetics and Human Nutrition (382)

Please see the School of Dietetics and Human Nutrition entry in the Faculty of Agricultural and Environmental Sciences section for further information about the School's other courses, programs and academic staff.

382-307B HUMAN NUTRITION. (3) (Prerequisites: 180-212 and 177-201 or equivalents. Credit cannot be obtained for both 382-307 and 382-207.) Cellular and organismal aspects of nutrition with emphases on biochemical and physiological roles of carbohydrates, lipids, proteins, minerals and vitamins in disease prevention and promotion of optimal health.

Professors Jones and Wykes

11.10 Earth and Planetary Sciences (186)

Frank Dawson Adams Building, Room 238
3450 University Street
Montreal, QC, H3A 2A7
Telephone: (514) 398-6767
Fax: (514) 398-4680
http://www.eps.mcgill.ca

Chair — A.E. (WILLY) WILLIAMS-JONES
Emeritus Professors — WALLACE H. MACLEAN, COLIN W. STEARN
Professors — JAFAR ARRANI-HAMED, RON DOIG (DAWSON PROFESSOR OF GEOLOGY), DON FRANCIS, ANDREW J. HYNES, OLIVIA G. JENSEN, ROBERT F. MARTIN, ERIC W. MOUNTJOY (WILLIAM E. LOGAN PROFESSOR OF GEOLOGY), ALFONSO MUCCI, A.E. (WILLY) WILLIAMS-JONES
Associate Professors — DON BAKER, HOJATOLLAH VALI (DIRECTOR, ELECTRON MICROSCOPY CENTRE)
Assistant Professor — JEANNE PAQUETTE

The domain of Earth and Planetary Sciences includes the solid Earth and its hydrosphere and extends to the neighboring terrestrial planets. It is a multidisciplinary field in which the principles of chemistry, physics, and mathematics are applied to the rich problems of the real world in order to understand how planets like the Earth work; in the past, the present, and the future.

Career opportunities are many and varied for graduates in the Earth and Planetary Sciences. There is presently a very strong de-
mand for graduates with expertise in geology. Students graduating in this field are recruited for employment in the mining and petroleum industries, and in the environmental sector. In addition, government geological surveys employ geoscientists. During the summer months undergraduate students are generally able to obtain employment from industry and government agencies, providing them with both financial benefits and first-hand geoscientific experience. Career opportunities in planetary science are presently limited to universities and research organizations.

The Department has a full-time staff of 11 professors and one faculty lecturer. There are approximately 50 graduate and 50 undergraduate students. Classes are therefore small at all levels, resulting in an informal and friendly atmosphere throughout the Department in which most of the faculty and students interact on a first name basis. Emphasis is placed equally on quality teaching and research providing undergraduate students with a rich and exciting environment in which to learn and explore. The Department offers two entrance scholarships of $1,000 each to new undergraduate students. To be considered for one of these scholarships, new applicants should forward a copy of their transcript directly to the Department Chair.

The undergraduate curriculum is designed to provide both a rigorous foundation in the physical sciences and the flexibility to create an individualized program in preparation for careers in industry, teaching, or research. In addition to the Major and Honours undergraduate programs, the Department also offers a Joint Major in Physics and Geophysics which provides a rigorous mathematics and physics preparation and a geological background in the geosciences.

The Minor in Geological Sciences offers Science students from other departments the opportunity to obtain exposure to the Earth Sciences while the Minor in Geochemistry is oriented towards Chemistry Major students who want to see the application of chemistry to problems in the Earth and Planetary Sciences.

Students interested in any of the programs should inquire at Room 238, Frank Dawson Adams Building, (514) 398-6767, or should consult the Undergraduate Director, Don Francis, Room 311, Frank Dawson Adams Building, (514) 398-4885, if they do not have an advisor.

MINOR PROGRAM IN EARTH AND PLANETARY SCIENCES (25 credits)

Required Courses (7 credits)

186-210A (3) Mineralogy
186-212B (4) Petrology

Complementary Courses (18 credits)

186-201A (3) Understanding Planet Earth
or 186-233A (3) Earth & Life History

15 credits selected from:

186-203B (3) Structural Geology I
186-231E (2) Field School I
186-243A.B (3) Environmental Geology
186-334B (3) Invertebrate Palentology & Evolution
186-350B (3) Tectonics
186-430B (3) Geology of Energy Sources
186-451B (3) Hydrothermal Mineral Deposits
186-452A (3) Mineral Deposits
186-542A (3) Chemical Oceanography
177-352B (3) Vertebrate Evolution

Other Earth and Planetary Sciences courses may be substituted with permission.

MINOR PROGRAM IN GEOCHEMISTRY (25 credits)

Required Courses (10 credits)

186-210A (3) Mineralogy
186-212B (4) Petrology

Complementary Courses (15 credits)

15 credits selected from:

186-220B (3) Principles of Geochemistry
186-243A.B (3) Environmental Geology
186-501A (3) Crystal Chemistry
186-519A (3) Isotope Geology
186-542A (3) Chemical Oceanography
186-545B (3) Low-Temperature Geochemistry & Diagenesis

MAJOR AND HONOURS PROGRAMS IN EARTH AND PLANETARY SCIENCES

Common U1 Year:

Required Courses (27 credits)

186-210A (3) Mineralogy
186-220A (3) Principles of Geochemistry
186-233A (3) Earth and Life History
189-222A (3) Calculus III
186-203B (3) Structural Geology
186-212B (4) Petrology
186-312B (3) Spectroscopy of Minerals
186-320B (3) Elementary Earth Physics
186-231C (2) Field School I

Note: Students intending to take the Honours Planetary Sciences Program in U2 must also take 189-223B Linear Algebra.

Note: Students who have not had the following courses or their equivalents in CEGEP or the Freshman Program may be required to take them as electives:

186-201A Introduction to Geology
189-133B Vectors, Matrices and Geometry
189-222A (3) Calculus III
308-202A,B Introduction to Computing I

U2 and U3: MAJORS PROGRAM (39 additional credits)

Students who began their programs prior to 1996-97 should refer to the 1995-96 Calendar for program requirements.

Undergraduate Director: Don Francis, FDA 311, (514) 398-4885

Required Courses (24 credits)

186-215A (3) Analysis of Geological Data I
186-350B (3) Tectonics
186-423B (3) Igneous Petrology
186-425A (3) Depositional Environments & Sequence Stratigraphy
186-445B (3) Metamorphic Petrology
186-452A (3) Mineral Deposits
186-519A (3) Isotope Geology
186-331C (3) Field School II
or 186-341C (3) Field School III

Complementary Courses (15 credits)

To be approved by EPS Academic Advisor

U2 and U3: HONOURS IN EARTH SCIENCES PROGRAM

(CGPA ≥ 3.2) (48 additional credits)

Required Courses (39 credits)

186-215A (3) Analysis of Geological Data I
186-350B (3) Tectonics
186-423B (3) Igneous Petrology
186-425A (3) Depositional Environments & Sequence Stratigraphy
186-445B (3) Metamorphic Petrology
186-452A (3) Mineral Deposits
186-480D (6) Honours Research Project
186-519A (3) Isotope Geology
186-331C (3) Field School II
or 186-341C (3) Field School III
180-301B (3) Inorganic Chemistry II
189-314A (3) Advanced Calculus
189-315A (3) Ordinary Differential Equations

Complementary Courses (9 credits)

To be approved by EPS Academic Advisor

U2 and U3: HONOURS IN PLANETARY SCIENCES PROGRAM

(CGPA ≥ 3.2) (50 additional credits)

Required Courses (41 credits)

186-330B (3) Earthquakes & Earth Structure
186-350B (3) Tectonics
186-423B (3) Igneous Petrology
JOINT MAJOR PROGRAM IN PHYSICS AND GEOPHYSICS

See the Physics section for complete program information.

COURSE DESCRIPTIONS

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

- Denotes courses not offered in 1998-99.
- The following courses are without prerequisite and could be taken by students in the Faculty of Arts: 186-200A,B; 186-201A,B; 186-233A; and 186-243A,B. Other courses assume as a prerequisite completion of the courses required in the Sciences option of the CEGEP curriculum.

186-200A, B THE TERRESTRIAL PLANETS. (3) (3 hours lectures) A comparative survey of the planets of our solar system with an emphasis on the terrestrial planets and their implications for the Earth as a planet. Topics include: structure and origin of the solar system, meteorites, and comparisons of the terrestrial planets in terms of their rotational properties, magnetic fields, atmospheres, surface histories, internal structure, chemical composition, volcanism, and tectonics. Staff


186-202A INTRODUCTION TO GEOLOGY – LABORATORY. (1) (3 hours laboratory) (Corequisite: 186-201A.) Identification of minerals and rocks; interpretation of geological maps and cross-sections. Staff

186-203B STRUCTURAL GEOLOGY I. (3) (2 hours lectures, 3 hours laboratory) Primary igneous and sedimentary structures, attitudes of planes and lines, stress and strain, fracturing of rocks, faulting, homogeneous strain, description and classification of folds, foliation and lineation, orthogonal and stereographic projections. Professor Hynes

186-210A INTRODUCTION TO MINERALOGY. (3) (2 hours lecture, 3 hours laboratory) Crystal chemistry and identification of the principal rock-forming and ore minerals. Elementary crystallography. Optional 2-day field trip. Professor Paquette

186-212B INTRODUCTORY PETROLOGY. (4) (3 hours lecture, 3 hours laboratory) (Prerequisite: 186-210A) Survey course of igneous, sedimentary and metamorphic rocks and the processes leading to their formation. Emphasis in the laboratory on hand-specimen description and classification, supplemented by thin sections. Professor Francis

186-215B ANALYSIS OF GEOLOGICAL DATA I. (3) (3 lectures, and problems) (Note: Credit for other statistics courses may preclude credit for this course and conversely, see "Course Overlap" on page 335.)

186-220A PRINCIPLES OF GEOCHEMISTRY. (3) (2 lectures, 3 hours laboratory) (Prerequisites: 186-201A, -210A) Basic concepts in geochemistry and the application of geochemical principles of chemistry to geological subdivisions. Particular emphasis on origin of elements, controls on their distribution in Earth and cosmos, isotopes, organic geochemistry and water chemistry. Application of phase diagrams to geology. Professors Mucci and Baker

186-231C FIELD SCHOOL I. (2) (Two-week field school in May) (Prerequisite: 186-203B, 186-212B, or equivalent.) Geological mapping of selected areas, preparation of maps, reports from field notes, aerial photographs, etc. Professor Hynes

186-233A EARTH AND LIFE HISTORY. (3) (3 lectures) Interpretation of stratified rocks; history of Earth with special emphasis on the regions of North America; outline of the history of life recorded in fossils. Staff

186-243A,B ENVIRONMENTAL GEOLOGY. (3) (3 lectures) Introduction to the relationship of geological processes and materials to the human environment; geologic hazards; hydrogeology; impacts of waste disposal, energy use, land resource development. Professor Baker or Staff

186-312A SPECTROSCOPY OF MINERALS. (3) (6 hours laboratory and relevant in-lab lectures) (Prerequisites: 186-210A) Identification of minerals with electromagnetic radiation. Optical mineralogy on thin and polished sections. Demonstrations of other spectroscopic techniques applied to the identification of minerals and to the analysis of their composition and structure. Professor Paquette

186-320B ELEMENTARY EARTH PHYSICS. (3) (3 lectures) (Corequisite: 189-222A,B) Physical properties of Earth and the processes associated with its existence as inferred from astronomy, geodesy, seismology, geology, terrestrial magnetism and thermal evolution. Professor Arkani-Hamed

186-330B EARTHQUAKES & EARTH STRUCTURE. (3) (3 lectures, tutorial as required) (Prerequisites: 186-314B, 186-320A) Corequisites: 189-319) Seismic wave theory; body waves, surface waves and free oscillations; seismicity and earthquakes; seismology and Earth's internal structure. Professor Jensen or Staff

186-331C FIELD SCHOOL II. (3) (Two-week field school in May.) Geological field study of igneous, sedimentary and metamorphic terranes of the Appalachian origin, including preparation of stratigraphic sections, and edited field notes. Staff

186-334B INVERTEBRATE PALEONTOLOGY AND EVOLUTION. (3) (2 lectures and one laboratory period) Preservation of fossils; the fossil record of invertebrates; use of fossils in stratigraphy and paleoecology; fossils in evolutionary studies. Fossils of invertebrates are studied in the laboratory. Professor Hynes

186-341C FIELD SCHOOL III. (3) (Prerequisites: 186-210A, -203B, -212B and -231E or permission of the instructor.)

186-350B TECTONICS. (3) (Prerequisites: 186-320A, Calculus III or equivalent.) Rheology of the earth, mechanics of the crust and mantle and core, convection in the mantle, evolution and kinematics and deformations of the oceanic and continental plates, thermal evolution of the earth, the unifying theory of plate tectonics. Professor Hynes or Jensen

186-401B ADVANCED ENVIRONMENTAL GEOLOGY. (3 credits, 1 lecture, 2 seminar) (Prerequisite: 186-220B or 180-204A or equivalent. Corequisite: 186-580A)

186-402C ENVIRONMENTAL FIELD SCHOOL. (2) (1 laboratory, 2 other) (Prerequisites: 186-220B or 180-204A or equivalent.)

186-405A PLANETARY GEOLOGY. (3) (3 lecture) (Prerequisites: 186-210A, -203B, -212B or permission of the instructor.)

186-423B IGNEOUS PETROLOGY. (3) (2 hours lecture, 3 hours laboratory) (Prerequisites: 186-212B, 312B)

186-425A DEPOSITIONAL ENVIRONMENTS & SEQUENCE STRATIGRAPHY. (3) (2 lecture, 3 laboratory) (Prerequisites: 186-210A, -212B) Carbonate and clastic sedimentation: Physical processes of transport and deposition, facies associations and sequences, depositional environments of modern and ancient
settings. Stratigraphic correlations, seismic and sequence stratigraphy. Basin analysis. Tectonics and sedimentation. Staff

- 186-430A GEOLOGY OF ENERGY SOURCES. (3) (2 lecture and 2 hours laboratory or seminar) (Corequisite: 186-425A or permission of the instructor.)

- 186-435A EXPLORATION & ENVIRONMENTAL GEOPHYSICS. (3) (3 hours lecture) (Prerequisites: Calculus III, Linear Algebra and 186-320A Elementary Earth Physics or equivalents.)

- 186-445B METAMORPHIC PETROLOGY. (3) (Prerequisites: 186-212B, 303A, 312B) The origin, classification and petrological significance of metamorphic rocks, from the point of view of theory, experiment and field observations. Professor Williams-Jones

- 186-451B HYDROTHERMAL MINERAL DEPOSITS. (3) (Prerequisite: 186-220B)

- 186-452A MINERAL DEPOSITS. (3) (Prerequisite: 186-312B, 220B) A systematic review of the nature and origin of the major types of metallic and non-metallic mineral deposits; typical occurrences; geographic distribution; applications to exploration. Emphasis on magmatic ores, massive sulfides, iron formations. Staff

- 186-480D HONOURS RESEARCH PROJECT. (9) (For Honours students in 3rd year.) A written proposal outlining the studies to be undertaken must be submitted to the undergraduate Student Adviser by May 1st of the U-2 year. The proposal will be reviewed by a committee and a decision forwarded by mail. If approved the investigation will be supervised by a staff member, and the results must be presented in the form of an undergraduate thesis. Staff

- 186-482A,B,D INDEP. STUDIES IN EARTH & PLANETARY SCIENCES. (3) (May not be taken concurrently with 186-480D.) Research and/or reading project enabling independent study under the guidance of qualified staff in areas of special interest to the student. A statement of the proposed project and the method of evaluation must be approved by the Department curriculum committee before commencement of the course. This statement will be included in the student's file. Staff

- 186-483D INDEP. STUDY IN ENVIRONMENTAL GEOLOGY. (3) (To be taken concurrently with 186-500D.)

- 186-501B CRYSTAL CHEMISTRY. (3) (2 hours lectures, 1 hour seminar) (Prerequisite: 180-203A or 180-213A,B) Discussion of crystal structures and compositions of important mineral groups, especially oxides, sulphides and silicates. Solid solution. Relation of structures and compositions of important mineral groups, especially oxides, sulphides and silicates. Staff

- 186-510B GLOBAL GEODYNAMICS AND GEOMAGNETISM. (3) (3 lecture) (Prerequisites: 186-320A, 189-319B or permission of the instructor. Corequisite: 186-350B.) The gravity field of the earth and planets, body and orbital dynamics the earth, moon and planets, tidal interactions of the earth-moon-sun system, deformation of the earth under static and dynamic loads, the magnetic field of the earth and planets; the magnetosphere, the external radiation belts, magnetohydrodynamic models of the core dynamo, geochemical convection in the core, fluid dynamic motions of the outer core, dynamics of the inner core. Professor Arkani-Hamed

- 186-519A ISOTOPE GEOLOGY. (3) (3 lectures) (Prerequisites: U2 core program.) Geochronology, the fractionation of the stable isotopes, and applications to petrology and mineral deposits. Professor Doig

- 186-540B PHANEROZOIC GEOLOGY OF NORTH AMERICA. (3) (2 hours lectures, 3 hours laboratory) (Prerequisite: U2 Major sequence. Corequisite: U3 Major sequence.)


- 186-545B LOW-TEMPERATURE GEOCHEMISTRY & DIAGENESIS. (3) (Prerequisites 180-203A/213B, 186-212B, -312B)

- 186-546A DIAGENESIS OF SEDIMENTARY ROCKS. (3) (2 lecture, 3 laboratory/seminars) (Prerequisites: 186-212B, -220B, -312A)

- 186-547A THERMOCHEMISTRY OF HIGH-TEMPERATURE GEOLOGICAL SYSTEMS. (3) (2 hours lectures, 3 hours laboratory) (Prerequisites 180-203/4 or 180-213, or permission of instructor.) The application of thermodynamic principles to igneous and metamorphic petrology and economic geology. Topics include but are not restricted to: solid solutions in minerals, behaviour of geological fluids, phase equilibria, flow processes, estimation of thermodynamic data.

- 186-548A MECHANISMS OF IGNEOUS PETROGENESIS. (3) (2 hours lecture, 1 hour seminar) (Prerequisite: 186-423B)

- 186-549B HYDROGEOLOGY. (3) (3 hours lecture) (Prerequisite: permission of the instructor.)

- 186-550A SELECTED TOPICS IN EARTH AND PLANETARY SCIENCES I. (3) (2 hours seminar, permission of department undergraduate adviser.) Research seminar and readings in topics concerning some aspects of current development in geological sciences.

- 186-551B SELECTED TOPICS IN EARTH AND PLANETARY SCIENCES II. (3) (2 hours seminar, permission of department undergraduate adviser.) Research seminar and readings in topics concerning some aspects of current development in geological sciences.

- 186-570B COSMOCHEMISTRY. (3) (3 hours lecture) (Prerequisites: 186-220B, -210A or permission of instructor.)

- 186-580A AQUEOUS GEOCHEMISTRY. (3) (3 hours lecture) (Prerequisites: 186-210A, 186-212B or permission of instructor.)

- 186-590B APPLIED GEOCHEMISTRY SEMINAR. (3) (3 hours seminar) (Prerequisite: permission of instructor.) Seminar course devoted to field case studies that illustrate the applications of geochemical principles to solving geologic problems. Each student will prepare and lead a class devoted to a geochemical subject of their own choosing. Professors Mucci and Williams-Jones

The following courses are offered by the Department of Earth and Planetary Sciences for Faculty of Engineering students:

- 186-221A GENERAL GEOLOGY. (3) (3 hours lecture, 3 hours laboratory) A survey course in physical geology with emphasis on engineering and economic aspects. Staff

- 186-225A PROPERTIES OF MINERALS. (1) (1 hour lecture, 1 hour laboratory) (Not open to students who have taken 186-210A) Survey of the physical and chemical properties of the main mineral groups. Discussion of their relationships to the chemical composition and structure of minerals. The practical exercises emphasize the physical and chemical properties that relate to industrial uses and environmental issues, and the identification of hand specimens. (Awaiting University Approval) Professor Paquette

11.11 Environmental Studies
Science students who are interested in studying the environment should refer to the McGill School of Environment section where they will find information concerning the Minor, the Major, and the Diploma in Environment.

Students who were enrolled in one of the Environmental Studies programs in Science may continue in that program until they receive their degree. They should refer to the Calendar for the year in which they entered the program or contact their advisor.
11.12 Experimental Medicine (516)

Experimental Medicine is a division of the Department of Medicine. Information regarding these courses may be obtained by calling the telephone numbers indicated below:

516-401 – (514) 842-1231, ext. 5738
516-502 and 516-503 – (514) 842-1231, ext. 5243 or 5833
516-504 – (514) 934-8038
516-506 – (514) 937-6011, ext. 2920
516-507 and 516-508 – (514) 398-3864
516-509 – (514) 937-6011, ext. 8093
516-510 – (514) 398-3864
516-511 – (514) 398-3466
516-512 – (514) 937-6011, ext. 8015

516-401B PHYSIOLOGY AND BIOCHEMISTRY OF ENDOCRINE SYSTEMS. (3) (Prerequisite: 177-200A and 177-201B) Offered in conjunction with the Department of Physiology. The course provides a basic knowledge of endocrine systems encompassing biosynthesis, metabolism and physiological actions of hormones. Specific topics covered are hormones of the hypothalamus, pituitary, adrenals, thyroids, parathyroids, pancreas, gut and the gonads. The role of hormones and growth factors in pregnancy and fetal development are also discussed.

Professors Mulay, Cianflone and Staff

516-502A ADVANCED ENDOCRINOLOGY – PART I. (3) (Prerequisite: 516-301A or an equivalent course.) This course is designed for U3 students who are in a major or honours program in anatomy, biology, biochemistry or physiology and for graduate students. A multidisciplinary approach will be used to teach biosynthesis and processing of hormones, their regulation, function and mechanism of action. The material will cover hypothalamic, pituitary, thyroid, atrial and adrenal hormones as well as prostaglandins and related substances.

Professors Bennett, Bateman and Staff

516-503B ADVANCED ENDOCRINOLOGY – PART II. (3) (Prerequisite: 516-502A) Study of the parathyroids, gut and pancreatic hormones and growth factors. In addition, the role of hormones and growth factors in reproduction and fetal maturation will be discussed.

Professors Bennett, Bateman and Staff

516-504A BIOLOGY OF CANCER. (3) (Prerequisite: A good knowledge of biology at the cellular and molecular level. Open to U3 and graduate students only.) An introduction to the biology of malignancy. A multidisciplinary approach dealing with the etiology of cancer, the biological properties of malignant cells, the host response to tumour cell growth and the principles of cancer therapy.

Professor Thomson and Staff

516-506B ADVANCED CARDIOVASCULAR PHYSIOLOGY. (3) (Prerequisite: 552-313B or by permission of Instructors.) Offered in conjunction with the Department of Physiology. Current topics, methods and techniques for studying the cardiovascular system. Basic and applied cardiac electrophysiology, mechanisms of pacemaker activity, arrhythmias, the effects of drugs on cardiac functions, fetal circulation, coronary circulation, mechanics of blood flow, cardiovascular diseases, renal and neural control of the circulation, and cardiac assist devices.

Professors Goldsmith and Shrier

516-507A ADVANCED APPLIED RESPIRATORY PHYSIOLOGY. (3) (Prerequisite: 552-313B) Offered in conjunction with the Department of Physiology. In depth coverage of respiratory biology including: functional anatomy of the respiratory system, pulmonary statics and dynamics, chest wall and respiratory muscles, ventilation and perfusion, control of breathing, and defense mechanisms. This course is aimed at providing a solid grounding in pulmonary biology and its research applications.

Professors Eidelman and Grassino

516-508B ADVANCED TOPICS IN RESPIRATION. (3) (Prerequisite: 516-507A) Offered in conjunction with the Department of Physiology. In depth coverage of developmental physiology, pulmonary vascular physiology, biology of airway smooth muscle, respiratory epithelium and molecular biology of respiratory muscles. Dyspnea, mechanical ventilation and respiratory failure will also be covered. This course emphasizes application of respiratory biology to basic and applied research and touches on pulmonary pathophysiology.

Professors Eidelman and Grassino

516-509B GASTROINTESTINAL PHYSIOLOGY AND PATHOPHYSIOLOGY. (3) (Prerequisite: Graduate students, U3 undergraduates.) Course deals with various aspects of gastrointestinal and hepatic function in health and altered physiological states. The principal focus is on the recent literature pertaining to cell and molecular mechanisms underlying the motility secretary process, absorption and secretion. The molecular biology of the hepatic viruses and various aspects of colonic neoplasia will also be considered.

Professors Wild and Barkun

516-510A BIOANALYTICAL SEPARATION METHODS. (3) The student will be taught the capabilities and limitations of modern separation methods (gas and high-performance liquid chromatography, capillary electrophoresis, hyphenated techniques). Application of these techniques to solve analytical problems relevant to biomedical research will be emphasized, with special attention being paid to the processing of biological samples.

Professors Wainer and Lloyd

516-511B JOINT VENTURING WITH INDUSTRY. (3) (Offered in conjunction with the Centre for Continuing Education.) Using problem-based learning, the course examines the various business interactions between researchers and their business partners in support and development of research into commercial endeavours using models such as venture capital, business partnerships, or grants-in-aid.

Professors Price and Yalovsky

516-512D RECENT PROGRESS IN AIDS RESEARCH. (6) Interdisciplinary seminar course on basic, clinical, epidemiological and psychosocial aspects of HIV infection. Topics include: the pathophysiology of HIV-associated immunodeficiency; review of current antiviral treatment and mechanisms of resistance to anti-HIV drugs; sessions on the natural history, clinical manifestations and general aspects of treatment interventions, as pertaining to different populations.

Professors Falutz, Sekaly and Staff

11.13 Geography (183)

This course emphasizes application of respiratory biology to basic and applied research and touches on pulmonary pathophysiology. The World Commission on Environment and Development has advocated for the protection of the environment and the well-being of all people. Geographic isolation, climate change, and human activities have contributed to the degradation of ecosystems and the loss of biodiversity. Professors Eidelman and Grassino

516-509B GASTROINTESTINAL PHYSIOLOGY AND PATHOPHYSIOLOGY. (3) (Prerequisite: Graduate students, U3 undergraduates.) Course deals with various aspects of gastrointestinal and hepatic function in health and altered physiological states. The principal focus is on the recent literature pertaining to cell and molecular mechanisms underlying the motility secretary process, absorption and secretion. The molecular biology of the hepatic viruses and various aspects of colonic neoplasia will also be considered.

Professors Wild and Barkun

516-510A BIOANALYTICAL SEPARATION METHODS. (3) The student will be taught the capabilities and limitations of modern separation methods (gas and high-performance liquid chromatography, capillary electrophoresis, hyphenated techniques). Application of these techniques to solve analytical problems relevant to biomedical research will be emphasized, with special attention being paid to the processing of biological samples.

Professors Wainer and Lloyd

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Professors Price and Yalovsky

516-512D RECENT PROGRESS IN AIDS RESEARCH. (6) Interdisciplinary seminar course on basic, clinical, epidemiological and psychosocial aspects of HIV infection. Topics include: the pathophysiology of HIV-associated immunodeficiency; review of current antiviral treatment and mechanisms of resistance to anti-HIV drugs; sessions on the natural history, clinical manifestations and general aspects of treatment interventions, as pertaining to different populations.

Professors Falutz, Sekaly and Staff

The Department of Geography offers programs in both Arts and Science. Students planning to do a B.A. Honours in Geography or a B.A. Major Concentration in Geography or Urban Systems should refer to the Geography entry in the Faculty of Arts section of this Calendar for B.A. program information.

Geography is the study of physical environments and human habitats. It covers issues such as global warming and climate change, regional economic disparities, urban transportation, native land claims and permafrost problems. Both a physical and social science, it provides a unique opportunity to obtain a broad exposure to the many environmental and locational problems of contemporary society.

The World Commission on Environment and Development has identified the evidence and possible consequences of currently widespread land use practices which cannot be sustained. Geog-
raphy is an integrative discipline concerned with the relations between culture systems and resource bases. Students interested in understanding, or working towards the resolution of, the environmental “crisis” should select courses which deal with (1) the dynamics of natural systems (courses in the physical geography of terrestrial, atmospheric and hydrological systems); (2) the dynamics of human systems (courses in cultural, social, economic, political and urban geography); (3) the context of development and land use changes; and (4) practical skills such as Geographical Information Systems, cartography, remote sensing, image analysis and resource management.

Students may pursue programs focusing on urban systems, the geography of economic development, people and their natural environment, the geography of living systems. The interdisciplinary Minor in Environment is also available to students in Arts or Science. Students planning to enter a program in Geography should telephone (514) 398-4111 for an appointment with an advisor and should consult the Department of Geography Undergraduate Handbook, which is available from the departmental office.

Graduates find employment in a wide range of industrial and commercial activities, as well as in government and education. Others pursue graduate work in geography or urban planning.

**Required Courses**

The Major is designed to provide a coverage of the main elements of physical geography.

### Required Courses (22 credits)

**Geography**

183-200 (3) Geographical Perspectives on World Environmental Problems

183-205 (3) Global Change: Past, Present and Future

**B.Sc. MAJOR PROGRAM IN GEOGRAPHY** (55 credits)

The Major is designed to provide a coverage of the main elements of physical geography.

**Required Courses** (22 credits)

- **Geography**
  - 183-201 (3) Geographic Information Systems I
  - 183-203 (3) Environmental Systems
  - 183-216 (3) Geography of the World Economy
  - 183-217 (3) The Canadian City
  - 183-272 (3) Landforms & Environmental Systems
  - 183-302 (3) Environmental Analysis and Management

**Mathematics**

189-203 (3) Principles of Statistics I

**Complementary Courses** (33 credits)

- 3 credits from GIS techniques:
  - 183-306 (3) Geographic Information Systems II
  - 183-308 (3) Remote Sensing

- 12 credits from systematic physical geography:
  - 183-305 (3) Soils and Environment
  - 183-321 (3) Climatic Environments
  - 183-322 (3) Environmental Hydrology
  - 183-350 (3) Ecological Biogeography
  - 183-372 (3) Running Water Environments

- 3 credits from field courses:
  - 183-395C (3) Field Studies - Physical Geography
  - 183-496B (3) Regional Geographical Excursion
  - 183-497T (3) Coastal Marsh Plant Ecology
  - 183-499T (3) Subarctic Field Studies: Schefferville

15 credits from **approved courses** in Geography, or elsewhere in the Faculty of Science, or in the Faculty of Engineering; at least 9 credits of which are to be taken outside Geography. Students may also include any courses that are not already counted towards the GIS techniques or the systematic physical geography requirements. Admission to 500-level courses in Geography requires the instructor’s permission. It is not advisable to take more than one 500-level course in a semester.

### B.Sc. HONOURS PROGRAM IN GEOGRAPHY (64 credits)

The Honours program is designed to provide specialized systematic training in physical geography. The student must maintain marks of B or higher and must complete a 6-credit research paper. Honours students are encouraged to participate in 500-level seminars with graduate students, but it is not advisable to take more than one in a semester.

**Required Courses** (31 credits)

- 22 credits of introductory courses (see B.Sc. Major program in Geography)
- 9 credits of research and thesis courses:
  - 183-381B (3) Evolution of Geography
  - 183-491D,N (6) Honours Research and Reading

**Complementary Courses** (33 credits)

from the same list as for the B.Sc. Major Program in Geography.

### ENVIRONMENTAL STUDIES COURSES

See the McGill School of Environment section for other courses that may be relevant to Geography programs.

**COURSE DESCRIPTIONS**

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

- Denotes courses not offered in 1998-99.
- Denotes Limited Enrolment.

- **183-190A ENVIRONMENTAL PERSPECTIVES.** (FYS – for first year, non-geography, students only; maximum 25.) This course will (a) introduce non-geography students to some of the basic philosophical foundations and paradigms of geography; (b) acquaint students with the contrasting landscapes, processes and land uses in the three major physiographic regions of Southern Quebec; and (c) introduce students to basic field techniques used in geomorphology, climatology and biogeography. Two field trips. **Professor Pollard**

- **183-200A GEOGRAPHICAL PERSPECTIVES ON WORLD ENVIRONMENTAL PROBLEMS.** (3) (3 hours) Introduction to geography as the study of nature and human beings in a spatial context. An integrated approach to environmental systems and the human organization of them from the viewpoint of spatial relationships and processes. Special attention to environmental problems as a constraint upon Third World development. **Professors Coomes and Wenzel**

- **183-201B GEOGRAPHIC INFORMATION SYSTEMS I.** (3) (3 hours and lab) (Priority for first-year Geography Majors and Honours.) An introduction to Geographical Information Systems. The systematic management of spatial data. The use and construction of maps. The use of microcomputers and software for mapping and statistical work. Air photo and topographic map analyses. **Professors Lewis and Ewing**

- **183-203A ENVIRONMENTAL SYSTEMS.** (3) (3 hours) (Not open to B.A. students in Freshman year.) Earth surface processes in environmental systems and their geographical variation. The major environmental processes and the interaction between the components (atmosphere, lithosphere and biosphere). Human impact on the environment and its consequences. **Professors Roulet and Lapointe**
183-205B GLOBAL CHANGE: PAST, PRESENT AND FUTURE. (3) (3 hours) An examination of global change, from the Quaternary Period to the present day involving changes in the physical geography of specific areas. Issues such as climatic change and land degradation will be discussed, with speculations on future environments.

Professor Chmura and Staff

183-216A GEOGRAPHY OF THE WORLD ECONOMY. (3) (3 hours) The course introduces the geography of the world economic system. It describes the spatial distribution of economic activities and examines the factors which influence their changing location. Case studies from both "developed" and "developing" countries will test the different geographical theories presented in lectures.

Professor Armstrong and Staff

183-217B THE CANADIAN CITY. (3) (3 hours) An introduction to the social, economic, political and built environments of Canadian cities. Theories of the internal structure of cities, and relationships between urban places of various sizes. The course situates Canadian urbanism in the North American context, and emphasizes social and economic processes distinctive to Montreal.

Professor Ray

183-272B LANDFORMS & ENVIRONMENTAL SYSTEMS. (3) (3 hours) Introduction to the study of landforms as products of geomorphic and geologic systems acting at and near the Earth's surface. The process geomorphic approach will be used to demonstrate how landforms of different geomorphic settings represent a dynamic balance between forces acting in the environment and the physical properties of materials present.

Professor Pollard

183-290A LOCAL GEOGRAPHICAL EXCURSION. (1 credit) (Open to first-year Geography Major and Honours students only. Not open to students who have taken 183-199.) Introduction to landscape interpretation and geographical site analysis in physical and human geography. A three-day fall excursion with preparatory and concluding seminars. September 25-27, 1998.

Staff

183-300B HUMAN ECOLOGY IN GEOGRAPHY. (3) (3 hours) (Prerequisite: 183-203 or 151-202 or 177-111) The course will examine research approaches in human ecology since its inception early in this century. Emphasis will be placed on the theoretical shifts that have led to its emergence as an important social science perspective. The course will also involve case studies to evaluate the methodological utility of the approach.

Professor Wenzel

183-301A GEOGRAPHY OF THE CIRCUMPOLAR NORTH. (3) (3 hours) An introduction to the northern circumpolar lands and seas, their resources, peoples, socio-economic and political systems and future developments. Introduction to library resource materials on northern regional physical geography; northern ecology; cultural geography of the circumpolar countries.

Professors Pollard and Wenzel

183-302B ENVIRONMENTAL ANALYSIS AND MANAGEMENT: PROBLEMS AND POLICY. (3) (3 hours) (Prerequisite: 183-203 or permission of instructor.) An ecological analysis of the physical and biotic components of natural resource systems. Emphasis on scientific, technological and institutional aspects of related environmental management. Study of the use of Canadian biological resources and of the impact of industrial processes. Students develop dossiers and assess applied research methods.

Professor Meredith

183-305A SOILS AND ENVIRONMENT. (3) (2 hours and laboratory) (Prerequisite: 183-203 or introductory course in biology or geology.) Discussion of the major properties of soils; soil formation, classification and mapping; land capability assessment; the role and response of soils in natural and disturbed environments (e.g. global change, ecosystem disturbance).

Professor Moore

183-306A GEOGRAPHIC INFORMATION SYSTEMS II. (3) (2 hours and laboratory) (Prerequisite: 183-201) Formal introduction to a computer-based Geographical Information System (GIS). Topics will focus on map analysis and on transforming and displaying spatial data. GIS will be used by students to solve problems in both physical and human geography.

Professor Lewis

183-307B SOCIOECONOMIC APPLICATIONS OF G.I.S. (3) (2 hours and laboratory) (Prerequisites: 183-201, 189-203 or equivalent) GIS applied to the spatial analysis of socioeconomic and market data. Topics include geographic market segmentation, geodemographics, spatial decision-support systems and modelling applications of GIS. Empirical focus is on analysing spatial patterns of population and consumption characteristics in cities and on facility location problems. Emphasis on visualization and problem solving.

Professor Ewing

183-308B REMOTE SENSING. (3) (3 hours and laboratory periods) (Prerequisite: 183-201 or permission of instructor.) The principles of air photo interpretation and remote sensing of the environment, applications to urban problems, geomorphology, land use and inventory of natural resources. Elementary photogrammetry and field work.

Professor Pollard

183-309A GEOGRAPHY OF CANADA. (3) (3 hours) An introduction to the geography of Canada. A comprehensive geographical interpretation of Canada's salient physical and human characteristics, including landscapes and their evolution, climate, vegetation, society/land relationships and socio-economic attributes of the population.

Staff

183-311A CANADA — A GEO-ECONOMIC PERSPECTIVE. (3) (3 hours) (Prerequisite 183-216 or permission of the instructor.)

183-315A URBAN TRANSPORTATION GEOGRAPHY. (3) (3 hours) (Prerequisite 183-217 or permission of instructor.) Discusses the urban transportation problem and proposed solutions from a geographic perspective. Specific topics include an analysis of the land use-transportation system in North American cities; its social environmental impacts; the analysis of urban travel behaviour; and the geographical implications of various policy alternatives.

Professor Ewing

183-316A POLITICAL GEOGRAPHY. (3) (3 hours)

183-321B CLIMATIC ENVIRONMENTS. (3) (3 hours) (Prerequisite: 183-203 or 195-210 or permission of the instructor.)

183-322B ENVIRONMENTAL HYDROLOGY. (3) (3 hours) (Prerequisite: 183-203 or equivalent) Quantitative, experimental study of the principles governing the movement of water at or near the earth's surface and how the research relates to the chemistry and biology of ecosystems.

Professor Ewing

183-323B GEOGRAPHY OF EUROPE'S NORTH. (3) (3 hours)

183-326B GEOGRAPHY OF QUEBEC. (3) (3 hours)

183-331A URBAN SOCIAL GEOGRAPHY. (3) (3 hours) (Prerequisite: 183-216 or 217 or permission of instructor.) Social space and social time. The reflection of social structure in the spatial organization of the city. Historical perspective on changing personal mobility, life cycle, family structure and work organization. The appropriation and alienation of urban spaces.

Professor Ray

183-333C THE HABITABLE CITY. (Seminar) (Open to students with at least one pertinent 300 level course or permission of instructor.)

183-350A ECOLOGICAL BIOGEOGRAPHY. (3) (3 hours) (Prerequisite: 183-302 or 177-205) The study of the patterns of distribution of organisms in space and time with emphasis on plant communities. Ecological, geographical, historical and anthropological factors affecting these distribution patterns will be discussed. Particular consideration is given to methods for description and classification of plant communities.

Professor Chmura

183-351A QUANTITATIVE METHODS IN GEOGRAPHY. (3) (3 hours) (Prerequisite: Mathematics 189-203 or permission of instructor.) Survey design; uni- and multi-dimensional scaling; location-allocation, multiple regression and correlation; logit models; gravity models; population projection. Please see regulations concerning statistics courses under Course Overlap in the Faculty Degree Requirements section.

Professor Ewing

183-372B RUNNING WATER ENVIRONMENTS. (3) (3 hours) (Prerequisites: 183-203 and 183-272 or MSE core courses [once approved].) The course focuses on the physical habitat conditions
found in streams, rivers, estuaries and deltas. Based on the laws governing flow of water and sediment transport, it emphasizes dif-
fferences among these environments, in terms of channel form, flow patterns, substrate composition and mode of evolution. Flood-
ing, damming, channelisation, forestry impacts.

Professor Lapointe

183-381B EVOLUTION OF GEOGRAPHY. (3) (3 hours) This course provides an overview of the history and philosophy of geography, with emphasis on the development of the subject from around 1800 to the present, mainly in English-language traditions. The course includes discussion of the discipline's major theoretical underpinnings and issues.

Staff

183-395C FIELD STUDIES - PHYSICAL GEOGRAPHY. (3) (2-week field school) (Prerequisites: 183-203 and -272) Field methods in physical geography including bio-physical survey and air photo interpretation. The course will be organised around projects designed to familiarise students with a range of field survey procedures. Offered in 1998 May summer session. Preregistration required by March 15.

Professor Seutin

183-398T FIELD STUDIES IN HUMAN GEOGRAPHY. (3) (3 hours) (Prerequisite: Any introductory human geography course; or by permission of the instructor.)

183-404A ENVIRONMENTAL MANAGEMENT FOR DEVELOPING AREAS. (3) (3 hours) (Prerequisite: 183-302, course in development studies, or permission of instructor.) A study of the practical application of environmental planning, analysis and management techniques with reference to the needs and problems of third world countries and areas in the Canadian north. Special challenges posed by cultural differences and traditional resource systems are discussed.

Professor Seutin

183-408B GEOGRAPHY OF UNEQUAL DEVELOPMENT. (3) (3 hours) (Prerequisite: 183-216 or permission of instructor.)

183-410B GEOGRAPHY OF UNDERDEVELOPMENT: CURRENT PROBLEMS. (3) (3 hours) (Prerequisite: 183-216 or permission of instructor.) An examination of the cultural, political, and economic mechan-
isms and manifestations of contemporary underdevelopment and the response to it from different regional and national peripheral societies within the dominant world economic system.

Staff

183-415B GEOGRAPHY OF TOURISM. (3) (3 hours)

183-424A PLACE, PEOPLE & CULTURE: EUROPE. (6) (6 hours) (Prerequisite: 6 credits from any of History, Art History, Anthropology, Philosophy, Political Science, Sociology or permission of instruc-
tor) The course studies the dynamics of change in distinct European landscapes and among diverse people and their customs during the modern era, 16th to early 20th centuries. Empha-
sis is placed upon divergence/convergence in popular and elite cultures, emergent nationalism and the implications for contempo-
rary issues of international cooperation.

Professor Armstrong

183-490A,B,D,G,T INDEPENDENT STUDIES IN GEOGRAPHY. (3) (Open to U3 Geography Major students only.) Research or reading projects permitting independent study under the guidance of a staff member specializing in the field of interest. A project must be arr-
anged with an instructor before registration.

Staff

183-491D,N HONOURS RESEARCH AND READING. (6) (For U3 B.A. and B.Sc. honours and joint honours geography students.) Supervised reading, research and preparation of an undergraduate thesis under the direction of a member of staff.

Professor Lapointe and Staff

183-492D,N JOINT HONOURS RESEARCH AND READING. (3) (Only for those U3 joint honours students in geography who opt to enrol in a parallel course in another department.) Supervised reading, research and preparation of an undergraduate thesis under the direction of a member of staff.

Professor Lapointe and Staff

183-494T FIELD STUDIES IN GEOGRAPHY: URBAN. (3) (Prereq-
usites: 200-level courses in cartography, statistics, and urban geography, and 183-331B) Geographical research in urban public and semi-public spaces. Demonstration of techniques of mapping, sampling, measurement, photography, interviewing. Attention to research design. Will be offered in 1998 for two weeks in late August, intensive in Montreal and Toronto. Pre-registration required by March 15.

Professor Ray

183-496B REGIONAL GEOGRAPHICAL EXCURSION. (3) (Prereq-
usites: 183-290 and permission of instructor.)

183-497T FIELD STUDIES IN GEOGRAPHY: COASTAL MARSH PLANT ECOLOGY. (3) (Prerequisite: 183-350 or 183-305 or 177-308)

183-499T SUBARCTIC FIELD STUDIES IN GEOGRAPHY: SCHEFFERVILLE. (3) (Prerequisite: 183-203 or 301) An introduction to the geography of the subarctic with emphasis on the application of field methods in physical and/or human geography. The course will be given in 1998 at the McGill Subarctic Research Station, Schefferville, during ten days in late August. Preregistration re-
quired by March 15.

Professor Pollard

183-500B GEOGRAPHY OF REGIONAL IDENTITY. (3) (3 hours) (Re-
striction: Graduate students and final year undergraduates and/or those who have taken 183-408A.) The response of diverse ethnic and national groups in Europe to the centralising tendencies of na-
tion-states and global economic and cultural pressures. Examples and case studies are drawn from eastern and western European regions and examined in the unfolding historical context of the modern era.

Professor Armstrong

183-502A GEOGRAPHY OF NORTHERN DEVELOPMENT. (3) (3 hours) (Prerequisite: 183-301 or 436, or permission of instructor.) Analy-
sis of the evolution of development policies and their spatial impli-
cations in circumpolar areas with an emphasis on the application of geographical concepts. Special attention is given to indigenous peoples and new immigrant populations in northern North America.

Professor Wenzel

183-504A INDUSTRIAL RESTRUCTURING – THE GEOGRAPHIC IMPLICATIONS. (3) (Prerequisites: 183-311 or permission of instruc-
tor.)

183-505A GLOBAL BIOGEOCHEMISTRY. (3) (2 hours and research) (Prerequisite: 183-306 and permission of instructor.) An examina-
tion of the storage, transfers and cycling of major elements and substances, with an emphasis on the global scale and the linkages between the atmosphere, hydrosphere, lithosphere and bio-
sphere.

Professors Moore and Roulet

183-506B PERSPECTIVES ON GEOGRAPHIC INFORMATION ANALYSIS. (3) (2 hours and laboratory) (Prerequisite: 183-201 and 306 and permission of instructor.) Examination of a range of appli-
cations in automated processing of spatial data. Discussion will fo-
cus on both theoretical and practical aspects of Geographic Informa-
tion Systems. Topics such as resource data base structure, methods of spatial interpolation and data quality and errors are covered. The application of Geographic Information Systems such as GRASS and digital image processing routines are used to answer questions in geographical research. Individual student projects will be emphasized.

Professor Lewis

183-510B HUMID TROPICAL ENVIRONMENTS. (3) (3 hours) (Pre-
require: 183-203 or equivalent and written permission of the in-
structor.)

183-513B BEHAVIOURAL GEOGRAPHY. (3) (3 hours) (Prerequi-
site: a course in introductory statistics.)

183-522B ADVANCED ENVIRONMENTAL HYDROLOGY. (3) (2 hours and 1 tutorial) (Prerequisite: 183-322, or permission of instructor.)

183-523B ADVANCED CLIMATOLOGY. (3) (3 hours) (Prerequisite: a previous course in climatology or meteorology, and written per-
mission of the instructor.)

183-535B REMOTE SENSING METHODS & INTERPRETATION. (3) (3 hours) (Prerequisite: 183-308 and written permission of instruc-
tor.)

183-536B PERIGLACIAL AND PERMAFROST ENVIRONMENTS. (3) (3 hours) (Prerequisite: 183-272 and any 300-level geomorpholo-
183-537B Advanced Fluvial Geomorphology. (3) (Prerequisites: permission of instructor.) An examination of current advancements in fluvial geomorphology; sediment entrainment and transport, alluviation and river channel evolution. Professor Pollard

183-550A Quaternary Paleoecology. (3) (2 hours, laboratory and seminar) (Prerequisite: course in ecology or biogeography, or permission of instructor.) Examination of landscape and ecosystem response to climatic change; addressing persistent problems in Pleistocene and Holocene paleoecology; episodes of temporary warming and cooling, locations of glacial refugia and sea level change. Principles and methods of Quaternary paleoecology and paleoclimatological reconstruction. Professor Lapointe

183-551A Environmental Decisions. (3) (2 hours seminar, 1 hour tutorial) (Prerequisites: 183-302, 182-451, 183-306 or equivalents) This course deals with the role of geographic information, paradigms and modes of analysis - including but not restricted to GIS - in environmental impact assessment and decision making. The focus will be on community-based decision making, particularly where conservation issues are involved. Cross-cultural situations, developing areas and the role of non-government organizations. Professor Meredith

183-552A Advanced Quaternary Paleoclimatology. (6) (3 hours laboratory, 3 hours seminar) (Prerequisite: 183-550A or 183-551A or 183-557A or 183-559A) Study of the unique geomorphic response to climatic change; addressing persistent problems in Pleistocene and Holocene paleoecology: episodes of temporary warming and cooling, locations of glacial refugia and sea level change. Principles and methods of Quaternary paleoecology and paleoclimatological reconstruction. Professor Lapointe

U1 Complementary Courses (6 credits)
Selected from:
- 528-211A (3) Biology of Microorganisms
- 528-212A (2) Laboratory in Microbiology
- 177-202A,B (3) Basic Genetics
- 177-204A (3) Evolution
- 177-205B (3) Biology of Organisms
- 504-214A (3) Systematic Human Anatomy
- 504-261A* (4) Introduction to Dynamic Histology
*students must take this course in U1 or U2

U2 Required Courses (15 credits)
- 507-300D (6) Laboratory in Biochemistry
- 507-311A (3) Metabolic Biochemistry
- 507-312B (3) Biochemistry of Macromolecules
- 528-314B (3) Immunology

U2 Complementary Courses (9 credits)
one of:
- 504-261A (4) Introduction to Dynamic Histology
- 528-211A (3) Biology of Microorganisms
- 552-210B (3) Mammalian Physiology II

U3 Complementary Courses (9 credits)
9 credits selected from:
- 177-314A (3) Molecular Biology of Oncogenes
- 177-300A (3) Molecular Biology of the Gene
- 552-210B (3) Mammalian Physiology II
- 180-302A,B (3) Organic Chemistry III
- 180-313A (3) Intermediate Physical Chemistry I
- 189-133A,B (3) Vectors, Matrices and Geometry
- 189-222A,B (3) Calculus II
- 189-315A,B (3) Ordinary Differential Equations

U3 Required Courses (15 credits)
- 528-414A (3) Advanced Immunology
- 507-503B (3) Immunology
- 552-419D (6) Project & Seminar in Immunology
- 552-513A (3) Cellular Immunology

U1 Required Courses (20 credits)
- 177-200A (3) Molecular Biology
- 177-201B (3) Cell Biology and Metabolism
- 507-212B (3) Molecular Mechanisms of Cell Function
11.15 Management Minor Program

The purpose of the Minor in Management is to allow Science students, who so wish, to include in their undergraduate program courses which will prepare them for a career in management.

Enrolment in this program is restricted, and a CGPA greater than 2.5 is normally required. Application forms and appointments will be available from February 15, 1999. Applications are considered on a first-come, first-served basis, and the first 25 applicants who qualify will be accepted. At the time of application, at least one course toward the Minor program must be completed with a grade of C or better.

Students who are not formally registered for the Minor but who nevertheless complete all its requirements may apply to have the Minor approved during their last term.

Students who were registered in 1996-97 or earlier should consult the Minor advisor in the Student Affairs Office regarding their Minor approved during their last term.

To obtain the Minor in Management, students must complete the 24 credits with grades of C or better.

MINOR PROGRAM IN MANAGEMENT (24 credits)

Required Courses (9 credits)

- 280-211 (3) Introduction to Financial Accounting
- 280-293 (3) Managerial Economics
- 189-203 (3) Principles of Statistics I or its equivalent as authorized by the Faculty of Science.

Students majoring in certain programs, for example in Mathematics, cannot take 189-203 but must take 189-324 instead.

Complementary Courses (15 credits)

- 3 credits from:
  - 280-213 (Introduction to Management Accounting)
  - 280-341 (Finance I)
  - 280-382 (International Business)

- 3 credits from:
  - 280-222 (Organizational Behaviour)
  - 280-320 (Managing Human Resources)
  - 280-352 (Marketing Management I)

- 3 credits from:
  - 280-360 (Social Context of Business)
  - 280-373 (Operations Research)
  - 280-423 (Organizational Policy)

- 6 credits from:

  any available 300- or 400-level Management courses for which the prerequisites, if any, have been met.

11.16 Mathematics and Statistics (189)

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Chair — GEORG SCHMIDT

Emeritus Professors — JOACHIM LAMBEK (PETER REDPATH EMERITUS PROFESSOR OF PURE MATHEMATICS), WILLIAM O.J. MOSER


Associate Professors — IVO KLEMES, JOHN A. TOOTH

Associate Members — LUC P. DEVROYE (COMPUTER SCIENCE), LEON GLASS (PHYSIOLOGY), LAWRENCE JOSEPH (Epidemiology & Biostatistics), MICHAEL MACKEY (PHYSIOLOGY), LAWRENCE A. MYSAK (A.O.S.), PRAKASH PANANGADEN (COMPUTER SCIENCE), JAMES O. RAMSAY (PSYCHOLOGY), GEORGE ALEXANDER WHITMORE (MANAGEMENT).

Adjunct Professors — THOMAS FOX, VICTOR HAVIN, BRIAN ROWLEY, ROBERT A. SEELY

Mathematics has evolved to a discipline which is mainly characterized by its method of proof, its concern for a progressive broadening of its concepts, and by the search for mathematical entities and operations that represent aspects of reality. It is a subject which is pursued by many for its own sake, and regarded as part of the mainstream of human culture. Mathematics pervades modern society with an impact which, already immense, is rapidly growing.

The two principal divisions of mathematics are pure mathematics and applied mathematics. The pure mathematician is interested in abstract mathematical structures and in mathematics as an intellectual enterprise. The primary concern may not be with its utilitarian aspects or with the current needs of science and technology, although many problems in pure mathematics have developed from the sciences.

The applied mathematician is more interested in how mathematics can be used to study some aspects of the world. Mathematicians are engaged in the creation, study and application of advanced mathematical methods relevant to scientific problems. Statistical science and methodology today is concerned with phenomena in which there is a background of uncertainty arising from inherent variability and the investigator is obliged to arrive at decisions from limited data. A key tool in statistics is probability.

Some of the fields in which pure mathematicians work are algebra, analysis, geometry, topology, number theory and foundations. Applied mathematics which once referred to the application of mathematics to such disciplines as mechanics and fluid dynamics, has currently assumed a much broader meaning and embraces such diverse fields as communication theory, theory of optimization, theory of games and numerical analysis.

Mathematics offers many vocational possibilities. Such fields as teaching, computing, applied statistics and actuarial science offer opportunities for B.Sc. graduates. Opportunities to do original research in pure and applied mathematics are available in universities and research institutions. Employment is to be found in financially or technologically oriented business firms. The Department of Mathematics and Statistics through its various programs attempts to provide courses to suit the diverse interests within mathematics and statistics.

The Honours Program in Mathematics demands of the student a talent for abstraction in addition to a high level of competence in the use of mathematical tools. This program is intended for students who plan to work in an area where mathematical innovations may be needed. It is almost essential for students contemplating a career in mathematical research.

The Major Program involves the same subjects as the Honours Program but is less demanding in terms of abstraction. It is designed primarily for students who will need mathematical tools in their work but whose creative activity will involve applications of mathematics to other areas. Within the framework of the Mathematics Major, various combinations of courses are suggested to meet the needs of different students. These include course suggestions for secondary school teachers, careers in management, and for careers in industry, government or actuarial sciences.
It is possible for Major students to include a number of Honours courses in their programs. This will be an advantage for those students who plan to use their mathematics in graduate studies. Students interested in a less intensive mathematics program linked to other disciplines are advised to consider the available Faculty Programs.

In planning their programs students are advised to seriously consider developing some depth in another discipline – preferably one for which mathematics has some relevance and use. Mathematics has been closely linked to areas such as computer science, physics and engineering but has recently come to play an increasingly important role in fields such as biology, linguistics, management and psychology. Students should consider completing the requirements for Minor programs such as those available in Cognitive Science, Computer Science and Statistics.

Students considering programs in Mathematics and Statistics should contact the Department to arrange for academic advising. The student's attention is called to the fact that a B.Com. degree with a Major in Mathematics is available from the Faculty of Management. In addition the Faculty of Music offers the B.Mus. degree with Honours in Theory with Mathematics Option.

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

MINOR PROGRAM IN MATHEMATICS (24 credits)
The Minor may be taken in conjunction with any primary program in the Faculty of Science (other than programs in Mathematics). Students should declare their intention to follow the Minor in Mathematics at the beginning of the penultimate year and should obtain approval for the selection of courses to fulfill the requirements for the Minor from the Departmental Chief Adviser (or delegate).

It is strongly recommended that students in the Minor Program take 189-323. The remaining credits may be freely chosen from the required and complementary courses for Majors and Honours students in Mathematics, with the obvious exception of courses that involve duplication of material. Alternatively up to six credits may be allowed for appropriate courses from other departments. All courses counted towards the Minor must be passed with a grade of C or better.

Generally no more than six credits of overlap are permitted between the Minor and the primary program. However, with an approved choice of substantial courses the overlap restriction may be relaxed to nine credits for students whose primary program requires 60 credits or more and to 12 credits when the primary program requires 72 credits or more.

Required Courses (9 credits)
189-222 (3) Calculus III
189-223* (3) Linear Algebra
189-315 (3) Ordinary Differential Equations I
*189-223 may be replaced by 189-235 and 189-236. In this case the complementary credit requirement is reduced by three.

Complementary courses (15 credits)
To be selected from the required and complementary courses for Majors and Honours students in Mathematics, with 189-323 strongly recommended; alternatively up to 6 credits may be allowed for appropriate courses from other departments.

MINOR PROGRAM IN STATISTICS (24 credits)
The Minor may be taken in conjunction with any primary program in the Faculty of Science. Students should declare their intention to follow the Minor in Statistics at the beginning of the penultimate year and must obtain approval for the selection of courses to fulfill the requirements for the Minor from the Departmental Chief Adviser (or delegate).

All courses counted towards the Minor must be passed with a grade of C or better. Generally no more than six credits of overlap are permitted between the Minor and the primary program. However, with an approved choice of substantial courses the overlap restriction may be relaxed to nine credits for students whose primary program requires 60 credits or more and to 12 credits when the primary program requires 72 credits or more.

Required Courses (15 credits)
189-222 (3) Calculus III
189-223* (3) Linear Algebra
189-323 (3) Probability Theory
or 189-356 (3) Probability
189-324 (3) Statistics
or 189-357 (3) Statistics
189-423 (3) Regression and Analysis of Variance
*189-223 may be replaced by 189-235 and 189-236. In this case the complementary credit requirement is reduced by three.

Complementary Courses (9 credits)
selected from:
189-425 (3) Sampling Theory and Applications
189-447 (3) Stochastic Processes
189-523 (4) Generalized Linear Models
189-556 (4) Mathematical Statistics I
189-557 (4) Mathematical Statistics II
166-504 (3) Quantitative Methods of Social Research I
166-505 (3) Quantitative Methods of Social Research II
180-593 (3) Statistical Thermodynamics
183-351 (3) Quantitative Methods in Geography
198-362 (3) Statistical Mechanics
198-559 (3) Advanced Statistical Mechanics

No more than 6 credits may be taken outside the Department of Mathematics and Statistics.

Further credits (if needed) may be freely chosen from the required and complementary courses for Majors and Honours students in Mathematics, with the obvious exception of courses that involve duplication of material.

FACULTY PROGRAMS
Programs linking mathematics and other disciplines are available. With careful selection of courses in U1, it is possible to transfer to a Major program in Mathematics in U2. Except where otherwise noted these Faculty Programs lead to a B.Sc. degree. Students interested in any of these Faculty Programs should consult the Department of Mathematics and Statistics for an adviser.

FACULTY PROGRAM IN BIOLOGY AND MATHEMATICS
See the Biology section of this Calendar for complete program information.

FACULTY PROGRAM IN CHEMISTRY AND MATHEMATICS
See the Chemistry section of this Calendar for complete program information.

FACULTY PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (54 credits)
27 credits in Mathematics and 27 credits in Computer Science

Required Courses (48 credits)
189-222 (3) Calculus III
189-223* (3) Linear Algebra
189-315 (3) Ordinary Differential Equations I
189-317 (3) Numerical Analysis
189-323 (3) Probability Theory
189-324 (3) Statistics
189-343 (3) Discrete Mathematics & Applied Algebra
or 189-240 (3) Discrete Structures & Computing
308-202** (3) Introduction to Computing I
308-203** (3) Introduction to Computing II
308-251 (3) Data Structures and Algorithms
308-273 (3) Principles of Assembly Languages
308-302 (3) Programming Languages and Paradigms
308-305 (3) Computer System Architecture
308-310 (3) Computer Systems and Organization
308-420 (3) Files and Databases
308-530 (3) Formal Languages

*189-223 may be replaced by 189-235 and 189-236. In this case the complementary credit requirement is reduced by three.

**308-202 and 308-203 may be replaced by 308-250 with an additional three credits at the 300 level.

Complementary Courses (6 credits)
selected from:

189-314 (3) Advanced Calculus
189-318 (3) Mathematical Logic
189-327 (3) Matrix Numerical Analysis
189-328 (3) Computability & Mathematical Linguistics
189-407 (3) Dynamic Programming
189-417 (3) Mathematical Programming

FACULTY PROGRAM IN MATHEMATICS, STATISTICS AND COMPUTER SCIENCE (54 credits)

Required Courses (30 credits)
189-222 (3) Calculus III
189-223* (3) Linear Algebra
189-315 (3) Ordinary Differential Equations I
189-323 (3) Probability Theory
189-324 (3) Statistics
189-423 (3) Regression and Analysis of Variance

*189-223 may be replaced by 189-235 and 189-236. In this case the complementary credit requirement is reduced by three.

**308-202 and 308-203 may be replaced by 308-250 with an additional three credits at the 300 level.

Complementary Courses (24 credits)
at least 6 credits selected from:

189-314 (3) Advanced Calculus
189-317 (3) Numerical Analysis
189-318 (3) Mathematical Logic
189-319 (3) Partial Differential Equations
189-327 (3) Matrix Numerical Analysis
189-328 (3) Computability & Mathematical Linguistics
189-343 (3) Discrete Mathematics & Applied Algebra
189-407 (3) Dynamic Programming
189-417 (3) Mathematical Programming

at least 6 credits in Statistics selected from:

189-329 (3) Theory of Interest
189-425 (3) Sampling Theory and Applications
189-447 (3) Stochastic Processes
189-523 (4) Generalized Linear Models

at least 6 credits in Computer Science selected from:

308-302 (3) Programming Languages and Paradigms
308-305 (3) Computer System Architecture
308-310 (3) Computer Systems and Organization
308-420 (3) Files and Databases
308-530 (3) Formal Languages

FACULTY PROGRAM IN MATHEMATICS, CHEMISTRY AND PHYSICS (56 credits)

Required Courses (50 credits)

180-201 (3) Modern Inorganic Chemistry I
or 180-281 (3) Inorganic Chemistry I
180-204 (3) Physical Chem./Biol. Sci. I
or 180-213 (3) Physical Chemistry I
180-212 (4) Organic Chemistry I
180-214 (3) Physical Chem./Biol. Sci. II
180-222 (4) Organic Chemistry II
180-313 (3) Intermediate Physical Chemistry I
180-222 (3) Calculus III
180-223 (3) Linear Algebra
189-314 (3) Advanced Calculus
189-315 (3) Ordinary Differential Equations I
189-319 (3) Partial Differential Equations I
198-230 (3) Dynamics of Simple Systems
198-232 (3) Heat and Waves
198-241 (3) Signal Processing
198-340 (3) Electricity and Magnetism
308-202 (3) Introduction to Computing I

Complementary Courses (6 credits)

3 credits in Physics, 200 level or higher
3 credits in Mathematics, Chemistry or Physics, chosen in consultation with the advisor.

MAJOR PROGRAM IN MATHEMATICS (54 credits)

Students entering the Major program are normally expected to have completed 189-133, 189-140 and 189-141 or their equivalents. Otherwise they will be required to make up any deficiencies in these courses over and above the 54 credits of required courses.

Major students who have done well in 189-242 and 189-235 are urged to consider, in consultation with their advisor and the instructors concerned, entering the Honours stream by registering for 189-251 and 189-255.

Guidelines for Selection of Courses in the Major Program

The following informal guidelines should be discussed with the student's adviser. Where appropriate, Honours courses may be substituted for equivalent Major courses. Students planning to pursue graduate studies are encouraged to make such substitutions.

Students interested in computer science are advised to choose courses from the following 189-317, 189-318, 189-327, 189-328, 189-343, 189-407, 189-417 and to complete the Computer Science Minor.


Students considering a career in secondary school teaching are advised to take 189-318, 189-328, 189-338, 189-339, 189-346, 189-348.

Students interested in careers in business, industry or government are advised to select courses from the following list: 189-317, 189-319, 189-327, 189-329, 189-407, 189-417, 189-423, 189-425, 189-447, 189-523.

Required Courses (27 credits)

189-222 (3) Calculus III
189-235 (3) Basic Algebra I
189-236 (3) Linear Algebra I
189-243 (3) Real Analysis
189-314 (3) Advanced Calculus
189-315 (3) Ordinary Differential Equations I
189-316 (3) Functions of a Complex Variable
189-417 (3) Mathematical Programming

or 189-249 (3) Advanced Calculus

Complementary Courses (27 credits)

21 credits selected from the following list, with at least 6 credits selected from:

189-317 (3) Numerical Analysis
189-324 (3) Statistics
189-343 (3) Discrete Mathematics & Applied Algebra
189-318 (3) Mathematical Logic
189-319 (3) Partial Differential Equations
189-320 (3) Differential Geometry
189-322 (3) Dynamical Systems, Fractals and Chaos
189-327 (3) Matrix Numerical Analysis
189-328 (3) Computability & Mathematical Linguistics
189-329 (3) Theory of Interest
189-338 (3) History and Philosophy of Mathematics
189-339 (3) Topics in the Foundations of Mathematics
189-346 (3) Number Theory
189-348 (3) Topics in Geometry
Required Courses (48 credits)
189-222 (3) Calculus III
189-235 (3) Basic Algebra I
189-236 (3) Linear Algebra I
189-242 (3) Analysis I
189-315 (3) Ordinary Differential Equations I
189-317 (3) Numerical Analysis
189-318 (3) Mathematical Logic
189-323 (3) Probability Theory
308-250* (3) Introduction to Computer Science
308-251 (3) Data Structures and Algorithms
308-273 (3) Principles of Assembly Languages
308-302 (3) Programming Languages and Paradigms
308-305 (3) Computer System Architecture
308-310 (3) Computer Systems and Organization
308-330 (3) Theoretical Aspects of Computer Science
308-360 (3) Algorithm Design Techniques

Required Courses (72 credits)
189-222 (3) Calculus III
189-235 (3) Basic Algebra I
189-236 (3) Linear Algebra I
189-242 (3) Analysis I
189-315 (3) Ordinary Differential Equations I
189-317 (3) Numerical Analysis
189-318 (3) Mathematical Logic
189-323 (3) Probability Theory
308-250* (3) Introduction to Computer Science
308-251 (3) Data Structures and Algorithms
308-273 (3) Principles of Assembly Languages
308-302 (3) Programming Languages and Paradigms
308-305 (3) Computer System Architecture
308-310 (3) Computer Systems and Organization
308-330 (3) Theoretical Aspects of Computer Science
308-360 (3) Algorithm Design Techniques

Complementary Courses (24 credits)
12 credits from the set of courses recommended for a Major or Honours Program in Mathematics.
12 credits from the set of courses recommended for a Major or Honours Program in Computer Science.

Students will not receive credit for 189-240.

HONOURS PROGRAMS

The minimum requirement for entry into the Honours program is that the student has completed with high standing the following courses: 189-133, 189-140, 189-141, or their equivalents. In addition, a student who has not completed the equivalent of 189-222 must take it in the first term without receiving credits towards the credits required in the Honours program.

Students who transfer to Honours in Mathematics from other programs will have credits for previous courses assigned, as appropriate, by the Department.

To remain in an Honours program and to be awarded the Honours degree, the student must maintain a 3.00 GPA in the required and complementary Mathematics courses of the program, as well as an overall CGPA of 3.00.

HONOURS PROGRAM IN APPLIED MATHEMATICS (68 credits)
Aside from seeking to develop a sound basis in Applied Mathematics, one of the objectives of the program is to kindle the students' interest in possible areas of application. The extra-mural courses are included to ensure that the student has some appreciation of the scope of Applied Mathematics and is familiar with at least one of the diversity of areas in which applications can be found.

Required Courses (39 credits)
189-235 (3) Basic Algebra I
189-242 (3) Analysis I
189-248 (3) Advanced Calculus I
189-251 (3) Algebra II
189-255 (3) Analysis II
189-325 (3) Ordinary Differential Equations
189-355 (3) Probability
189-356 (3) Statistics
189-375 (3) Differential Equations II
189-387 (3) Numerical Analysis
189-466 (3) Complex Analysis
or 189-249 (3) Advanced Calculus II
308-251 (3) Data Structures and Algorithms
308-250* (3) Introduction to Computer Science

Complementary Courses (29 credits)
at least 6 credits selected from:
189-354 (3) Analysis III
189-355 (3) Analysis IV
189-370 (3) Algebra III
189-371 (3) Algebra IV
189-380 (3) Differential Geometry

or 189-247 (3) Advanced Calculus II
308-251 (3) Data Structures and Algorithms
308-250* (3) Introduction to Computer Science

at least 9 credits selected from:
189-382 (3) Dynamical Systems, Fractals and Chaos
189-397 (3) Matrix Numerical Analysis
189-470 (3) Honours Project
189-487 (3) Mathematical Programming
189-523 (4) Generalized Linear Models
189-555 (4) Fluid Dynamics
189-556 (4) Mathematical Statistics I
189-557 (4) Mathematical Statistics II
189-560 (4) Optimization
189-561 (4) Analytical Mechanics
189-574 (4) Ordinary Differential Equations
189-575 (4) Partial Differential Equations
189-579 (4) Numerical Differential Equations
189-585 (4) Integral Equations and Transforms
189-586 (4) Applied Partial Differential Equations

and the following, for which half credit only may be counted:
189-407 (3) Dynamic Programming
189-423 (3) Regression and Analysis of Variance
189-425 (3) Sampling Theory and Applications
189-447 (3) Stochastic Processes
12 credits of extra-mural courses: chosen in consultation with the student's advisor from approved courses in other departments. A list of such courses is available from the Department of Mathematics and Statistics. Student initiative is encouraged in suggesting other courses that fulfill the intentions of this section as described above. Such suggestions must receive departmental approval. They must be in a field related to Applied Mathematics such as Atmospheric and Oceanic Science, Biology, Biochemistry, Chemistry, Computer Science, Earth and Planetary Science, Economics, Engineering, Management, Physics, Physiology and Psychology. At least 6 credits must be chosen from a single department other than Computer Science.

HONOURS PROGRAM IN PROBABILITY AND STATISTICS
(63 credits)
All Honours students are encouraged to take 189-325, 189-375, 189-376 and 189-447 in their program.
Students primarily interested in probability should include courses 189-325, 189-375 and 189-447 in their program.

Required Courses (46 credits)
189-235 (3) Basic Algebra I
189-242 (3) Analysis I
189-248 (3) Advanced Calculus I
189-249 (3) Advanced Calculus II
or 189-466 (3) Complex Analysis
189-251 (3) Algebra I
189-255 (3) Analysis II
189-354 (3) Analysis III
189-356 (3) Probability
189-357 (3) Statistics
189-358 (3) Mathematical Statistics I
189-359 (4) Mathematical Statistics II
189-367 (4) Advanced Probability Theory I
189-369 (4) Advanced Probability Theory II
308-250* (3) Introduction to Computer Science
*308-250 may be replaced by 308-202 and 308-203

Complementary Courses (17 credits)
selected from:
189-325 (3) Ordinary Differential Equations
189-355 (3) Analysis IV
189-375 (3) Differential Equations II
189-387 (3) Numerical Analysis
189-397 (4) Matrix Numerical Analysis
189-470 (3) Honours Project
189-523 (4) Generalized Linear Models
189-524 (4) Nonparametric Statistics
and the following, for which half credit only may be counted:
189-423 (3) Regression and Analysis of Variance
189-425 (3) Sampling Theory and Applications
189-447 (3) Stochastic Processes

JOINT HONOURS PROGRAM IN MATHEMATICS AND COMPUTER SCIENCE (72 credits)
Students must consult an Honours advisor in both departments.

Required Courses (45 credits)
189-235 (3) Basic Algebra I
189-242 (3) Analysis I
189-248 (3) Advanced Calculus I
189-251 (3) Algebra II
189-255 (3) Analysis II
189-387 (3) Numerical Analysis
308-250* (3) Introduction to Computer Science
308-251 (3) Data Structures and Algorithms
308-273 (3) Principles of Assembly Languages
308-302 (3) Programming Languages and Paradigms
308-305 (3) Computer System Architecture
308-310 (3) Computer Systems and Organization
308-330 (3) Theoretical Aspects of Computer Science
308-420 (3) Files and Databases
308-506 (3) Advanced Analysis of Algorithms
*308-250 may be replaced by 308-202 and 308-203

Complementary Courses (27 credits)
18 credits selected from:
189-325 (3) Ordinary Differential Equations
189-354 (3) Analysis III
189-355 (3) Analysis IV
189-356* (3) Probability
189-357* (3) Statistics
189-370 (3) Algebra III
189-371 (3) Algebra IV
189-375 (3) Differential Equations II
189-466 (3) Complex Analysis
9 credits selected from:
308-335 (3) Software Engineering Methods
308-421 (3) Introduction to Database Systems
308-424 (3) Topics in Artificial Intelligence I
308-426 (3) Automated Reasoning
308-433 (3) Personal Software Engineering
308-505 (3) High-Performance Computer Architecture
308-507 (3) Computational Geometry
308-524 (3) Compiler Design
308-524 (3) Theoretical Found. of Prog. Languages
308-530 (3) Formal Languages
308-531 (3) Theory of Computation
308-534 (3) Team Software Engineering
308-535 (3) Computer Networks
308-538 (3) Person-Machine Communication
308-540 (3) Matrix Computations
308-557 (3) Fundamentals of Computer Graphics
308-566 (3) Computer Methods in Operations Research
308-573 (3) Microcomputers
308-575 (3) Fundamentals of Distributed Algorithms
*Students with appropriate background in probability may substitute 189-355 and 189-356 for 189-357 and 189-358 and must then also register for 189-355.

JOINT HONOURS PROGRAM IN MATHEMATICS AND PHYSICS
See the Physics section of this Calendar for complete program information.

COURSE DESCRIPTIONS
Note: When this Calendar went to press final information was not yet available on which courses at the 400 and 500 levels would be given in 1998-99. Consult the Department of Mathematics and Statistics for up-to-date information on these courses.

The names appearing after the course descriptions are those of instructors who were associated with the courses during the 1997-98 academic year.

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

• Denotes courses not offered in 1998-99.
★ Denotes courses offered only in alternate years.

189-112A,B FUNDAMENTALS OF MATHEMATICS, (3) (Not open to students who have taken CEGEP course 201-101.) (Open only to those students who are deficient in a pre-calculus background.) Equations and inequalities, graphs, relations and functions, exponential and logarithmic functions, trigonometric functions and their use, mathematical induction, binomial theorem, complex numbers. Staff

189-133A,B VECTORS, MATRICES AND GEOMETRY, (3) (Prerequisites: a course in functions.) (Not open to students who have taken 189-221 or CEGEP course 201-105.) Systems of linear equations, matrices; geometric vectors in three dimensions, dot product, cross product, lines and planes; introduction to vector spaces, lin-
ear dependence and independence, bases; quadratic loci in two
and three dimensions.  

189-139A,B CALCULUS. (4) (3 hours lecture; 2 hours tutorial) (Prerequi-
site: a course in functions.) (Not open to students who have
taken 189-120 or CEGEP course 201-103. This course is intended
for students with no previous knowledge of Calculus; it is not open
to students who have had one term of College level Calculus.)
(Students continue in 189-141.) Review of functions and graphs.
Limits, continuity, derivative. Differentiation of elementary func-
Note: Each Tutorial section is enrolment limited.  

189-140A,B CALCULUS I. (3) (3 hours lecture, tutorial sessions)
(Prerequisite: High School Calculus.) (Not open to students who
have taken 189-122 or CEGEP course 201-103.) Review of func-
tions and graphs. Limits, continuity, derivative. Differentiation of
elementary functions. Antidifferentiation. Applications. Staff

189-141A,B CALCULUS II. (4) (3 hours lecture; 2 hours tutorial)
(Not open to students who have taken 189-121 or CEGEP course
201-203) (Prerequisites: 189-139 or 189-140 or 189-150) The def-
finite integral. Techniques of integration. Applications. Introduction
To sequences and series.
Note: Each Tutorial section is enrolment limited.

189-150A CALCULUS A. (4) (3 hours lecture, 2 hours tutorial)
(Prerequisite: A course containing Vector Geometry or corequisite:
189-133. Intended for students with high school calculus who have
not received six advanced placement credits.) (Not open to stu-
dents who have taken CEGEP course 201-103.) (189-150 and
189-151 cover the material of 189-139, 189-141, 189-150 and
189-151 cover the material of 189-139, 189-141, 189-222.)
Functions, limits and continuity, differentiation, L'Hopital's rule,
applications, Taylor polynomials, parametric curves, functions of
several variables.
Note: Each Tutorial section is enrolment limited.

189-151B CALCULUS B. (4) (3 hours lecture; 2 hours tutorial) (Pre-
requisite: 189-150.) (Not open to students who have taken CEGEP
course 201-203.) Integration, methods and applications, infinite
sequences and series, power series, arc length and curvature,
multiple integration.

189-203A,B PRINCIPLES OF STATISTICS I. (3) (No calculus prereq-
usites.) (This course is intended for students in all disciplines and
is not open to students in Mathematics programs; or to students
who have taken or are taking 189-324.) Examples of statistical
data and the use of graphical means to summarize the data. Basic
sampling distributions.

189-204B PRINCIPLES OF STATISTICS II. (3) (Prerequisite: 189-203
or equivalent. No calculus prerequisites.) (This course is intended
for students in all disciplines and is not open to students in Math-
ematics programs; or to students who have taken or are taking 189-
324.) (Note: Credit for other statistics courses may preclude credit
for this course and conversely, see "Course Overlap" on page
335.) The concept of degrees of freedom and the analysis of vari-
ability. Planning of experiments. Experimental designs. Polynomial
and multiple regressions. Statistical computer packages (no previ-
ous computing experience is needed). General statistical proce-
dures requiring few assumptions about the probability model.

189-211B PRACTICAL METHODS OF MATHEMATICS. (3) (Prerequi-
site: 189-111 or CEGEP 101 or consent of instructor.) (Not open to
students in the Faculty of Science, students in Mathematics or
Computer Science programs or students who have taken or are
taking any of 189-240, 189-343, 189-363 or any statistics course.)
The course consists of elementary topics in graph theory and sta-
tistics with a number of applications to practical situations. Topics
include street networks (Euler circuits), travelling salesman problem, planning and schedul-
ing, critical path schedules, linear programming. Random
sampling, statistical evidence, describing data, probability models,
sampling distributions.

189-222A,B CALCULUS III. (3) (Prerequisite: 189-141. Corequi-
site: 189-133) (Not open to students who have taken CEGEP
course 201-303 or 189-150, 189-151 or 189-227.) Taylor series,
Taylor's theorem in one and several variables. Partial differenta-
tion, directional derivative. Extreme of functions of 2 or 3 variables.
Parametric curves and arc length. Polar and spherical coordi-
nates. Multiple integrals.

189-223A,B LINEAR ALGEBRA. (3) (Prerequisite: 189-133 or equiva-
 lent.) (Not open to students in Mathematics programs nor to
students who have taken or are taking 189-247. It is open to stu-
dents in Faculty Programs.) Review of matrix algebra, determi-
nants and systems of linear equations. Vector spaces, linear
operators and their matrix representations, orthogonality. Eigen-
values and eigenvectors, diagonalization of Hermitian matrices.
Applications.

189-227A,MATHEMATICS FOR LIFE SCIENCE STUDENTS. (3) (Pre-
requisite: 189-141 or equivalent.) (Not open to students who have
taken CEGEP course 201-303 or to students who have taken or are
taking 189-222, 189-150, 189-151.) Vectors, lines and planes in
R3. Partial differentitation; gradients, chain rule, max/min of func-
tions of two and three variables. Curves in polar coordinates.
Curves in space: arc length, curvature. Double integration. Intro-
donary to ordinary differential equations. Applications.

189-235A,BASIC ALGEBRA I. (3) (3 hours lecture; 1 hour tutorial)
(Prerequisite: 189-133 or equivalent.) Sets and relations. Rings
and fields. Integers, rationals, real and complex numbers; modular
arithmetic. Polynomials over a field. Divisibility theory for integers
and polynomials. Linear equations over a field. Introduction to vec-
tor spaces.

189-236B LINEAR ALGEBRA I. (3) (Prerequisite: 189-235) Continu-
ation of the topics of 189-235. Linear mappings. Matrix represen-
tation of linear mappings. Determinants. Eigenvectors and
Bilinear and quadratic forms. Inner product spaces, orthogonal
diagonalization of symmetric matrices. Canonical forms.

189-240A DISCRETE STRUCTURES AND COMPUTING. (3) (Corequi-
sites: 189-133 and 189-222. For Major and Honours students in
Computer Science only. Others only with the instructor's permis-
sion.) Abstractly defined mathematical structures. Mathematical
induction. Sets, relations and functions. Combinatorics; graphs;
recurrences; generating functions. Lattices, Boolean algebras,

189-242A ANALYSIS I. (3) (Prerequisite: 189-141) A rigorous presen-
tation of sequences and of real numbers and basic properties of
continuous and differentiable functions on the real line.

189-243B REAL ANALYSIS. (3) (Prerequisite: 189-242) Infinite
series; series of functions; power series. The Riemann integral
in one variable. A rigorous development of the elementary functions.

189-247B LINEAR ALGEBRA. (3) (Prerequisite: 189-133 or equiva-
 lent. Intended for Honours Physics and Engineering students.)
(Not open to students who have taken or are taking 189-236 or
189-248A Advanced Calculus I. (3) (Prerequisites: 189-133 and 189-222 or consent of Department. Intended for Honours Mathematics, Physics and Engineering students.) (Not open to students who have taken or are taking 189-316.) Partial derivatives; implicit functions; Jacobians; maxima and minima; Lagrange multipliers. Scalar and vector fields; orthogonal curvilinear coordinates. Multiple integrals; arc length, volume and surface area. Line integrals; Green's theorem; the divergence theorem. Stokes' theorem; rotational and solenoidal fields; applications. Professor Zlobec

189-249B Advanced Calculus II. (3) (Prerequisite: 189-248. Intended for Honours Physics and Engineering students.) (Not open to students who have taken or are taking 189-316.) Functions of a complex variable; Cauchy-Riemann equations; Cauchy's theorem and consequences. Taylor and Laurent expansions. Residue calculus; evaluation of real integrals; integral representation of special functions; the complex inversion integral. Conformal mapping; Schwarz-Christoffel transformation; Poisson's integral formulas; applications. Professor Roth


189-255B Analysis II. (3) (Prerequisites: 189-242 or permission of the Department.) Series of functions including power series. Riemann integration in one variable. Elementary functions. Professor GowriSankaran

189-314A,B Advanced Calculus. (3) (Prerequisites: 189-133, 189-222.) (Not open to students who have taken or are taking 189-248.) Derivative as a matrix. Chain rule. Implicit functions. Constrained maxima and minima. Jacobians. Multiple integration. Line and surface integrals. Theorems of Green, Stokes and Gauss. Staff

189-315A,B Ordinary Differential Equations. (3) (Prerequisite: 189-222. Corequisite 189-133.) (Not open to students who have taken or are taking 189-325.) First order ordinary differential equations including elementary numerical methods. Linear differential equations. Laplace transforms. Series solutions. Professor Hurtubise

189-316A Functions of a Complex Variable. (3) (Prerequisites: 189-314 and 189-243.) (Not open to students who have taken or are taking 189-249.) Algebra of complex numbers, Cauchy-Riemann equations, complex integral, Cauchy's theorems. Taylor and Laurent series, residue theory and applications. Professor GowriSankaran


189-318A Mathematical Logic. (3) (Not open to students who are taking or have taken 107-210.) Propositional calculus, truth tables, switching circuits, natural deduction, first order predicate calculus, axiomatic theories, set theory. Professor Bunge

189-319B Partial Differential Equations. (3) (Prerequisites: 189-223 or 189-236, 189-314, 189-315) First order equations, geometric theory; second order equations, classification; Laplace, wave and heat equations, Sturm-Liouville theory, Fourier series, boundary and initial value problems. Professor Schmidt

189-320A Differential Geometry. (3) (Prerequisites: 189-236 or 189-223 or 189-247, and 189-314 or 189-248) Review of Euclidean geometry. Local theory of plane and space curves: the Frenet formulas. Local theory of surfaces: the first and second fundamental forms, the shape operator, the mean and Gaussian curvatures, surfaces of revolution with prescribed curvature, ruled and developable surfaces. Geodesic curves on surfaces of revolution. The Gauss-Codazzi equations, rigidity. Staff

189-322A Dynamical Systems, Fractals and Chaos. (3) (Prerequisites: 189-133, 189-222; a programming language or consent of instructor.) (Not open to students who have taken 189-222.)

189-323A,B Probability Theory. (3) (Prerequisites: 189-141 or equivalent. Intended for students in Science, Engineering and related disciplines, who have had differential and integral calculus.) (Not open to students who have taken or are taking 189-356.) Sample space, events. Conditional probability, independence. Bayes' theorem with applications. Random variables, univariate distributions. Mathematical expectation, moment generating function. The binomial, Poisson, exponential, normal and other distributions. Joint distributions, transformation of variables. The weak law of large numbers. Sampling distributions, chi-squared, student-t, F variables. The central limit theorem. Staff

189-324A,B Statistics. (3) (Prerequisite: 189-323 or equivalent.) (Not open to students who have taken or are taking 189-357.) (Note: Credit for other statistics courses may preclude credit for this course and conversely, see “Course Overlap” on page 335.) The notion of a random sample. Sampling distributions, with reference to those related to the normal; chi-squared, F and t (review). Point estimation. Hypothesis testing, the notion of power function. Likelihood-ratio tests. Contingency tables, goodness-of-fit. Some nonparametric procedures. Regression and the method of least squares, analysis of variance, one-way and two-way classifications. Staff

189-325A,B Ordinary Differential Equations. (3) (Prerequisite: 189-222. Intended for Honours Mathematics, Physics and Engineering programs.) (Not open to students who have taken 189-261, 189-315.) First and second order equations, linear equations, applications, series solutions, elementary numerical methods, Fourier series, Laplace transforms. Professors Drury and Schmit

189-327B Matrix Numerical Analysis. (3) (Prerequisites: 189-223 or 189-236. Corequisite 189-317)

189-328B Computability and Mathematical Linguistics. (3)

189-329B Theory of Interest. (3) (Prerequisite: 189-141) Simple and compound interest, annuities certain, amortization schedules, bonds, depreciation. Professor Turner

189-338A History and Philosophy of Mathematics. (3) Egyptian, Babylonian, Greek, Indian and Arab contributions to mathematics are studied together with some modern developments they give rise to, for example, the problem of trisecting the angle. European mathematics from the Renaissance to the 18th century is discussed in some detail. Professor Barr

189-339B Topics in the Foundations of Mathematics. (3) (Prerequisites: 189-235, 189-318) A continuation of 189-338. Topics are chosen mainly from 19th and 20th century mathematics, with some emphasis on philosophical and foundational problems. Sample topics are: progress in number theory, construction of the number system, infinity according to Cantor, logic and foundations from Aristotle to Cohen, G"odel's incompleteness theorem, calculability and programs, formalism versus intuitionism, abstract mathematics and categories. Staff

189-340B Abstract Algebra and Computing. (3) (Prerequisites: 189-240, 189-223 (or 236)) (For Major and Honours students in Computer Science only. Others only with the instructor's permission.) Basic number theory: divisibility, Euclid's algorithm, congruences, Fermat's "little" theorem, primality testing, factoriza-
189-343A DISCRETE MATHEMATICS AND APPLIED ALGEBRA. (3) (Prerequisites: 189-236, 308-202) Basic combinatorics, introduction to graph theory, matching, elementary group theory and symmetry, direct graphs and networks, modular arithmetic and its applications. **Professor Brown**

189-348A TOPICS IN GEOMETRY. (3) (Prerequisite: Previous course in Mathematics.) Selected topics – the particular selection may vary from year to year. Topics include: isometries in the plane, symmetry groups of frieze and ornamental patterns, equidecomposability, non-Euclidean geometry and problems in discrete geometry. **Staff**

189-354A ANALYSIS III. (3) (Prerequisite: 189-255 or equivalent) Introduction to metric spaces. Multivariable differential calculus, implicit and inverse function theorems. **Professor Choksi**

189-355B ANALYSIS IV. (3) (Prerequisite: 189-255 or equivalent) Lebesgue measure on R^n and integration, convergence theorems, Fubini's theorem. Further topics in metric spaces, introduction to L^p spaces, Fourier series. **Staff**

189-356A PROBABILITY. (3) (Prerequisites: 189-255 or -243) Basic combinatorial probability. Introductory distribution theory of univariate and multivariate distributions with special reference to the binomial, Poisson, Gamma and Normal distributions. Characteristic functions. Weak law of large numbers. Central limit theorem. **Professor Wolfson**

189-357B STATISTICS. (3) (Prerequisite: 189-356 or equivalent) Data analysis. Estimation and hypothesis testing. Power of tests. Likelihood ratio criterion. The chi-squared goodness of fit test. Introduction to regression analysis and analysis of variance. **Professor Wolfson**

189-370A ALGEBRA III. (3) (Prerequisite: 189-251) Introduction to monoids, groups, permutation groups; the isomorphism theorems for groups; the theorems of Cayley, Lagrange and Sylow; structure of groups of low order. Introduction to ring theory; integral domains, fields, quotient field of an integral domain; polynomial rings; unique factorization domains. **Professor Labute**

189-371B ALGEBRA IV. (3) (Prerequisite: 189-370) Introduction to modules and algebras; finitely generated modules over a principal ideal domain. Field extensions; finite fields; Galois groups; the fundamental theorem of Galois theory; application to the classical problem of solvability by radicals. **Professor Labute**

189-375A DIFFERENTIAL EQUATIONS. (3) (Prerequisite: 189-325) First order partial differential equations, geometric theory, classification of second order linear equations, Sturm-Liouville problems, orthogonal functions and Fourier series, eigenfunction expansions, separation of variables for heat, wave and Laplace equations, Green's function methods, uniqueness theorems. **Professor Roth**

189-377B NUMBER THEORY. (3) (Prerequisite: Enrolment in Mathematics Honours program or consent of instructor.) This course consists of the lectures of 189-346B together with a special project or projects assigned after consultation between the instructor and student. **Staff**

189-380B DIFFERENTIAL GEOMETRY. (3) (Prerequisites: 189-251 or 189-247, and 189-248 or 189-314) In addition to the topics of 189-320, topics in the global theory of plane and space curves, and in the global theory of surfaces are presented. These include: total curvature and the Fary-Milnor theorem on knotted curves, abstract surfaces as 2-d manifolds, the Euler characteristic, the Gauss-Bonnet theorem for surfaces. **Professor Hurtubise**

189-382A DYNAMICAL SYSTEMS, Fractals and Chaos. (3) (Prerequisites: 189-133, 189-222; a programming language or consent of instructor.) (Not open to students who have taken 189-422.) **Professor Evans**

189-387A NUMERICAL ANALYSIS. (3) (Prerequisites: 189-222 and 308-202 or 308-250 or equivalent, or consent of instructor.) (Intended primarily for Honours students.) This course consists of the lectures of 189-317 together with a special project or projects assigned after consultation between the instructor and student. **Professor Drury**

189-407B DYNAMIC PROGRAMMING. (3) (Prerequisites: 308-202; 189-236, 189-314, and 189-323) Sequential decision problems, resource allocation, transportation problems, equipment replacement, integer programming, network analysis, inventory systems, project scheduling, queuing theory calculus of variations, markovian decision processes, stochastic path problems, reliability, discrete and continuous control processes. **Professor Zlobec**

189-420A B INDEPENDENT STUDIES IN MATHEMATICS. (3) Reading projects permitting independent study under the guidance of a staff member specializing in a subject where no appropriate course is available. Arrangements must be made with an instructor and the Chair before registration. **Professor Styan**


189-425A SAMPLING THEORY AND APPLICATIONS. (3) (Prerequisites: 189-324 or equivalent) Basic sampling designs and estimators; simple random, stratified, systematic, and cluster sampling; sampling with unequal probabilities; ratio and regression techniques. **Professor Klemes**

189-437A MATHEMATICAL METHODS IN BIOLOGY. (3) (Prerequisites: 189-315 or 189-325, and 189-323 or 189-356, a CEGEP or higher level Computer Programming course.) The formulation and treatment of realistic mathematical models describing biological phenomena through such qualitative and quantitative mathematical techniques as local and global stability theory, bifurcation analysis and phase plane analysis. Numerical simulation. Concrete and detailed examples will be drawn from molecular, cellular and population biology and mammalian physiology. **Staff**

189-447B STOCHASTIC PROCESSES. (3) (Prerequisites: 189-323) **Professor Drury**
189-480A,B INDEPENDENT STUDIES IN MATHEMATICS. (3) Reading projects permitting independent study under the guidance of a staff member specializing in a subject where no appropriate course is available. Arrangements must be made with an instructor and the Chair for registration.

189-487A MATHEMATICAL PROGRAMMING. (3) (Prerequisites: 189-248, 189-251 and 308-202 or 189-250 or equivalent.) Intended primarily for honours students. This course consists of the lectures of 189-417 together with a special project or projects assigned after consultation between the instructor and the student.


189-505A FLUID DYNAMICS. (4) (Prerequisites: 189-315 and 189-319 or equivalent) Kinematics. Dynamics of general fluids. Inviscid fluids. The Navier-Stokes equations. Exact solutions of the Navier-Stokes equations. Low and high Reynolds number flow.

189-574A ADVANCED REAL ANALYSIS I. (4) (Prerequisites: 189-354, 189-355 or equivalents.) Review of theory of measure and integration; product measures, Fubini's theorem; L^2 spaces; basic principles of Banach spaces; Riesz representation theorem for C(X); Hilbert spaces; part of the material of 189-565B may be covered as well.

189-575A PARTIAL DIFFERENTIAL EQUATIONS. (4) (Prerequisite: 189-574A) Sample theory, (including large-sample theory), Likelihood functions and information matrices. Hypothesis testing, estimation theory. Regression and correlation theory. Weak point.


189-581A ANALYTICAL MECHANICS. (4) (Prerequisites: 189-354 and 189-380 or instructor's approval.) Basic differential geometry. Lagrangian formulation: Euler-Lagrange equations, Noether's theorem, applications. Hamiltonian formalism: symplectic forms and Legendre transformation, symmetry and conserved quantities, completely integrable systems, Poisson brackets.

189-584A ADVANCED REAL ANALYSIS II. (4) (Prerequisite: 189-564) Continuation of topics from 189-564. Signed measures, Hahn and Jordan decompositions. Radon-Nikodym theorems, complex measures, differentiation in R^1, Fourier series and integrals, additional topics.

189-586B ADVANCED COMPLEX ANALYSIS. (4) (Prerequisites: 189-466A, 189-564A) Simple connectivity, use of logarithms; argument, conservation of domain and maximum principles; analytic continuation, monodromy theorem; conformal mapping; normal families, Riemann mapping theorem; harmonic functions, Dirichlet problem; introduction to functions of several complex variables.

189-570A HIGHER ALGEBRA I. (4) (Prerequisite: 189-371 or equivalent) Review of group theory; free groups and free products of groups. Sylow theorems. The category of R-modules; chain conditions, tensor products, flat, projective and injective modules. Basic commutative algebra; prime ideals and localization, Hilbert Nullstellensatz, integral extensions. Dedekind domains. Part of the material of 189-571B may be covered as well.

189-571B HIGHER ALGEBRA II. (4) (Prerequisites: 189-570 or consent of instructor.) Completion of the topics of 189-570. Rudiments of algebraic number theory. A deeper study of field extensions; Galois theory, separable and regular extensions. Semi-simple rings and modules. Representations of finite groups.


189-575A PARTIAL DIFFERENTIAL EQUATIONS. (4) (Prerequisite: 189-375) A continuation of topics introduced in 189-375.

189-576A GEOMETRY AND TOPOLOGY I. (4) (Prerequisite: 189-354) Basic point-set topology, including connectedness, compactness, product spaces, separation axioms, metric spaces. The fundamental group and covering spaces. Simplicial complexes. Singular and simplicial homology. Part of the material of 189-577B may be covered as well.


189-579B NUMERICAL DIFFERENTIAL EQUATIONS. (4) (Prerequisites: a background in ordinary and partial differential equations as well as numerical analysis, with instructor's approval.) Basic error analysis. Numerical solution of initial and boundary value problems for ordinary differential equations; simple, multiple shooting methods and finite difference methods. Finite difference methods for partial differential equations; parabolic, hyperbolic and elliptic equations, consistency, convergence and stability of numerical schemes. Explicit and implicit methods, alternating direction explicit and alternating direction implicit methods.


Professor Tam

189-586A APPLIED PARTIAL DIFFERENTIAL EQUATIONS. (4) (Prerequisites 189-316, 189-375 or equivalent.) Linear and nonlinear partial differential equations of applied mathematics. Classification and appropriate partial initial and/or boundary conditions for elliptic, hyperbolic and parabolic equations. Method of characteristics for first-order systems and quasi linear equations. Transform methods. Introduction to generalized functions. Special techniques for finding exact solutions of nonlinear equations.

Professor Tam


Professor Drury


11.17 Microbiology and Immunology (528)

Lyman Duff Medical Sciences Building, Room 511
3775 University Street
Montreal, QC H3A 2B4
Telephone: (514) 398-3915
Facsimile: (514) 398-7052
Internet: OFFICE@MICROIMM.MCGILL.CA

Chair — MICHAEL S. DUBOW

Professors — ZAHER ALI-KHAN, EDDIE C.S. CHAN, JAMES W. COULTON, MICHAEL S. DUBOW, JOHN HISCOTT, JONATHAN I. MEINERS, JACOB MENDELSON, ROBERT A. MURGITA, HUGH G. ROBSON, MARK A. WAINBERG

Associate Professors — NICHOLAS H. ACHESON, MALCOLM G. BAINES, DALIUS J. BRIEDIS, MICHAEL J.H. RATCLIFFE

Assistant Professors — GREGORY T. MARCZYNSKI, DAVID PORTNOY, JOSEPH PORTNOY, PIERRE RENE

Associate Members — JONATHAN J. EVANS, REPORT, BRIAN J. RICHARDSON, NAOMI A. ROBB, J. GREGORY RICE, JOSEPH S. G. FELDMAN, JOHN S. DAWSON, JAMES W. COULTON, JOHN HISCOTT, JONATHAN I. MEINERS, JACOB MENDELSON, ROBERT A. MURGITA, HUGH G. ROBSON, MARK A. WAINBERG

Adjunct Professor — PATRICK HUGO, CHRIS RICHARDSON, RAFICK-P. SEKALY, URSULA UTZ

Affiliated centre: Centre for Host Resistance, Montreal General Hospital, 1650 Cedar Avenue, Montreal, QC H3G 1A4.

Telephone: (514) 398-8038. Director: E. Skamane

Microbiology is the study of microorganisms such as bacteria, viruses, unicellular eukaryotes, and parasites. Microorganisms play an important role in human and animal disease, food production (bread, cheese, wine), decay and spoilage, contamination and purification of water and soil. Microbiologists study these tiny, self-replicating machines to understand the basic principles of life: growth, metabolism, cell division, control of gene expression, response to environmental stimuli. Microbiologists are also concerned with controlling or harnessing microorganisms for the benefit of people, by isolating antibiotics or producing vaccines to protect against disease, and by developing and perfecting microorganisms for industrial uses.

Immunology is the study of the molecular and cellular basis of host resistance and immunity to external agents such as pathogenic microorganisms. Immunologists study the mechanisms by which the body recognizes foreign antigens, generates appropriate antibodies to an enormously diverse spectrum of antigens, and secretes and kills invading microorganisms. Their discoveries lead to vaccination against disease, transfusions and organ transplants, allergies, cancer, autoimmune diseases and immune-deficiency diseases such as AIDS. Antibodies may soon be used in conjunction with antibiotics or chemical agents as specific "magic bullets" to diagnose disease and attack microbes and cancers.

The disciplines of microbiology and immunology are natural partners in research, and both fields use the modern methods of cell biology, molecular biology and genetics to study basic life processes. The members of the Department of Microbiology and Immunology perform research on microbiological physiology and genetics, microbial pathogenesis, molecular virology, cellular and molecular immunology, and parasitology. Students registered in the Department therefore are exposed to these related areas and receive an excellent background in basic biology and chemistry as well as in the more applied areas of biotechnology and medicine.

Many opportunities exist for careers in basic or applied microbiology and immunology, medical microbiology, environmental microbiology, and biotechnology. They include positions in industry (pharmaceutical and biotechnology), hospitals, universities, and government (environment, public health, and energy). A degree in microbiology also provides an excellent basis for entering professional and postgraduate programs in medicine, dentistry, the veterinary sciences, research, and education.

Notes on admission to Microbiology and Immunology programs. Please note that enrolment to Microbiology and Immunology programs is limited to a total of 120 students per year. Students seeking admission to the Faculty, Majors and Honours programs must have completed 177-111A, 177-112B, 180-110B, 180-111B, 180-120A, 180-121A, 189-112A/B, 189-139A/B or 189-149A/B, 198-161A/B and 198-102A/B or their equivalent with a minimum grade of 65% (B-). Students transferring from other programs may be admitted with a B- average up to the maximum program capacity of 120 students. Applicants not admitted will be placed on a waiting list and will be considered should vacancies occur.

An Undergraduate Handbook, containing detailed course descriptions, a listing of faculty research interests, and information on careers in microbiology and immunology, is available from the Student Affairs Office in room 511 of the Lyman Duff Building.

All students (U1, U2, U3) must meet with an adviser prior to registration. For an appointment, telephone (514) 398-3915.

FACULTY PROGRAM IN MICROBIOLOGY AND IMMUNOLOGY (57 credits)

The Faculty Program is intended to offer a basic education in microbiology and immunology to undergraduate students who wish greater flexibility to choose a substantial number of courses from other departments or faculties within the University.
The Honours Program is designed to offer, in addition to the substantial background given by the Major Program, a significant research experience in a laboratory within the Department during the U3 year. Students are prepared for this independent research project by following an advanced laboratory course in U2. This Program is intended to prepare students for graduate study in microbiology and immunology or related fields, but could also be chosen by students intending to enter medical research after medical school, or intending to enter the job market in a laboratory research environment.

Students intending to apply to Honours should follow the Major program in U1 and must obtain a GPA of at least 3.0 to be admitted. A CGPA of 3.3 must be obtained after the U2 year for continuation in the Honours Program. For graduation in Honours, students must pass all required courses with a C or better, and achieve a sessional GPA of at least 3.1 in the U3 year.

U1 Required Courses (25 credits)

as for the Major Program

U1, U2 or U3 Required Statistics Courses (3 credits)

as for the Faculty Program

U2 Required Courses (21 credits)

as for the Major program

U3 Required Courses (21 credits)

as for the Major Program, plus:

528-502D (12) Honours Research

U2 or U3 Complementary Courses (3 credits)

3 credits selected from the Major Program complementary course list

INTERDEPARTMENTAL HONOURS PROGRAM IN IMMUNOLOGY

The Departments of Biochemistry, Microbiology and Immunology and Physiology offer an interdepartmental Honours program in Immunology. Students interested in immunology may choose between this Honours program and the Honours program of the Department of Microbiology and Immunology.

Details of this program may be found under Immunology or by consulting Professor Baines in the Department of Microbiology and Immunology, Room 404, telephone (514) 398-4443 or 3928 or mgbaines@microimm.mcgill.ca

COURSE DESCRIPTIONS

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

- Denotes courses not offered in 1998-99.

528-211A BIOLOGY OF MICROORGANISMS. (3) (3 hours of lecture) (Corequisite: 177-200A) A general treatment of microbiology bearing specifically on the biological properties of microorganisms. Emphasis will be on procaryotic cells. Basic principles of immunology and microbial genetics are also introduced. Professor Chan

528-212A LABORATORY IN MICROBIOLOGY. (2) (3 hours of laboratory, 1 hour of conference) (Corequisite: 528-211A) This laboratory course is designed to complement 528-211A. Sessions introduce general techniques peculiar to the handling of microorganisms. Professor Chan
528-314B IMMUNOLOGY. (3) (3 hours of lecture) (Prerequisite: 177-200A and 177-201B or 507-212B) An introduction to the immune system, antigens, antibodies and lymphocytes. The course will cover the cellular and molecular basis of lymphocyte development and mechanisms of lymphocyte activation in immune responses. 

Professor Ratcliffe

528-323A MICROBIAL PHYSIOLOGY. (3) (3 hours of lecture) (Prerequisites: 528-211A) An introduction to the composition and structure of microbial cells, the biochemical activities associated with cellular metabolism and how these activities are regulated and coordinated. The course will have a molecular and genetic approach to the study of microbial physiology. 

Professor Coulton

528-324A FUNDAMENTAL VIROLOGY. (3) (3 hours of lecture) (Prerequisites: 528-211A, 177-200A, 177-201B or 507-212B) A study of the fundamental properties of viruses and their interactions with host cells. Bacteriophages, DNA- and RNA-containing animal viruses, and retroviruses are covered. Emphasis will be on phenomena occurring at the molecular level and on the regulated control of gene expression in virus-infected cells. 

Professor Acheson

528-386D LABORATORY IN MICROBIOLOGY & IMMUNOLOGY. (6) (1 hour lecture, 6 hours laboratory, 1 hour follow-up) (Prerequisites: 528-211A, 528-212A. Corequisites: 528-314B, 528-323A, 528-324A) A series of illustrative exercises in bacterial classification, bacterial and viral molecular genetics and immunological techniques. The objective is to provide a practical introduction to microbiological and immunological research and technology. 

Professor Baines

528-387B APPLIED MICROBIOLOGY AND IMMUNOLOGY. (3) (Prerequisite: 528-211A) The ability to select and manipulate genetic material has lead to unprecedented interest in the industrial applications of procaryotic and eucaryotic cells. Beginning in the 1970s the introduction of and subsequent refinements to recombinant DNA technology and hybridoma technology transformed the horizons of the biopharmaceutical world. This course will highlight the important events that link basic research to clinical/commercial application of new drugs and chemicals. 

Professor Murgita

528-413B PARASITOLOGY. (3) (Prerequisite: 528-314B or equivalent – 504-261A is strongly recommended) A study of the biology, immunological aspects of host-parasite interactions, pathogenicity, epidemiology and molecular biological aspects of selected parasites of medical importance. Laboratory will consist of a lecture on techniques, demonstrations and practical work. 

Professor Ali-Khan

528-414A ADVANCED IMMUNOLOGY. (3) (3 hours lecture) (Prerequisite: 528-314B) An advanced extending course serving as a logical extension of 528-314B. The course will integrate molecular, cellular and biochemical events involved in the ontogeny of the lymphoid system and its activation in the immune response. The course will provide the student with an up-to-date understanding of a rapidly moving field. 

Professor Ratcliffe

528-465A BACTERIAL PATHOGENESIS AND HOST DEFENCES. (3) (3 hours of lecture) (Prerequisites: 528-211A, 528-314B, 528-323A, or the permission of the instructor) Organized by the McGill Centre for the Study of Host Resistance. This course focuses on the interplay of the host and the pathogen. The cellular and molecular basis of the host defense mechanism against infections will be considered in relationship to the virulence factors and evasion strategies used by bacteria to cause disease. 

Professor Hiscott

528-466B VIRAL PATHOGENESIS AND HOST DEFENCES. (3) (3 hours of lecture) (Prerequisites: 528-211A, 528-324A, 528-314B) A study of the biological and molecular aspects of viral pathogenesis with emphasis on pathogenic viruses; of man including the human retroviruses, HIV and HTLV-1, herpes viruses: papilloma viruses; hepatitis viruses; and new emerging human viral diseases. These viruses will be discussed in terms of virus multiplication, gene expression virus-induced cytopathic effects and host immune response to infection. 

Professor Hiscott

528-502D HONOURS RESEARCH PROJECT. (12) (More than 15 hours per week for an independent research project) (U3 Honours students and Majors students are eligible. Required CGPA: 3.3 or higher.) An information meeting about the course is held annually in February for students who intend to apply for registration. Subject to the availability of space and resources, professors in the Department of Microbiology and Immunology provide research opportunities for registrants in this course. Students present their research findings in a seminar and a final written report is required. Because this is a 12 credit course, students are expected to devote at least 40% of their academic effort towards their research. 

Professor Coulton

528-509B SEMINARS ON INFLAMMATORY PROCESSES. (3) (3 hours of seminar) (Prerequisite: 528-314B. Corequisite: 552-513A or 528-414A) This course concentrates on the non-specific aspects of the immune response, an area which is not adequately covered by the other immunology courses presented at the university. Interactions between guest researchers (from McGill and other universities) and students will be furthered. This course will be given in conjunction with the Division of Experimental Medicine. 

Professor Coulton
210-211A,B THE ART OF LISTENING. (3) hours An introduction to the major forms and styles in Western music from the baroque to the present, with emphasis on guided listening in the classroom. The ability to read music is not a prerequisite. TBA (Co-ordinator)

Not all of the following courses in List I will be offered in 1998-99; for an up-to-date listing, please consult the final 1998-99 Faculty of Music timetable.

Students who read music and have an instrumental or vocal background may proceed directly to courses at the 300 level.

210-374A OR B SPECIAL TOPICS IN MUSIC. (3) hours A course whose topics will correspond to special historical events and their associated musical, political, and cultural contexts.

★ 210-384A OR B ROMANTICISM & THE PIANO. (3) hours (Prerequisite: 210-201 or 210-211 or permission of instructor.)

210-385A MUSIC OF THE AVANT-GARDE. (3) hours (Prerequisite: 210-201 or 210-211) Explorations into post-1945 sound environments; new timbres (Berio and Crumb); "technological" music (electronic and computer music); minimalism (Glass); new aesthetics (Cage); the World Soundscape Project (Schafer); global trends (cross-cultural influences; the New Romanticism; multimedia; protest music). Professor Levitz

★ 210-387A OR B THE OPERA. (3) hours (Prerequisite: 210-201 or 210-211) A survey of opera from c.1600 to the present. Opera as ritual, opera as spectacle, opera as catharsis, opera as business, opera and its literary models. The continuing relevance of the operatic experience today. Professor Lawton

210-389B THE SYMPHONY AND CONCERTO. (3) hours (Prerequisite: 210-201 or 210-211) An historical overview of two major genres in the current concert repertoire: baroque foundations, the Viennese achievement, Beethoven's influence, visionaries and nationalists after 1850, cross-currents in the twentieth century. Professor Morrison

210-392B POPULAR MUSIC AFTER 1945. (3) hours (Prerequisite: 210-201 or 210-211) and permission of instructor.) An historical survey of major artists, genres, and styles in the most widespread traditions of postwar commercial music. The course will include practice in techniques of listening, discussion of the shaping institutions of commercial music, and consideration of the interaction of musical style and culture. Professor White

For course descriptions, please consult Section 8.3 of the Faculty of Music listing.

210-211A,B BASIC MATERIALS OF WESTERN MUSIC I. (3) hours A combination of elementary theory and ear training (sightsinging and aural recognition), and basic piano skills. Topics include: notation of pitch and rhythm, intervals, scales and modes, concept of key, triads and seventh chords, introductory melody and accompaniment writing. Mr. Townsend (Co-ordinator)

210-212A,B BASIC MATERIALS OF WESTERN MUSIC II. (3) hours (Prerequisite: 210-211A,B or permission of instructor.) Integrated course in music theory with creative applications of acquired skills. Analysis and writing: concepts of melodic organization, elementary harmonic progressions, two-part contrapuntal techniques, fundamental formal procedures, examination of popular song and jazz. Development of individual skills: intermediate sightsinging, aural recognition, keyboard techniques, small group performance in class.

210-212A,B ELECTROACOUSTIC MUSIC TECHNIQUES I. (3) hours (Prerequisite: 210-211A,B or permission of instructor.) Integrated course in music theory with creative applications of acquired skills. Analysis and writing: concepts of melodic organization, elementary harmonic progressions, two-part contrapuntal techniques, fundamental formal procedures, examination of popular song and jazz. Development of individual skills: intermediate sightsinging, aural recognition, keyboard techniques, small group performance in class.
THEORY
For course descriptions, please consult Section 8.1 of the Faculty of Music listing.

Note: Students not in the B.A. or B.Sc. Music programs are not required to take the corequisites for the following courses. However, students intending later to enter either the B.A. Major Concentration or the B.Mus. program would then be required to sit placement tests in Musicianship and Keyboard Proficiency and may be required to take these courses.

211-110A MELODY AND COUNTERPOINT. (3) (4 hours) (Prerequisite: Matriculation Music or McGill Conservatory Theory Secondary V or its equivalent. Corequisites: 212-129 and -170 or permission of co-ordinator or instructor.)

Professor Minorgan (Co-ordinator) and Staff

211-111B ELEMENTARY HARMONY AND ANALYSIS. (3) (4 hours) (Prerequisite: 211-110. Corequisites: 212-131 and 212-171)

Professor Schubert (Co-ordinator) and Staff

211-210A,B TONAL THEORY AND ANALYSIS I. (3) (3 hours) (Prerequisites: 211-110 and 111. Corequisite: 212-229. Prerequisite or corequisite: 212-171) (Professor Caplin (Co-ordinator) and Staff)

211-211A,B TONAL THEORY AND ANALYSIS II. (3) (3 hours) (Prerequisite: 211-210. Corequisite: 212-231)

Professor Schubert (Co-ordinator) and Staff

214-185B HISTORY SURVEY (CLASS., ROMANTIC, 20TH-C.). (3) (3 hours) (Prerequisite: audition) Students enroling in Choral Ensembles will be assigned to one of the following groups:

- Section 01 Chamber Singers
- Section 02 Concert Choir
- Section 03 University Chorus
- Section 04 Women's Chorale

215-381A OR B TOPICS IN PERF. PRACTICE BEFORE 1800. (3) (3 hours) Professor Helmer

Music Ensembles
Arts and Science students may, with the permission of the Instructor and the Associate Dean of their own Faculty, participate in one of the following ensembles in a given year. Auditions are held starting the week prior to the beginning of classes in September and continuing during that first week and, in the case of the McGill Symphony Orchestra (243-497A,B), in early January for the winter term. The schedule and requirements for these auditions are available at the end of June from the Department of Performance office (514) 398-4542. Normally both the A and B sections of an ensemble are taken in the same academic year.

The deadline for withdrawing from ensembles is the end of the second week of classes in any term.

For course descriptions, please consult Section 8.9 of the Faculty of Music listing.

243-489A,B WOODWIND ENSEMBLES. (1 plus 1 credit) (2-3 hours) (Prerequisite: audition) Professor Kestenberg (Co-ordinator)

243-490A,B MCGILL WINDS. (2 plus 2 credits) (4-6 hours) (Prerequisite: audition) Professor Gibson (Co-ordinator)

243-491A,B BRASS ENSEMBLES. (1 plus 1 credit) (2-3 hours) (Prerequisite: audition) Professor Gibson (Co-ordinator)

243-493A,B CHORAL ENSEMBLES. (2 plus 2 credits) (4 hours) (Prerequisite: audition) Students enrolling in Choral Ensembles are required to take the corequisites for the following courses. However, unless otherwise indicated the following courses are prerequisites to 300-, 400- and 500-level theory courses: 211-211 or 213-240 AND 212-231 AND 212-171.

211-310A MID & LATE 19TH-C. THEORY & ANALYSIS. (3) (3 hours)

211-311B 20TH-CENTURY THEORY AND ANALYSIS. (3) (3 hours)

243-494A,B CONTEMPORARY MUSIC ENSEMBLE. (2 plus 2 credits) (4 hours) (Prerequisite: audition) Professors Boulelane and Vernon

243-495A,B JAZZ ENSEMBLES. (2 plus 2 credits) (4-6 hours) (Prerequisite: audition) Professors Dotas and Foote

243-496A,B OPERA STUDIO. (4 plus 4 credits) (3-6 hours) (Prerequisite: audition) Professors Ross-Nellig, Vernon and Staff

243-497A,B ORCHESTRA. (2 plus 2 credits) (6-7 hours) (Prerequisite: audition. Corequisite for wind players: 243-478A,B) N.B. Woodwind and brass players will take one hour per week of Repertoire Class as part of Orchestra.

243-499A,B STRING ENSEMBLES. (1 plus 1 credit) (2-3 hours) (Prerequisite: audition) N.B. Guitar ensemble is restricted to Performance Majors only. Section 01 Chamber Music Section 02 Bass Ensemble Section 03 Guitar Ensemble

Professor Saint-Cyr (Co-ordinator)

11.19 Neurology and Neurosurgery (531)

Chair — J ACK ANTEL

Proфессоры — ALBERT AGUAYO, JACK ANTEL, MASSIMO AVOLI, ALAIN BEAUDET, GARTH BRAY, SALVATORE CARBONETTO, MIRKO DIKSIC, ALAN EVANS, JEAN GOSMAN, DANIEL GUITTON, PAUL HOLLAND, BARBARA JONES, GEORGE KAPRATI, BRENDA MILNER, RICHARD MURPHY, YOGESH PATEL, MICHAEL PETRIDES, MICHAEL RASMINSKY, PETER RICHARDSON, GLORIA TANNENBAUM, CHRISTOPHER THOMPSON

Associate Proфессоры — ANGEL ALONSO, EVA ANDERMAN, DOUGLAS ARNOLD, CHARLES BOURQUE, NEIL CASHMAN, HOWARD CHERKOW, SAM DAVID, PIERRE DRAPEAU, ROBERT DUNN, HEATHER DURHAM, EDITH HAMEL, KENNETH HASTINGS, MARYLON JONES-GOTMAN,
It is the brain that makes us what we are, and understanding how the brain works and how it is affected by disease is a major goal of Neuroscience. Neuroscience is both pure science, offering challenging basic research pursuits, as well as medical science, with important clinical applications. The approach to problems in Neuroscience has roots in many of the basic sciences including biology, biochemistry, pharmacology, physiology, and psychology. Powerful techniques of molecular biology, biochemistry, and genetics have revealed new molecules, given insight into how gene expression is controlled, and allowed the identification of defective genes responsible for diseases of the nervous system. Neuronal and glial cells are studied in the context of adult or developing nervous systems, and how neural networks are formed and maintained. Signalling and information transfer within and between cells are investigated by studying individual cells and their synaptic connections, or through research on complex neuronal circuits. Higher neural functions are explored by mapping neural architecture, through the study of specific systems with sophisticated physiological and imaging techniques, and by investigations of the neurobiological mechanisms of behaviour.

The Department of Neurology and Neurosurgery sponsors an undergraduate course in Neuroscience, and additional undergraduate courses are offered in the departments of Biology, Pharmacology, Biochemistry, Psychology, Physiology, and Anatomy. Graduate studies are a very large component of the Department of Neurology and Neurosurgery. The curriculum for graduate degrees in Neurology and Neurosurgery is provided in the Faculty of Graduate Studies and Research Calendar. Inquiries should be directed to the Graduate Program Coordinator, Montreal Neurological Institute, 3801 University Street, Montreal, H3A 2B4.

**11.20 Neuroscience**

**Minor Program in Neuroscience**

Program Coordinator: Professor Ellis Cooper, Department of Physiology. Telephone: (514) 398-4337.

Neuroscience is a multidisciplinary science devoted to the understanding of the nervous system. The brain is one of the most complex systems in the universe, and understanding how it functions is among the most challenging questions in science. Scientists are investigating the brain at many levels, from the molecules at synapses to complex forms of behaviour, with diverse approaches ranging from genetic, biochemical, anatomical, physiological, embryological and psychological. In addition, scientists are investigating the nervous system of many different animals, from simple invertebrates to humans. These wide-ranging investigations are providing a clearer understanding of how neurons work; how they communicate with one another; how they are organized into local or distributed networks; how the connections between neurons are established and change with experience; how neuronal functions are influenced by drugs, nutrients, toxins, and disease states. As a result, we are gaining deeper insights into the neural basis of mental activity, as well as developing new therapeutic approaches to alleviate neurological and psychological diseases.

**MINOR PROGRAM IN NEUROSCIENCE** (24 credits)

The Minor Program in Neuroscience is a program designed for undergraduate students interested in how the nervous system functions. The program consists of courses from the departments of Anatomy and Cell Biology (504), Biochemistry (507), Biology (177), Neurology and Neurosurgery (311), Pharmacology and Therapeutics (549), Physiology (552), Psychiatry (555), and Psychology (204). The Minor is composed of 24 credits, 18 of which must be selected from two of the five topic areas listed below. Twelve credits of the 18 must be at the 400/500 level and from at least two different departments. A maximum of 6 credits can be counted both for the student's primary program and for the Minor Program in Neuroscience, where appropriate.

**All course selections for the Minor Program in Neuroscience must be approved by the Program Coordinator.**

**Complementary Courses** (24 credits)

6 credits selected from:

- 204-308A (3) Physiological Psychology I: Fundamentals
- or 177-306A (3) Neurobiology and Behaviour
- or 552-311A (3) Intermediate Physiology I
- 504-321A (3) Circuity of the Human Brain
- 531-310B (3) Cellular Neurobiology

18 additional credits:

9 credits each from 2 of the 5 areas listed below. 6 credits in each area must be from 400- or 500-level courses.

**Neurobiology and Behaviour**

- 177-306A (3) Neurobiology and Behaviour
- 177-389B (3) Laboratory in Neurobiology
- 204-318B (3) Physiological Psychology II: Motivation and Learning
- 552-311A (3) Intermediate Physiology I
- 177-430B (3) Neural Basis of Behaviour
- 177-431A (3) Neurobiology of Learning & Memory
- 204-422B (3) Neurochemical Basis of Behaviour
- 204-427B (3) Motor Control and Human Performance
- 204-505A (3) The Psychology of Pain
- 552-556B (3) Topics in Systems Neuroscience
- 555-500B (3) Advances in the Neurobiology of Mental Disorders

**Molecular and Developmental Neurobiology**

- 504-321B (3) Circuitry of the Human Brain
- 531-310B (3) Cellular Neurobiology
- 552-311A (3) Intermediate Physiology I
- 177-532B (3) Developmental Neurobiology Seminars
- 177-588A (3) Molecular/Cellular Neurobiology
- 204-431B (3) The Environment and the Developing Brain
- 507-455B (3) Neurochemistry
- 552-451A (3) Advanced Neurophysiology

**Neurophysiology**

- 177-389B (3) Laboratory in Neurobiology
- 504-322B (3) Neuroendocrinology
- 552-311A (3) Intermediate Physiology I
- 177-431A (3) Neurobiology of Learning & Memory
- 177-588A (3) Molecular/Cellular Neurobiology
- 204-427B (3) Motor Control and Human Performance
- 552-451A (3) Advanced Neurophysiology
- 552-520B (3) Ion Channels
- 552-556B (3) Topics in Systems Neuroscience

**Neuropsychology**

- 177-306A (3) Neurobiology and Behaviour
- 204-311A (3) Human Behaviour and the Brain
- 204-318B (3) Physiological Psychology II: Motivation and Learning
11.23 Pharmacology and Therapeutics (549)

McIntyre Medical Building
3655 Drummond
Montreal, QC H3G 1Y6
Telephone: (514) 398-3623

Chair — A. Claudio Cuello
Emeritus Professor — Mark Nickerson

Professors — Jack Aranda, Radan Capek (Vice-chair), Brian Collier, A. Claudio Cuello, Claude De Montigny, Barbara Hales, Peter J. McLeod, John B. Richardson, Bernard Robaire, Theodore L. Sourkes, Allan Tenenhouse, Daya R. Varma


Assistant Professors — Yves De Koninck, H. Uri Saragovi

Senior Adjunct Professor — Anthony Ford-Hutchinson

Adjunct Professors — Paul Albert, Sylvain Chemtob

Associate Members — Gerald Batist, Serge Gauthier, Yogesh Patel, Roger Prichard, Remi Quiron

Pharmacology is the science which deals with all aspects of drugs and their interactions with living organisms. Thus, it involves the physical and chemical properties of drugs, their biochemical and physiological effects, mechanisms of action, pharmacokinetics, and therapeutic and other uses. Since the word "drug" encompasses all chemical substances that produce an effect on living cells, it is evident that pharmacology is a very extensive subject. Pharmacology is a multi-disciplinary science. It has developed its own set of principles and methods to study the mode of the action of drugs, but it has also utilized many techniques and approaches from various disciplines including biochemistry, physiology, anatomy and molecular biology, as well as others. Pharmacology can be subdivided into a number of different areas such as neuropharmacology, molecular biology, reproductive pharmacology, endocrine pharmacology, receptor pharmacology, cardiovascular pharmacology, toxicology, developmental pharmacology, autonomic pharmacology, biochemical pharmacology, and therapeutics.

Training in pharmacology is conducted at both the undergraduate and graduate levels. Because of its breadth, students may be attracted to the subject from a variety of viewpoints; this includes those completing a Bachelor's degree in any number of basic science disciplines, such as biology, zoology, chemistry, physics, biochemistry, microbiology, anatomy and physiology. At the undergraduate level, four lecture courses are offered. A course involving research projects in pharmacology is also available to provide the student with the opportunity to get first-hand experience in a pharmacology research laboratory. These courses should provide students with knowledge concerning the actions of drugs on living systems and insight into approaches to basic pharmacological research.

MINOR PROGRAM IN PHARMACOLOGY (24 credits)

The Minor Program in Pharmacology is intended for students registered in a complementary B.Sc. program who are interested in a focused introduction to specialized topics in pharmacology to prepare them for professional schools, graduate education, or entry into jobs in industry or research institutes. Students should declare their intent to enter the Minor Program in Pharmacology at the beginning of their U2 year. They must consult with, and obtain the approval of, the Coordinator for the Minor Program in the Department of Pharmacology and Therapeutics.

All courses in the Minor Program must be passed with a minimum grade C or better. Generally, no more than 6 credits of overlap can be admitted between the Minor and the primary program.

11.21 Nursing (576)

Denotes limited enrolment.

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

576-308 CURRENT ISSUES IN WOMEN'S HEALTH. (3) (Prerequisite: Introductory Psychology or Sociology or permission of the instructor.) (Complementary course for the Women's Studies and Social Studies of Medicine Concentrations.) The roles of women as providers and users of health care. Concepts of health as well as models of women's health including theoretical perspectives, biological, social, economic and political determinants. Topics include reproduction, occupational health, mental health, and violence against women. A Health Science elective open to students in the Faculties of Arts, Science, and Medicine. TBA

576-309 CURRENT ISSUES IN WOMEN'S REPRODUCTIVE HEALTH. (3) (Prerequisite: Introductory Psychology or Sociology or permission of the instructor.) (Restriction: not open for credit to students who have taken 576-308 prior to September 1997.) (Complementary course for the Women's Studies and Social Studies of Medicine Concentrations.) Exploration of a wide range of issues on the reproductive health of women. An ethical framework will be developed. Topics include reproduction, occupational health, mental health, and violence against women. A Health Science elective open to students in the Faculties of Arts, Science, and Medicine. TBA

11.22 Pathology (546)

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

546-300B HUMAN DISEASE. (3) (Prerequisites: 177-200A, 177-201B or 507-212B, 552-209A. Pre- or co-requisite: 552-210B.) Provides a fundamental understanding of the diseases prevalent in North America, for upper level students in the biological sciences. Includes: general responses of cells and organ systems to injury; assessment of individual diseases by relating the causes, symptoms, diagnosis, treatment and prevention to the primary biological abnormalities in each disorder. Professor Zorychta
Required Courses (18 credits)
549-300A (3) Drug Action
549-301B (3) Drugs and Diseases
549-562A (3) General Pharmacology I
549-563B (3) General Pharmacology II
549-599A,B,D,T (6) Research Projects in Pharmacology

Complementary Courses (6 credits)
one of the following sets:
177-200A (3) Molecular Biology
and 177-201B (3) Cell Biology and Metabolism
or 507-201B (3) Molecular Mechanisms of Cell Function
OR
552-209A (3) Mammalian Physiology I
and 552-210B (3) Mammalian Physiology II

549-300A DRUG ACTION. (3) (Prerequisites: 177-200A and 177-201B or 507-212B, 552-209A and 552-210B or permission of instructor.) This course covers the fundamental principles of pharmacology and toxicology. Frequently encountered drugs are used as a focus to illustrate sites and mechanisms of action, distribution, metabolism, elimination and adverse effects.

Professors Zorychta and Hales
549-301B DRUGS AND DISEASE. (3) (Prerequisites: 177-200A, 177-201B or 507-212B, 552-209A and 552-210B or 549-300A or permission of instructor). This course further explores the basic principles of pharmacology as illustrated by drugs used in the treatment of disease. Emphasis is placed on drugs used for diseases prevalent in North America.

Professors Hales, Clarke and Sztyf
549-562A GENERAL PHARMACOLOGY I. (3) (Prerequisites: 552-209A and 552-210B, 177-200A and 177-201B or 507-311A and 507-312B or equivalent.) (Restrictions: U3 students with permission of instructors, and students registered in the Minor Pharmacology Program.) Principles of pharmacology as illustrated by current issues with an emphasis on the nervous system will be discussed. Drugs classified by their molecular target of action, their mechanism of action, and possibly a rationale for therapeutic use will be presented. Students will be required to examine and interpret scientific data, to write a paper and participate in small group discussions.

Professor Esplin and Staff
549-563B GENERAL PHARMACOLOGY II. (3) (Prerequisite: 549-562A) (Restrictions: U3 students with permission of instructors, and students registered in the Minor Pharmacology Program.) Selected topics of basic interactions between chemicals and biological systems. Actions of drugs at the molecular and cellular levels. Drug metabolism, agents affecting cardiovascular and endocrine systems. Chemotherapy of infections and of cancer. Toxicology and pharmacokinetics/dynamics.

Professor Saragovi and Staff
549-599A,B,C,D,T RESEARCH PROJECTS IN PHARMACOLOGY. (6) (Pre- or co-requisite 549-562A and 549-563B or 549-300A and 549-301B.) (Restrictions: U3 students with permission of instructors, and students registered in the Minor Pharmacology Program. Students should consult instructors 3 - 4 weeks before registration.) This course involves individual research work. Students select a laboratory project under the supervision of a staff member. Areas of interest include toxicology, endocrine, developmental, cardiovascular, reproductive and neuropharmacology. This course requires a minimum of 6 hours per week for the full year course (D), and a minimum of 12 hours per week for the half year course (A,B) to be spent in the laboratory and/or library.

Professors Maysinger, Sasyniuk, Varma and Staff

11.24 Physics (198)
Rutherford Physics Building, Room 108
3600 University Street
Montreal, QC H3A 2T8
Telephone: (514) 398-6485
Fax: (514) 398-8434

Internet: secretariat@physics.mcgill.ca

Chair — J. BARRETTE
Emeritus Professors — M.P. LANGLEBEN, E.R. POUNDER (WILLIAM C. MACDONALD EMERITUS PROFESSOR OF PHYSICS), R.T. SHARP

Post-Retirement — A.P. CONTOGOURIS


Assistant Professors — J. CLINE, P. GUTTIER

Lecturers — Z. ALTOUNIAN, F. BUCHINGER

Associate Members — R. DAVIES (ATMOSPHERIC AND OCEANIC SCIENCES), B.C. ELI (CHEMISTRY), G. FALLONE (RADIATION ONCOLOGY), M. MACKEY (PHYSIOLOGY), E. PODGORSKA (RADIATION ONCOLOGY), D. RONIS (CHEMISTRY)

Curator (Rutherford Museum and McPherson Collection) — M. COHEN

Physics is in many ways the parent of the other natural sciences, and its discoveries and laws continually affect their development. Its range and scope extend in space and time from subnuclear particles to the universe itself. The subfields of physics such as mechanics, thermodynamics, electricity, atomic physics and quantum mechanics, to mention but a few, permeate all other scientific disciplines. People trained in physics are employed in industry, government, and educational systems where they find many challenges as teachers, researchers, administrators and in the rapidly developing area of scientific business.

The two main undergraduate programs in Physics at McGill are the Honours and the Major. The Honours program is highly specialized and the courses are very demanding. This program is appropriate for students who wish to make an in-depth study of the subject in preparation for graduate work and an academic or professional career in physics. The Joint Honours in Mathematics and Physics is an even more specialized and demanding program, intended for students who wish to develop a strong basis in both mathematics and physics in preparation for graduate work and a professional or academic career. Although the program is optimized for theoretical physics, it is broad enough and strong enough to prepare students for further study in either experimental physics or mathematics. High standing in CEGEP or Freshman-year mathematics and physics is a requirement for admission to these Honours programs.

The Major program, on the other hand, offers a broad training in classical and modern physics and yet leaves room for the student to take a meaningful sequence of courses in other areas. It is intended primarily for students who wish to pursue careers in fields for which physics provides a basis. However this program also provides a preparation for graduate studies, especially if a student chooses in consultation with the departmental adviser, a number of Honours Physics courses in the U2 and U3 years.

There are also a number of other Major programs, Atmospheric Sciences and Physics, Physics and Geophysics, and Physiology and Physics, offered jointly with other departments, and a Minor program in Electrical Engineering, available only to students in the Physics Major program. In addition, there is a Faculty program in Physics and a Joint Faculty program in Mathematics, Chemistry and Physics, which both provide a broad base for students less interested in a specialized education. Almost all the Physics programs can be combined with an Internship Year, as part of the University's IYES program, which provides experience in an industrial or government laboratory as part of the degree program.
For those interested in a career as a high school science teacher, the concurrent program leading to both a B.Sc. and a B.Ed. degree provides two Physics options. Both of these combine physics courses from the Major program with Education courses. They are, respectively, the Major program in Chemistry and Physics for Teachers, and the Major program in Mathematics and Physics for Teachers. (For details, see the Science for Teachers section.)

Students outside of the Province of Quebec will ordinarily register in the Science Freshman program. Physics offers two sequences of courses for this program: they are described below.

The list of pre- and co-requisites is not absolute. In many cases permission of the Department may be sought to have a specific prerequisite waived. The procedure is to ask the professor in charge of the course to review the request for such a waiver. The prerequisites of the 100-level courses are described in the following section entitled Science Freshman Program.

Courses 198-200A, 198-201B, 198-204A,B and 198-224A are designed for students from faculties other than Science (such as Arts and Music) and have no prerequisites as such, although a reasonable knowledge of high-school level algebra, geometry and trigonometry is desirable.

The block of numbers 198-205A, 198-206A, 198-207A, 198-208A, and 198-209A has been reserved for a series of courses “Introduction to Selected Topics in Physics”. These courses, of one credit each, will introduce topics in physics which are of current interest. Topics given under numbers 198-205 or 198-206 will have CEGEP Physics* as prerequisite; those given under numbers 198-208 or 198-209 will have no Physics prerequisite. The topics will vary from year to year. For further information, enquire at the Department of Physics.

All other 200-level courses are designed primarily for Science students and assume successful completion of CEGEP level physics* and mathematics programs. The phrase “Prerequisite CEGEP Physics*” has been inserted to make this point clear. Students who have not included Calculus III in their CEGEP program, are, respectively, the Major program in Chemistry and Physics for Teachers and the concurrent program leading to both a B.Sc. and a B.Ed.

Students entering McGill with a Québec CEGEP profile in Science and Arts and Music) and have no prerequisites as such, although a reasonable knowledge of high-school level algebra, geometry and trigonometry at the high school level. If this is not the case, then Mathematics 189-112A should be taken concurrently with 198-101A. Those for whom this is not necessary are advised to take 189-139A concurrently with 198-101A.

SCIENCE FRESHMAN PROGRAM

Students entering McGill with a Québec CEGEP profile in Science will normally begin their programs in Physics with courses at the 200 level. Students without this profile will normally take courses 198-131A and 198-142B if they have previously taken physics at the high school level and will be taking differential calculus concurrently with 198-131A and integral calculus concurrently with 198-142B. Those students who have not previously taken physics at the high school level and who intend to do programs in the Biological Sciences may instead take courses 198-131A and 198-142B if they have previously taken physics at the high school level.

Students with this profile in their CEGEP program should register in the first term of the U1 year for Mathematics 189-222.

Students interested in any of the Physics programs should contact the Department for an Adviser.

*Physics 203-101, 203-201, 203-301-78 or equivalent – CEGEP course numbers, standard throughout the Province of Québec.

JOINT FACULTY PROGRAM IN MATHEMATICS, CHEMISTRY AND PHYSICS

See the Mathematics and Statistics entry in this Calendar for complete program information.

MAJOR PROGRAM IN PHYSICS (60 credits)

U1 Required Courses (21 or 24 credits)

198-230A (3) Dynamics of Simple Systems
198-232B (3) Heat and Waves
198-240B (3) Computers for Physics
198-259D (3) Lab in Mechanics, Heat & Optics

U2 Required courses (24 credits)

198-328A (3) Electronics
198-331B (3) Mechanics
198-333B (3) Thermal & Statistical Physics
198-339B (3) Measurements Laboratory
198-340A (3) Electricity and Magnetism
198-341B (3) Optics
198-342B (3) Electromagnetic Waves
198-391A (3) Advanced Calculus
198-391B (3) Ordinary Differential Equations

U3 Required Courses (15 credits)

198-434B (3) Optics
198-436B (3) Modern Physics
198-439A (3) Lab in Modern Physics
198-446A (3) Quantum Physics
198-449B (3) Project Laboratory

JOINT MAJOR PROGRAM IN PHYSICS AND GEOPHYSICS (65 credits)

The Joint Major program in Physics and Geophysics provides a firm basis for graduate work in Geophysics and related fields as well as a sound preparation for those who wish to embark on a career directly after the B.Sc.

U1 Required Courses (29 credits)

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
198-260B (3) Structural Geology I
198-261A (3) Introduction to Mineralogy
198-261E (2) Field School I
198-222A (3) Calculus II
198-223A (3) Linear Algebra
198-314B (3) Advanced Calculus

U2 Required Courses (27 credits)

198-331B (3) Mechanics
198-333B (3) Thermal & Statistical Physics
198-339B (3) Measurements Laboratory
198-340A (3) Electricity and Magnetism
JOINT MAJOR PROGRAM IN ATMOSPHERIC SCIENCE AND PHYSICS

Students should consult undergraduate advisors in both departments. See the Atmospheric and Oceanic Sciences section of this Calendar for complete program information.

The Major program in Physics and Atmospheric Science provides a firm basis for graduate work in Atmospheric Science and related fields as well as a sound preparation for those who wish to embark on a career directly after the B.Sc.

JOINT MAJOR PROGRAM IN PHYSIOLOGY AND PHYSICS

See the Physiology section of this Calendar for complete program information.

The Major program in Physiology and Physics provides a firm basis for graduate work in Bio-physics and other interdisciplinary fields involving the physical and biological sciences.

HONOURS PROGRAM IN PHYSICS (78 credits)

Students entering this program for the first time should have high standing in mathematics and physics. In addition, a student who has not completed the equivalent of 189-222 must take it in the first term without receiving credits toward the 78 credits required in the Honours program.

A student whose average in the required and complementary courses in any year falls below a GPA of 3.00, or whose grade in any individual required or complementary course falls below a C, may not register in the Honours program the following year, or graduate with the Honours degree, except with the permission of the Department.

U1 Required Courses (27 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>189-241B</td>
<td>Signal Processing</td>
</tr>
<tr>
<td>189-251A</td>
<td>Classical Mechanics I</td>
</tr>
<tr>
<td>189-253B</td>
<td>Thermal Physics</td>
</tr>
<tr>
<td>189-259D</td>
<td>Lab in Mechanics, Heat &amp; Optics</td>
</tr>
<tr>
<td>189-260A</td>
<td>Relativity and Modern Physics</td>
</tr>
<tr>
<td>189-247B</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>189-248A</td>
<td>Advanced Calculus I</td>
</tr>
<tr>
<td>189-249B</td>
<td>Advanced Calculus II</td>
</tr>
<tr>
<td>189-325A</td>
<td>Ordinary Differential Equations</td>
</tr>
</tbody>
</table>

U2 Required Courses (24 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>198-328A</td>
<td>Electronics</td>
</tr>
<tr>
<td>198-350A</td>
<td>Electromagnetism</td>
</tr>
<tr>
<td>198-357A</td>
<td>Quantum Physics I</td>
</tr>
<tr>
<td>198-359B</td>
<td>Lab in Modern Physics</td>
</tr>
<tr>
<td>198-362B</td>
<td>Statistical Mechanics</td>
</tr>
<tr>
<td>198-451B</td>
<td>Classical Mechanics</td>
</tr>
<tr>
<td>198-457B</td>
<td>Quantum Physics II</td>
</tr>
<tr>
<td>198-375A</td>
<td>Differential Equations</td>
</tr>
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U3 Required Courses (12 credits)

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>199-551A</td>
<td>Quantum Theory</td>
</tr>
<tr>
<td>199-352A</td>
<td>Electromagnetic Waves</td>
</tr>
<tr>
<td>198-459D</td>
<td>Honours Research Project</td>
</tr>
<tr>
<td>or 198-469A</td>
<td>Lab in Modern Physics II</td>
</tr>
<tr>
<td>and 198-479B</td>
<td>Honours Project Lab</td>
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U3 Complementary Courses (12 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>198-332B</td>
<td>Physics of Fluids</td>
</tr>
<tr>
<td>198-434B</td>
<td>Optics</td>
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U3 Required Courses (9 credits)

<table>
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<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>198-446A</td>
<td>Quantum Physics</td>
</tr>
<tr>
<td>189-332B</td>
<td>Physics of Fluids</td>
</tr>
<tr>
<td>or 189-330B</td>
<td>Earthquakes &amp; Earth Structure</td>
</tr>
</tbody>
</table>

JOINT HONOURS PROGRAM IN MATHEMATICS AND PHYSICS (81 credits)

This is a specialized and demanding program intended for students who wish to develop a strong basis in both Mathematics and Physics in preparation for graduate work and a professional or academic career. Although the program is optimized for theoretical physics, it is broad enough and strong enough to prepare students for further study in either experimental physics or in mathematics.

The minimum requirement for entry into the program is completion with high standing of the usual CEGEP courses in physics and in mathematics. In addition, a student who has not completed the equivalent of 189-222 must take it in the first term without receiving credits toward the 81 credits required in the Joint Honours program.

To remain in the Honours program and to be awarded the Honours degree, the student must maintain a 3.00 GPA in the required and complementary courses, and a grade of C or better in each required or complementary course.

The student will have two advisors, one from Mathematics and the other from Physics.

U1 Required Courses (30 credits)

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<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>198-241B</td>
<td>Signal Processing</td>
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<tr>
<td>198-251A</td>
<td>Classical Mechanics I</td>
</tr>
<tr>
<td>198-253B</td>
<td>Thermal Physics</td>
</tr>
<tr>
<td>198-259D</td>
<td>Lab in Mechanics, Heat &amp; Optics</td>
</tr>
<tr>
<td>189-249B</td>
<td>Advanced Calculus II</td>
</tr>
<tr>
<td>198-325A</td>
<td>Ordinary Differential Equations</td>
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U2 Required Courses (24 credits)

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>189-350A</td>
<td>Electromagnetism</td>
</tr>
<tr>
<td>189-357A</td>
<td>Quantum Physics I</td>
</tr>
<tr>
<td>189-362B</td>
<td>Statistical Mechanics</td>
</tr>
<tr>
<td>198-451B</td>
<td>Classical Mechanics</td>
</tr>
<tr>
<td>198-457B</td>
<td>Quantum Physics II</td>
</tr>
<tr>
<td>198-242A</td>
<td>Analysis I</td>
</tr>
<tr>
<td>198-255B</td>
<td>Analysis II</td>
</tr>
<tr>
<td>198-375A</td>
<td>Differential Equations</td>
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U3 Required Courses (15 credits)

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<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>189-359B</td>
<td>Lab in Modern Physics</td>
</tr>
<tr>
<td>198-352A</td>
<td>Electromagnetic Waves</td>
</tr>
<tr>
<td>189-354A</td>
<td>Analysis III</td>
</tr>
<tr>
<td>189-360A</td>
<td>Differential Geometry</td>
</tr>
<tr>
<td>189-370A</td>
<td>Algebra III</td>
</tr>
<tr>
<td>or 198-355B</td>
<td>Analysis IV</td>
</tr>
</tbody>
</table>

U3 Complementary Courses (12 credits)

9 credits selected from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>198-514B</td>
<td>General Relativity</td>
</tr>
<tr>
<td>198-551A</td>
<td>Quantum Theory</td>
</tr>
<tr>
<td>198-557A</td>
<td>Nuclear Physics</td>
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<tr>
<td>198-558A</td>
<td>Solid State Physics</td>
</tr>
<tr>
<td>198-559A</td>
<td>Advanced Statistical Mechanics</td>
</tr>
<tr>
<td>198-562B</td>
<td>Electromagnetic Theory</td>
</tr>
<tr>
<td>198-567B</td>
<td>Particle Physics</td>
</tr>
</tbody>
</table>

3 credits in Honours Mathematics
MINOR PROGRAM IN ELECTRICAL ENGINEERING
(23 or 25 credits)
The Minor program does not carry professional recognition. Only students who satisfy the requirements of the Major in Physics are eligible for this Minor. Students registered for this option cannot count 198-241 towards the requirements of the Major in Physics, and should replace this course by another Physics or Mathematics course. Students who select 304-334 in the Minor cannot count 198-328 towards the requirements of the Major in Physics, and should replace this course by another Physics or Mathematics course.

Required Courses (17 or 19 credits)
- 304-200 (3) Fundamentals of Electrical Engineering
- 304-210 (5) Circuit Analysis
- 304-303 (3) Signals and Systems
- 304-330 (3) Electronic Circuits
- 304-305 (3) Probability and Random Signals
- or 304-334 (5) Electronic Circuits II

Complementary Courses (6 credits)

COURSE DESCRIPTIONS
Instructors’ names are subject to change, since course assignments are made after this Calendar goes to press. See the Department’s Web page http://www.physics.mcgill.ca for up-to-date information.

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

NOTE: In general, Honours courses are indicated when the fifth character of the six digit course number is 5 or higher.

Denotes courses not offered in 1998-99
Denotes limited enrolment
Denotes courses offered only in alternate years

198-101A INTRODUCTORY PHYSICS – MECHANICS. (4) (3 hours lectures; 2 hours laboratory; tutorial sessions) (Not open to students taking or having taken 198-131A.) The object of this course is to give the students a basic understanding of the principles of physics, illustrating these, where possible, with current examples of their use in biology and medicine. (Laboratory sections have limited enrolment.)

198-102B INTRODUCTORY PHYSICS – ELECTROMAGNETISM. (4) (3 hours lectures; 2 hours laboratory; tutorial sessions) (Prerequisite: 198-101. Corequisite: 198-139) (Not open to students taking or having taken 198-142B.) Electric field and potential, D.C. circuits and measurements. Capacitance. Magnetic field and induction. A.C. circuits Semiconductor devices and their characteristics. Electromagnetic waves. (Laboratory sections have limited enrolment.)

Dr. Altounian

These courses, 101A and 102B together satisfy the minimum requirement in physics for Medical School.

198-109D GENERAL PHYSICS LABORATORY. (2) (2 hours laboratory) (Not open to students who have taken or are taking 198-101 or 198-102.) The laboratory component of 198-101A and 198-102B. May be taken only by students who have completed the lecture component but not the laboratory of 198-101 and 198-102.

198-119D GENERAL PHYSICS LABORATORY. (2) (3 hours laboratory) The laboratory component of 198-131A and 198-142B. This course may be taken only by students who have completed the lecture components of these courses but not the laboratory.

198-131A MECHANICS AND WAVES. (4) (3 hours lectures; 1 hour tutorial, 3 hours laboratory in alternate weeks; tutorial sessions) (Corequisite: 198-139A) (Not open to students taking or having taken 198-101A.) The basic laws and principles of Newtonian mechanics; oscillations and waves. (Laboratory sections have limited enrolment.)

198-142B ELECTROMAGNETISM & OPTICS. (4) (3 hours lectures, 3 hours laboratory in alternate weeks; tutorial sessions) (Prerequisite: 198-131A. Corequisite: 189-141B) (Not open to students taking or having taken 198-102B.) The basic laws of electricity and magnetism; geometrical and physical optics. (Laboratory sections have limited enrolment.)

Professor Grutter

198-199B PHYSICS AND BIOLOGY. (3) (3 hours per week, seminar format) (Prerequisite: 198-101A or permission of instructor. Co-requisite: 198-102B or permission of instructor.) (Not open to students who are taking or have taken 198-217B.) (FY5 - for first year students only, maximum 25.) This course addresses the physics of biological systems in a format which encourages active interaction of the students with the instructor and a number of guest lecturers. Topics discussed will include the physics of vision and the role of physical processes in bio-membranes.

Professor Zuckermann

198-200A SPACE, TIME & MATTER. (3) (3 hours lectures) (Not open to students in Science or Engineering.) See "Science for Arts Students" in the Arts section.

Professor Ragan

198-204A,B PLANETS, STARS & GALAXIES. (3) (3 hours lectures; 3 evening sessions for star identification and use of telescopes.) (Not open to students who have taken or are taking 198-214A.) An elementary astronomy course for non-science students (see "Science for Arts Students" in the Arts section) and for science students not taking a Physics program.

Professors Crawford and Burgess

198-208A TOPICS IN PHYSICS. (1 credit; 2 hours lectures, first six weeks) (Not open to students in Physics programs.)

198-214A ASTROPHYSICS. (3) (Prerequisite: CEGEP Physics.) (Not open to students who have taken or are taking 198-204A,B.) An introduction to astrophysics with emphasis placed on methods of observation and current models. Stellar radiation and detectors. Stellar classification systems, structures and evolution. Pulsars, quasars, black holes. Galaxies, large scale structure of the universe, cosmology.

Professor Ragan

198-217B PHYSICS AND THE LIFE SCIENCES. (3) (3 hours lectures) (Prerequisites: CEGEP Physics or permission of instructor.) (Not open to students who are taking or have taken 198-199B.)

198-219A STATISTICAL TREATMENT OF DATA. (3) (3 hours lectures) (Prerequisite: CEGEP physics.) (Note: Credit for other statistics courses may preclude credit for this course and conversely, see “Course Overlap” on page 335.)

198-224A PHYSICS & PSYCHOPHYSICS OF MUSIC. (3) (3 hours lectures) (Designed for students in the Faculty of Music but suitable for students with an interest in music, and how it is received.) An introduction to physics and psychophysics of music with demonstrations of the relevant phenomena and the theories explaining them. Pitch, loudness and timbre in the context of the physics properties of the human ear. The basic physics of music production including modes of oscillation of mechanical systems, resonance, feedback, transmission and reflection of sound. The human voice. Modern methods of sound production using electrical analogue devices and digital computers. Room reverberation and acoustics.

Professor Hanna

198-225B MUSICAL ACOUSTICS. (3) (3 hours lectures) (Prerequisites: CEGEP physics or both 198-112 and 198-224A) (Designed for students in music who have interests in sound recording and reproduction and also suitable for students in science with an interest in music.) Physical acoustics with applications to music. Resonators and radiators, acoustic impedance. Acoustic properties of strings, bars, membranes, pipes and horns. Application to selected musical instruments. Direction characteristics of sound sources. Room acoustics.

Professor Grant

198-230A DYNAMICS OF SIMPLE SYSTEMS. (3) (3 hours lectures) (Prerequisite: CEGEP physics. Corequisite: Mathematics 189-222A) (Not open to students taking or having passed 198-251A.) Translational motion under Newton's laws; forces, momentum, work/energy theorem. Special relativity; Lorentz transforms, rela-
tivistic mechanics, mass/energy equivalence. Topics in rotational dynamics. Noninertial frames. **Professor Das Gupta**

198-232B **HEAT AND WAVES.** (3) (3 hours lectures) (Prerequisite: 198-230A) (Not open to students taking or having passed 198-253B.) First and second laws of thermodynamics, kinetic theory of gases, optical interference, polarization, electro-optics, physics of microscopic systems. **Professor D.H. Ryan**

198-240B **COMPUTERS FOR PHYSICS.** (3) (2 hours lectures, 3 hours laboratory) (Prerequisite 198-230A or 198-250A) (Restricted to students in first year Honours and Majors physics or by permission of instructor.) The course will extend and consolidate previous knowledge of mechanics and general physics by introducing and applying techniques for data analysis, numerical computation and simulation. Included will be an introduction to local facilities, a programming language and computer graphics. **Professor Harris**

198-241B **SIGNAL PROCESSING.** (3) (2 hours lectures; 3 hours laboratory alternate weeks) (Prerequisite: CEGEP physics.) Linear circuit elements, resonance, network theorems, diodes, transistors, amplifiers, feedback, integrated circuits. **Professor Lee**

198-242B **ELECTRICITY & MAGNETISM.** (2) (2 hours lectures) (Prerequisites CEGEP Physics, 189-222A,B) Properties of electromagnetic fields, dipole and quadrupole fields and their interactions, chemical binding of molecules, electromagnetic properties of materials, Maxwell's equations and properties of electromagnetic waves, propagation of waves in media. **Professor Dominic Ryan**

198-248A **PHYSICS OF ENERGY.** (3) (3 hours lectures) (Prerequisite: CEGEP physics.) Various forms of energy: mechanical, electrical, chemical, thermal, nuclear; energy storage, conversion and transportation; energy sources on earth, fossil fuels, renewable resources, energy conservation and the environment. **Dr. Altounian**

198-251A **CLASSICAL MECHANICS I.** (3) (3 hours lectures) (Prerequisite: CEGEP physics. Corequisite: 189-222A) (Not open to student taking or having taken 198-230A) Newton's laws, work and energy, angular momentum. Harmonic oscillator, forced oscillations, inertial forces, rotating frames. Central forces, centre of mass, planetary orbits, Kepler's laws. **Professor David Ryan**

198-253B **THERMAL PHYSICS.** (3) (3 hours lectures) (Prerequisite: CEGEP physics. Corequisite: 189-222A,B) (Not open to students taking or having taken 198-230B.) Energy, work, heat; first law. Temperature, entropy; second law. Absolute zero; third law. Equilibrium, equations of state, gases, liquids, solids, magnets; phase transitions. **Professor Hanna**

198-259D **LAB IN MECHANICS, HEAT & OPTICS.** (3) (3 hours) (Prerequisite: CEGEP physics. Corequisite: 198-230A or 198-251A and 198-232B or 198-253B.) Illustrative experiments on topics in mechanics, heat and optics; a project. **Professors Lee, Muir and Dr. Buchinger**

198-260A **RELATIVITY AND MODERN PHYSICS.** (3) (3 hours lectures. Corequisite: 189-222A.) History of special relativity; Lorentz transformations: kinematics and dynamics; transformation of electric and magnetic forces; introduction to topics in modern physics. **Professor Lam**

198-328A **ELECTRONICS.** (3) (2 hours lectures; 3 hours laboratory) Semiconductor devices, basic transistor circuits, operational amplifiers, combinatorial and sequential logic, integrated circuits, analogue to digital converters. The laboratory component covers design, construction and testing of basic electronic circuits. **Professor Crawford**

198-331B **MECHANICS.** (3) (3 hours lectures) (Prerequisite: 198-230A. Corequisite: 189-314A, 189-315A or equivalent.) Forced and damped oscillators, Newtonian mechanics in three dimensions, rotational motion, Lagrangian mechanics, small vibrations, normal modes. Introduction to Hamiltonian mechanics. **Professor David Ryan**

198-332B **PHYSICS OF FLUIDS.** (3) (3 hours lectures) (Prerequisites: 198-230A, 198-223A, 189-314B, 189-315B) The physical properties of fluids. The kinematics and dynamics of flow. The effects of viscosity and turbulence. Applications of fluid mechanics in biophysics, geophysics and engineering. **Professor Lovejoy**

198-333B **THERMAL & STATISTICAL PHYSICS.** (3) (3 hours lectures) (Prerequisite: 198-232B) (Not open to students taking or having passed 198-362B.) Introductory equilibrium statistical mechanics. Quantum states, probabilities, ensemble averages. Entropy, temperature, Boltzmann factor, chemical potential. Photons and phonons. Fermi-Dirac and Bose-Einstein distributions; applications. **Professor Strom-Olsen**

198-339B **MEASUREMENTS LABORATORY.** (3) (6 hours) (Prerequisite: 198-241B) Introduction to modern techniques of measurement. The use of computers in performing and analysing experiments. Data reduction, statistical methods, report writing. Extensive use of computers is made in this laboratory; therefore some familiarity with computers and computing is an advantage. **Professor Grutter and Dr. Buchinger**


198-342B **ELECTROMAGNETIC WAVES.** (3) (3 hours lectures) (Prerequisites: 198-340A or 198-242A,B, Mathematics 189-314A, B, 189-315A, B) (Not open to students having passed 304-357A or equivalent.) The electromagnetic wave. The wave equation. The electromagnetic wave, reflection, refraction, polarization, guided waves. Transmission lines and wave guides. Vector potential. Radiation. The elementary dipole; the half-wave dipole; vertical dipole; folded dipole; Yagi antennas. Accelerating charged particles. **Professor Patel**

198-350A **ELECTROMAGNETISM.** (3) (3 hours lectures) (Prerequisites: 189-248A,B, 189-325B. Honours students, or permission of the instructor.) The vector and scalar potentials; plane waves in homogeneous media; refraction and reflection; guided waves; radiation from simple systems; dipole and quadrupole radiation; introduction to fields of moving charges; synchrotron radiation; Bremsstrahlung. **TBA**

198-352A **ELECTROMAGNETIC WAVES.** (3) (3 hours lectures) (Prerequisite: 198-350A. Honours students, or permission of the instructor.) Vector and scalar potentials; plane waves in homogeneous media; refraction and reflection; guided waves; radiation from simple systems; dipole and quadrupole radiation; introduction to fields of moving charges; synchrotron radiation; Bremsstrahlung. **TBA**

198-355A **MATHEMATICAL PHYSICS.** (3) (3 hours. Honours students, or permission of the instructor.) (Course 189-375B may not also be taken for credit.) Application of mathematical methods in physics. Ordinary and partial differential equations of mathematical physics; special functions; eigenvalue problems, boundary-value problems; Green's functions. **TBA**

198-357A **QUANTUM PHYSICS I.** (3) (3 hours lectures) (Honours students or permission of instructor.) (Not open to students taking or having passed 198-446A.) Experimental basis for quantum mechanics; wave-packets; uncertainty principle. Hilbert space formalism. Schroedinger equation; eigenvalues and eigenvectors; applications to 1-d problems including the infinite and finite potential wells and the harmonic oscillator. Tunneling. Time independent perturbation theory. **Professor Das Gupta**

198-359B **LABORATORY IN MODERN PHYSICS.** (3) (6 hours) (Prerequisite: 198-328A. Corequisite: 198-457B. Honours students or permission of instructor.) Advanced level experiments in modern physics stressing quantum effects and some properties of condensed matter. **Professor Sutton and Dr. Buchinger**

198-362B **STATISTICAL MECHANICS.** (3) (3 hours lectures) (Prerequisites: 189-248B or equivalents, 198-253B. Honours students, or permission of the instructor.) (Course 189-375B may not also be taken for credit.) Equilibrium statistical mechanics. Fermi-Dirac and Bose-Einstein distributions; applications. **Professor David Ryan**
permission of the instructor.) (Not open to students taking or having taken 198-333B.) Quantum states and ensemble averages. Fermi-Dirac, Bose-Einstein and Boltzmann distribution functions and their applications.  

Professor Zuckermann

**198-413A THE PHYSICAL BASIS OF PHYSIOLOGY.** (3) (3 hours lectures) (Prerequisite: 198-240A, B, or 198-241A.) Analytic and computer simulation techniques are used to examine the role of nonlinearities and time delays in determining the dynamic behaviour of physiological control systems and their relation to normal and pathophysiological states. Examples drawn from the control of respiration, cellular proliferation and differentiation, biochemical feedback networks, thermoregulatory mechanisms, and neural feedback. Professor Mackey

198-434B OPTICS. (3) (3 hours lectures) Geometrical optics, wave optics, lasers, Fourier transform spectroscopy, holography, optical data processing, stellar interferometry. Professor Sutton

198-436B MODERN PHYSICS. (3) (3 hours lectures) (Prerequisite: 198-446A.) One electron atoms, radiation, multielectron atoms, molecular bonds. Selected topics from condensed matter, nuclear and elementary particle physics. Professor Patel

198-439A LABORATORY IN MODERN PHYSICS. (3) (6 hours) (Prerequisite: 198-339B. Corequisite: 198-446A.) (Not open to students with credit in 198-359B except with permission of instructor.) Advanced level experiments in modern physics stressing quantum effects and some properties of condensed matter.

Professor Barrette and Dr. Buchinger


198-449B PROJECT LABORATORY. (3) (6 hours) (Prerequisite: 198-326A, 198-439A) Supervised project work in an area related to material covered in upper year courses. Professor D.H. Ryan and Dr. Buchinger

198-451B CLASSICAL MECHANICS. (3) (3 hours lectures) (Prerequisite: 198-251A. Honours students, or permission of instructor.) (Not open to students having taken 198-331B.) Rigid body motion, angular momentum, gyroscope, moment of inertia, principal axes, Euler's equations. Coupled oscillations and normal modes. Lagrangian mechanics and applications. Hamiltonian mechanics. Topics in advanced analytical mechanics. TBA

198-457B QUANTUM PHYSICS II. (3) (3 hours lectures) (Honours students or permission of instructor.) (Not open to students having taken 198-446A.) Angular momentum and spin operators. Operator methods in quantum mechanics. Coupling of spin and angular momenta. Variational principles and elements of time dependent perturbation theory (the Golden Rule). Solution of the Schroedinger equation in three dimensions. Applications to the hydrogen and helium atoms and to simple problems in atomic and molecular physics. Professor Cline

198-459D HONOURS RESEARCH PROJECT. (6) (6 hours) (Honours students or permission of instructor.) (Not open to students taking the sequence 198-469A/198-479B.) An experimental project, supervised by members of staff, on some topic related to the ongoing research in the department. Professor David Ryan and Dr. Buchinger

198-469A LAB IN MODERN PHYSICS II. (3) (6 hours) (Honours students, or permission of instructor) (Prerequisite: 198-359B) (Not open to students taking 198-459D.) Advanced level experiments in modern physics stressing quantum effects and some properties of condensed matter. Continuation of 198-359B.

Professor Sutton and Dr. Buchinger

198-479B HONOURS PROJECT LAB. (3) (6 hours) (Honours students, or permission of instructor) (Prerequisite 198-469A) (Not open to students taking 198-459D.) Supervised project work in an area related to material covered in upper year courses. Professor David Ryan and Dr. Buchinger

198-514B GENERAL RELATIVITY. (3) (3 hours lectures) (Honours students, or permission of the instructor.) Transition from special to general relativity. Non-Euclidean geometry. The basic laws of Physics in co-variant form, Einstein's equations. Gravitational waves; neutron stars; black holes; cosmology. Professor de Takacsy

198-551A QUANTUM THEORY. (3) (3 hours lectures) (Honours students, or permission of the instructor.) General formulation, scattering theory, WKBJ approximation, time-dependent perturbation theory and applications, angular momentum, relativistic wave equations. Professor Stairs

198-557A NUCLEAR PHYSICS. (3) (3 hours lectures) (Honours students, or permission of the instructor.) Properties of crystals, lattice vibrations and thermal properties of insulators, free electron model and band structure, semi-conductors, metals, optical properties. Professor Harris

198-559A ADVANCED STATISTICAL MECHANICS. (3) (3 hours lectures) (Honours students, or permission of the instructor.) Self averaging and central-limit theorem; thermodynamic fluctuations; ensemble theory; surface roughening; broken symmetry and Goldstone's theorem; phase transitions; mean-field, Landau and Onslein-Zernicke theory; Monte Carlo method; molecular dynamics; scaling; renormalization group; epsilon expansion; nonequilibrium theory. Professor Grant

198-562B ELECTROMAGNETIC THEORY. (3) (3 hours lectures) (Honours students, or permission of the instructor.) Electrodynamics, dielectrics, magnetostatics, timevarying fields, relativity, radiating systems, fields of moving charges. Professor De Takacsy

198-567B PARTICLE PHYSICS. (3) (3 hours lectures) (Honours students, or permission of the instructor.) Survey of elementary particles: hadrons, leptons and hadrons' constituents (quarks). Invariance principles and conservation laws. Detectors and accelerators. Phenomenology of strong, electromagnetic and weak interactions. Professor Stairs

11.25 Physiology (552)

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Telephone: (514) 398-4316
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Chair — Alvin Shrier
Emeritus Professor — G. Melvill Jones

Professors — Catherine Bushnell, Thomas M.S. Chang, Monroe W. Cohen, Ellis Cooper, Mony Frojmovic, Leon Glass, Phil Gold, David Goltzman (Hosmer Professor of Physiology), James L. Henry, Robert Kearney, Kresimir Krnjevic, Wayne S. Lapp, Mortimer Levy, Michael Mackey, Joseph Mileo-Emili, Jacapo P. Mortola, Premysl Ponka, Alvin Shrier, Douglas Watt

Associate Professors — Riaz Farookh, Mladen Glavinovic, Michael Guevara, John Hanrahan, Norma Lake, Sheldon Magder, John Orlovski, Teresa Trippenbach, Ann Wechsler, Peter Weldon, John White

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1998/99 Undergraduate Programs – McGill University
Faculty Program in Physiology

Required Courses (30 credits)
- 552-209A (3) Mammalian Physiology I
- 552-210B (3) Mammalian Physiology I
- 552-212D (2) Introductory Physiology Lab
- 552-311A (3) Intermediate Physiology I
- 552-312B (3) Intermediate Physiology II
- 552-313B (3) Intermediate Physiology III
- 177-200A (3) Molecular Biology
- 177-202B (3) Basic Genetics
- 177-301A,B (3) Cell and Molecular Laboratory
- 180-222A,B (4) Organic Chemistry II

Complementary Courses (24 credits)
- 6 credits selected from:
  - 177-201B (3) Cell Biology and Metabolism
  - or 507-212B (3) Molecular Mechanisms of Cell Function
  - or 177-373A (3) Biostatistical Analysis
  - or 177-309A (3) Mathematical Models in Biology
- 12 credits selected from upper level physiology courses

MAJOR PROGRAM IN PHYSIOLOGY (63-64 credits)

The Major Program includes, in addition to some intensive studies in Physiology, a strong core content of related biomedical and physical sciences. Admission to the Major Program will be in U2, upon completion of the U1 required courses, and in consultation with the student’s adviser.

If not previously taken 180-212A,B Organic Chemistry I must be completed in addition to the 63-64 program credits.

U1 Required Courses (18 credits)
- 552-209A (3) Mammalian Physiology I
- 552-210B (3) Mammalian Physiology II
- 552-212D (2) Introductory Physiology Lab
- 177-200A (3) Molecular Biology
- 177-202B (3) Basic Genetics
- 180-222A,B (4) Organic Chemistry II

U2 and U3 Required Courses (15 credits)
- 552-311A (3) Intermediate Physiology I
- 552-312B (3) Intermediate Physiology II
- 552-313B (3) Intermediate Physiology III
- 177-301A,B (3) Cell and Molecular Laboratory
- 507-311A (3) Metabolic Biochemistry

Complementary Courses (30-31 credits)
- 12-13 credits selected from:
  - 177-201B (3) Cell Biology and Metabolism
  - or 507-212B (3) Molecular Mechanisms of Cell Function
  - or 177-373A (3) Biostatistical Analysis
  - or 177-309A (3) Mathematical Models in Biology
  - or 180-204A,B (3) Physical Chem./Biol. Sci. I
  - or 504-214A (3) Systemic Human Anatomy
  - or 504-261A (4) Introduction to Dynamic Histology

9 credits selected from upper level physiology courses
9 credits selected from upper level science courses

JOINT MAJOR PROGRAM IN PHYSIOLOGY AND MATHEMATICS (71 credits)

U1 Required Courses (14 credits)
- 552-212D (2) Introductory Physiology Lab
- 189-222A,B (3) Calculus III
- 189-247A,B (3) Linear Algebra
- 177-200A (3) Molecular Biology
- 177-309A (3) Mathematical Models in Biology

U1 Complementary Courses (15 credits)
- 9 credits selected from:
  - 552-209A (3) Mammalian Physiology I
  - or 552-210B (3) Mammalian Physiology II
  - or 552-201A (3) Human Physiology
  - or 552-202B (3) Human Physiology
  - or 552-212D (2) Introductory Physiology Lab
  - or 177-201B (3) Cell Biology and Metabolism
  - or 552-207A (3) Molecular Mechanisms of Cell Function

If not previously taken 180-212A,B Organic Chemistry I must be completed in addition to the 54 program credits.
U2 Required Courses (21 credits)
552-311A (3) Intermediate Physiology I
552-312B (3) Intermediate Physiology II
552-313B (3) Intermediate Physiology III
189-242A (3) Analysis I
189-243B (3) Real Analysis
189-323A (3) Probability Theory
189-324B (3) Statistics

U2 Complementary Courses (3 credits)
198-413A (3) The Physical Basis of Physiology
or 189-437A (3) Mathematical Methods in Biology

U3 Required Courses (3 credits)
189-319B (3) Partial Differential Equations

U3 Complementary Courses (15 credits)
6 credits selected from Physiology courses (e.g. 552-461D)
3 credits selected from upper level science courses
6 credits selected from:
189-316B (3) Functions of a Complex Variable
or 189-249B (3) Advanced Calculus II
189-317A,B (3) Numerical Analysis
189-322B (3) Dynamical Systems, Fractals and Chaos
189-447B (3) Stochastic Processes

JOINT MAJOR PROGRAM IN PHYSIOLOGY AND PHYSICS
(77 credits)
This program provides a firm foundation in physics, mathematics and physiology. It is appropriate for students interested in applying methods of the physical sciences to problems in physiology and allied biological sciences.

U1 Required Courses (17 credits)
552-212D* (2) Introductory Physiology Lab
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
189-222A,B (3) Calculus III

U1 Complementary Courses (12 credits)
552-209A (3) Mammalian Physiology I
and 552-210B* (3) Mammalian Physiology II
or 552-210B* (3) Mammalian Physiology II
and 552-201A (3) Human Physiology: Control Systems
or and 552-202B (3) Human Physiology: Body Functions
189-223A (3) Linear Algebra
or 189-247A (3) Linear Algebra
189-314B (3) Advanced Calculus
or 189-248A (3) Advanced Calculus I

* The corequisite 177-200A, 177-201B is waived for this program.

U2 Required Courses (21 credits)
552-311A (3) Intermediate Physiology I
552-312B (3) Intermediate Physiology II
552-313B (3) Intermediate Physiology III
198-328A (3) Electronics
198-333B (3) Thermal & Statistical Physics
198-339B (3) Measurements Laboratory
198-340A (3) Electricity and Magnetism

U2 Complementary Courses (6 credits)
198-413A (3) The Physical Basis of Physiology
or 189-437A (3) Mathematical Methods in Biology
189-315A (3) Ordinary Differential Equations
or 189-325B (3) Ordinary Differential Equations

U3 Required Courses (12 credits)
552-461D (6) Experimental Physiology
198-446A (3) Quantum Physics
399-519A (3) Analysis of Biomedical Systems and Signals

U3 Complementary Courses (9 credits)
3 credits selected from upper level Physiology courses
6 credits to be approved by Physiology and Physics

HONOURS PROGRAM IN PHYSIOLOGY (71 credits)
All admissions to the Honours program will be in U2, and the student must have a U1 GPA of 3.3, with no less than a B in 552-209A and 210B. Admission to U3 requires a U2 CGPA of 3.2 with no less than a B in U2 Physiology courses. Decisions for admission to U3 will be heavily influenced by student standing in U2 courses.

The Department reserves the right to restrict the number of entering students in the Honours programs. Students who do not maintain Honours standing may transfer their registration to the Major Program in Physiology.

The deadline to apply to the Honours Program is June 1. Application forms are available in McIntyre 1021. Students should include in their letters telephone numbers where they can be reached during the last week of August. Students are responsible for picking up their letters of decision in McIntyre 1021 no later than one week before classes start.

Graduation: To graduate from the Honours Physiology Program the student will have a CGPA of 3.2 with a mark no less than a B in all Physiology courses.

If not previously taken 180-212A,B Organic Chemistry I must be completed in addition to the 71 program credits.

Required Courses (53 credits)
552-209A (3) Mammalian Physiology I
552-210B (3) Mammalian Physiology II
552-212D (2) Introductory Physiology Lab
552-311A (3) Intermediate Physiology I
552-312B (3) Intermediate Physiology II
552-313B (3) Intermediate Physiology III
552-351B (3) Research Techniques in Physiology
552-359D (1) Tutorial in Physiology
552-459D (6) Physiology Seminar
552-461D (6) Experimental Physiology
177-200A (3) Molecular Biology
177-202B (3) Basic Genetics
177-301A,B (3) Cell and Molecular Laboratory
180-222A,B (4) Organic Chemistry II
504-261A (4) Introduction to Dynamic Histology
507-311A (3) Metabolic Biochemistry

Complementary Courses (18 credits)
9 credits selected from:
177-201B (3) Cell Biology and Metabolism
or 507-212B (3) Molecular Mechanisms of Cell Function
177-373A (3) Biostatistical Analysis
or 177-309A (3) Mathematical Models in Biology
180-203A (3) A Survey of Physical Chemistry
or 180-204A,B (3) Physical Chem./Biol. Sci. I
6 credits selected from upper level physiology courses
3 credits selected from upper level science courses

INTERDEPARTMENTAL HONOURS PROGRAM IN IMMUNOLOGY
The Departments of Biochemistry, Microbiology and Immunology, and Physiology offer an Interdepartmental Honours Program in Immunology. Physiology students interested in the program should contact Dr. W.S. Lapp. Details of this program may be found under Immunology.

COURSE DESCRIPTIONS
The following courses are considered acceptable as upper level physiology courses: Biomedical Engineering 399-519A; Experimental Medicine 516-502A, 516-503B, 516-506B, 516-507A, 516-508B and 516-509A. See the appropriate department entry for course descriptions.

The course credit weight is given in parentheses (#) after the course title.
● Denotes courses not offered in 1998-99
Denotes courses offered in alternate years only
□ Denotes limited enrolment

552-198A FEEDBACK & RHYTHMS IN PHYSIOLOGY. (3) (3 hours seminar) (FYS – for first year students only, maximum 25.) (Pre-requisite: 189-140. Corequisite: 189-141) An interdisciplinary course about how mathematics provides insight into physiological rhythms and control systems. The concepts of feedback will be introduced and applied to physiological systems such as white blood-cell production and control of respiration by CO₂.

Professors Guevara and Mackey

552-199A HISTORY OF GENETIC ENGINEERING. (3) (3 hours seminar per week) (FYS - for first year students only, maximum 25.) The history of molecular biology and genetic engineering will be surveyed through a series of essays and reviews written by historic figures and prominent scientists of today. The course will trace key players and principal advances in our understanding of the gene, its manipulation, and the future of genetic engineering.

Professor White

552-201A HUMAN PHYSIOLOGY: CONTROL SYSTEMS. (3) (3 hours lecture weekly) (Prerequisites: collegiate courses in biology or anatomy, and in chemistry and physics; with 180-212 or equivalent, as a pre- or co-requisite.) (For students in Physical and Occupational Therapy, Nursing, and others with permission of the course coordinator.) (Not open to students who have taken 552-209A.) Physiology of body fluids, blood, nerve and muscle, peripheral nerves, central nervous system, special senses, autonomic nervous system, defense mechanisms.

Professor White and Staff

552-202B HUMAN PHYSIOLOGY: BODY FUNCTIONS. (3) (3 hours lecture weekly) (Prerequisites: collegiate courses in biology or anatomy and in chemistry and physics; with 180-212 or equivalent, as a pre- or co-requisite.) (For students in Physical and Occupational Therapy, Nursing, Education, and others with permission of the course coordinator.) (Not open to students who took 552-201A in 1976-77 or earlier, or 552-210B.) Physiology of the cardiovascular, respiratory, excretory, endocrine, and digestive systems; organic and energy metabolism; nutrition; exercise and environmental stress.

Professor Orlowski and Staff

552-201A and 552-202B are companion courses and it is recommended that they be taken in that sequence, but they may be taken in separate years or in the reverse sequence.

552-209A MAMMALIAN PHYSIOLOGY I. (3) (3 hours lectures weekly) (Prerequisites: as for 552-201A and 552-202B. Pre- or co-requisites: 177-200A, 177-201B or 507-212B) (Not open to students who have taken 552-211D or 552-201A.) For students in the Faculty of Science, and other students by permission of the instructor. The course covers the physiology of body fluids, blood, body defense mechanisms, peripheral and central nervous system, muscle. Students must be prepared to attend evening (19:00 - 20:00) class tests.

Professor Stochaj and Staff

552-210B MAMMALIAN PHYSIOLOGY II. (3) (3 hours lectures weekly) (Prerequisites: as for 552-201A and 552-202B. Pre or co-requisites: 177-200A, 177-201B or 507-212.) (Not open to students who have taken 552-211D or 552-202B.) (For students in the Faculty of Science, and other students by permission of the instructor.) The course covers the physiology of the cardiovascular, respiratory, endocrine and digestive systems, of the kidney and of physical exercise. Students must be prepared to attend evening (19:00 - 20:00) class tests.

Professor Trippenbach and Staff

552-212D INTRODUCTORY PHYSIOLOGY LAB. (2) (One 3-hour lab and one 1-hour lecture every second week) (Corequisites: 552-209A and 552-210B.) (Required for Physiology students enrolled in 552-209A and 552-210B. Open to Honours and Major students from some other departments.) Exercises illustrating fundamental principles in human physiology: blood, neurophysiology, smooth muscle; cardiovascular, respiratory, endocrine, and renal physiology.

Professors Cullen, Wechsler and Staff

552-311A INTERMEDIATE PHYSIOLOGY I. (3) (3 hours of lectures per week; 1-3 hours optional lab/demonstration/tutorial arranged for a maximum of 3 afternoons per term.) (Prerequisite: 552-209A and 552-210B or equivalent, or permission of the instructor.) In-depth presentation of experimental results and hypotheses underlying our current understanding of excitable cells: passive and active properties; the central nervous system; endocrine and reproduction.

Professors Cooper, Farookhi and Staff

552-312B INTERMEDIATE PHYSIOLOGY II. (3) (3 hours of lectures per week; 1-3 hours optional lab/demonstration/tutorial arranged for a maximum of 3 afternoons per term) (Prerequisite: 552-209A and 552-210B or equivalent, 552-311A or permission of the instructor.) In-depth presentation of experimental results and hypotheses underlying our current understanding of topics in immunology, kidney function and respiration explored beyond the introductory level.

Professor Hanrahan and Staff

552-313B INTERMEDIATE PHYSIOLOGY III. (3) (3 hours of lectures per week; 1-3 hours optional lab/demonstration/tutorial arranged for a maximum of 3 afternoons per term) (Prerequisite: 552-209A and 552-210B or equivalent, 552-311A or permission of the instructor.) In-depth presentation of experimental results and hypotheses underlying our current understanding of the physiology of the cardiovascular system; blood physiology including hemostasis and thrombosis; transport of fluids and cells; general cell kinetics and regulation, and gastrointestinal physiology.

Professor Frojmovic and Staff

552-351B RESEARCH TECH. IN PHYSIOLOGY. (3) (2 hour lecture and 3 hour lab weekly) (Prerequisites: 552-209, 552-210 and 552-311. Corequisites: 552-312 and 552-313.) (Restricted to Honours Physiology students.) The course provides an overview of common research methods in Physiology, including critical analysis and practical experience with some of the methods. Topics include ethics of animal experimentation, instrumentation, signal analysis, membrane biophysics, radioimmunoassay, ion sensitive dyes, immunocytochemistry, autoradiography, electron microscopy, and molecular biology.

Professor Lake and Staff

552-359D TUTORIAL IN PHYSIOLOGY. (1) (Prerequisites: 552-209A and 552-210B or equivalent. Corequisites: 552-311, 552-312 and 552-313. Enrolment restricted to Honours Physiology students.) The course consists of regularly scheduled meetings between each individual student and a chosen staff member, to consider current problems in biomedical research and to develop background for a research project to be carried out in U3. Brief written summaries of each meeting are required.

Professor Lake and Staff

552-419D PROJECT & SEMINAR IN IMMUNOLOGY. (6) (7 hours lab, 2 hours seminar weekly.) (Enrolment restricted to U3 Honours Immunology students.) Individual research projects in Immunology under the guidance of staff members in the three participating departments: Physiology, Biochemistry, and Microbiology and Immunology. The students will meet to discuss their research projects in a seminar format during the winter term. They will be evaluated on their laboratory and seminar performance.

Professor Lapp

552-423A PHYSIOLOGICAL DYNAMICS. (3) (Prerequisite: 552-209A and 552-210B or equivalent, and 177-309 or 189-315, or permission of the instructor.) The control of physiological system function from a theoretical standpoint. The basic roles of mass and momentum transport, pacemaker activity and wave propagation, and neural information processing are emphasized. These are related to the concepts of feedback, stability, and oscillation in normal and patho-physiological states.

Professors Mackey and Glass
nels, presynaptic and postsynaptic events in synaptic transmission and neuronal interactions in CNS function.  

Professors Cohen and Cooper

Box 552-459D Physiology Seminar. (6) (2 hours seminar) (Prerequisite: permission of instructors.) (Required course for U3 Honours students. Limited enrolment – 12 students maximum. Password required.) Discussion of topics in mammalian, cellular and molecular physiology. Students will be required to write one essay and make at least one oral presentation per term. A final course essay is required.  

Professors Farookhi and Lake

Box 552-461D Experimental Physiology. (6) (Permission of the instructor required. Password required.) (This course is a requirement for U3 students in the Honours Physiology program and the Major program in Physics and Physiology, and is open to a limited number of other U3 Physiology students.) Individual project work under the supervision of Departmental Staff members.  

Professor Wechsler and Staff

Box 552-502B Exercise Physiology. (3) (Prerequisite: 552-311A, 552-312B, and 552-313B) Behaviour of physiological processes in response to physical effort, in areas such as structural basis of muscle contraction, neural control of muscle, mechanics and energetics of muscle contraction, fuel utilization, fatigue, physiological adjustments during exercise and influence of training.  

Professor Wechsler and Staff

Box 552-508A Advanced Renal Physiology. (3) (Prerequisite: 552-312B or the equivalent.) (Limited enrolment. Open to advanced undergraduate and graduate students.) Offered in conjunction with the Department of Medicine. Lectures and seminars will cover advanced concepts in selected areas of kidney physiology (glomerular and tubular function) as well as membrane and epithelial transport. Students will be expected to critically discuss selected experimental papers.  

Professor Levy and Staff

Box 552-513B Cellular Immunology. (3) (4 hours lectures plus term paper) (Prerequisites: 528-314B, or permission of the instructor.) This course deals with cellular interactions, regulation and effector mechanisms of the normal immune response in relation to diseases and pathogenic processes. It is taught at an advanced level.  

Professor Lapp

Box 552-515A Physiology of Blood I. (3) (2 hours lecture plus 1 hour seminar weekly) (Prerequisites: 552-311B, or permission of the instructor.) Study of the cell and molecular physiology of hemostasis and its pathophysiology (bleeding and thrombosis). Emphasis on molecular mechanisms regulating clot formation, fibrinolysis, and cell adhesion/aggregation. Experimental approaches and specific clinical disorders will be analyzed. Weekly discussions, and a major term paper.  

Professors Frojmovic, Solymoss and staff

Box 552-516B Physiology of Blood II. (3) (2 hours lecture plus 1 hour seminar weekly) (Prerequisites: 552-312B, or permission of the instructor.) Bone marrow hematopoiesis, with emphasis on regulation of stem cell proliferation and differentiation along hematopoietic pathways. Formation and differentiation of red and white blood cells and some of the diseases associated with hemato-poiesis will be covered. Emphasis will be given to the molecular mechanisms involved in the normal and pathological conditions.  

Professors Ponka and Hiscott

Box 552-517B Artificial Internal Organs. (3) (Prerequisite: permission of instructors. Password required.) Physiological, bioengineering, chemical and clinical aspects of artificial organs including basic principles and physiopathology of organ failure. Examples: blood substitutes, oxygenator, cardiac support, vascular substitutes, cardiac pacemaker and others. Biomaterials and tissue engineering, biocompatibility.  

Professors Sipehia and Chang

Box 552-518A Artificial Cells & Biotechnology. (3) (Prerequisite: permission of instructors. Password required.) Physiology, bio-technology, chemistry and biomedical application of artificial cells, blood substitutes, immobilized enzymes, microorganisms and cells, hemoperfusion, artificial kidneys, artificial livers, and artificial pancreas. 552-517B and 552-518A when taken together, will give a complete picture of this field. However, the student can select one of these.  

Professors Chang and Yu

Box 552-520B Ion Channels. (3) (1½ hour lecture, 1½ hour seminar) (Prerequisite: 552-311A) (Priority to Graduate and Honours students; others by permission of instructors. Password required.) (Offered in odd numbered years.) A discussion of the principal theories and interesting new developments in the study of ion channels. Based on a textbook, computer exercises & critical reading and presentation of research papers. Topics include: Properties of voltage- and ligand-gated channels, single channel analysis, structure and function of ion channels.  

Professors Bourque and Hanrahan

Box 552-531B Topics in Applied Immunology. (3) (Permission of the instructor. U3 InterDept. Honours Immunology students and graduate students with strong immunology background i.e. 552-513A and 552-512B.) Seminar format course in which experts in immunologic mechanisms of resistance against a variety of infectious diseases, including AIDS, malaria, and tuberculosis oversee student moderators in their presentation of recent scientific literature in the field.  

Professors Stevenson and Bernard

Box 552-556B Topics in Systems Neuroscience. (3) (Permission of the instructor required. Limited enrolment. Password required.) (Not open to students who have taken 552-459B.) Topics of current interest in systems neurophysiology and behavioural neuroscience including: the neural representation of sensory information and motor behaviours, models of sensory motor integration, and the computational analysis of problems in motor control and perception. Students will be expected to present and critically discuss journal articles in class.  

Professors Cullen and Guittton

11.26 Psychiatry (555)  

Department of Psychiatry  
Research & Training Building  
1033 Pine Avenue West  
Montreal, QC  
Telephone: (514) 398-4176  

Chair — Joel Paris  
Professors — Joel Paris, Gilbert Pinard, Simon Young  
Associate Professors — Frances Abbott, Patricia Boksa, Bernardo Dubrovsy, Alain Gratton, Roberta Palmour, Judes Poirier  
Assistant Professors — Kathryn Gill, Satyabrata Kar, Joseph Rochford, Lalit Srivastava, Dominique Walker  

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

Denotes limited enrolment  

Box 555-199A Mental Illness and the Brain. (3) (1 hour lecture and 2 hours seminar weekly) (FYS - for first year students only, maximum 25. No prerequisites.) This course will introduce the student to the fundamentals of neuroscience, and then use these principles to illustrate recent advances made on the biological causes of, and treatments for, mental disorders with a strong biological component: schizophrenia, depression, mania, anxiety disorders, obsessive-compulsive disorder, Alzheimer’s and Parkinson’s diseases and alcohol and drug abuse.  

Professors Boksa and Rochford
11.27 Psychology (204)

Stewart Biological Sciences Building, Room W8/1
1205 Avenue Docteur Penfield
Montreal, QC, H3A 1B1
Telephone: (514) 398-6100
Fax: (514) 398-4896
Internet: www.psych.mcgill.ca
E-mail: info@hebb.psych.mcgill.ca

Chair — A.J.J. Marley
Emeritus Professors — George A. Ferguson, Wallace E. Lambert, Peter M. Milner
Assistant Professors — Juss H. Gropen, Gillian A. O’Driscoll
Lecturers — Nicole Allard, Rhonda Topstpon Amsel
Associate Members — Clinical Research Institute of Montreal: Terrance J Coderre; Douglas Hospital: Howard Steiger; Family Medicine: Vilma Patel; Montreal Neurological Institute: Barbara Jones, Marilyn Jones-Gotman, Brenda Milner, Robert Zatorre; Psychiatry: Sharon Welner; School of Nursing, Psychiatry: Frances Abbott; Vision Research Center: Curtis Baker, Robert Hess, Frederick A.A. Kingdom, Kathleen Muller
Part-time Appointments — Ian Bradley, James C. Macdougall, Yuriko Oshima-Takane, Carol Schopflocher, Philip R. Zelazo

555-301B ISSUES IN DRUG DEPENDENCE. (3) (3 hours) (Prerequisites: 552-201A or 552-209A or 552-210B or 204-100A or 177-201B or permission of instructor.) (Not open to students who have taken 576-301B.) The phenomenology and epidemiology of the use and abuse of alcohol, nicotine, opiates, stimulants, sedatives and psychotomimetic agents are discussed in relation to current theoretical and experimental issues. The perspective is multidisciplinary and the intention is to develop an understanding of the nature of the issues surrounding drug dependence.

Professor Gill

555-500B NEUROBIOLOGY OF MENTAL DISORDERS. (3) (3 hours) (Prerequisites: 507-212B and 507-311A, or 507-312B, or 177-200A and 177-210B, or 552-311A, or 204-422B, or 204-308A and an upper level biological science course with permission of the instructor, or equivalent. Basic knowledge of cellular and molecular biology is required. Open to U3 and graduate students only. Strongly recommended for M.Sc. students in Psychiatry.) Current theories on the neurobiological basis of most well known mental disorders (e.g. schizophrenia, depression, anxiety, dementia). Methods and strategies in research on genetic, physiological and biochemical factors in mental illness will be discussed. Discussion will also focus on the rationale for present treatment approaches and on promising new approaches.

Professors Boksa, Srivastava and Staff

555-502A BRAIN EVOLUTION & PSYCHIATRY. (3) (Prerequisites: 177-115B or equivalent as authorized by instructor.) The course will focus on the transcendental importance of evolution of nervous systems for normal and pathological behavior. Studies of allomeric brain growth and recent evolutionary theories of brain organization as they relate to normal and abnormal behavior will be emphasized.

Professor Dubrovsky
INFORMATION MEETINGS FOR NEW STUDENTS

All new students entering the Psychology undergraduate program are required to attend an Information Meeting prior to registration. Students who have been accepted into a Bachelor of Science program in Psychology must attend the meeting on August 24, 1998 at 13:00. The meeting will be held in Room S1/3 of the Stewart Biological Sciences Building. Students accepted into a Bachelor of Arts program must attend a separate information meeting. For details, consult the Psychology program listing in the Faculty of Arts section. At this meeting, Nicole Aliard, the Academic Adviser, will explain the requirements of the Department's programs. Incoming students will have an opportunity to ask questions and receive advice on how to plan their courses. After this meeting students will make appointments for individual advising sessions, during which they will fill out their Study Plan form for registration.

(For students entering the Psychology program in the winter term 1999, there will be an Information Meeting on December 17 at 11:30 in Room N2/20 of the Stewart Biology Building).

Entering students must bring their letter of acceptance and a copy of their collegial transcript(s). They will also need this Calendar and a preliminary Timetable. Students will also find the Psychology Department Handbook helpful. This Handbook contains more detailed descriptions of Psychology courses, as well as providing guidelines for how students might pursue particular areas of interest.

The Psychology Department Handbook can be purchased for $3.00 (including tax) in Room N7/9, Stewart Biological Sciences Building. Out-of-town residents may have a copy mailed to them upon receipt of $3.00. Requests should be mailed to the Department of Psychology Adviser’s Office, 1205 Avenue Docteur Penfield, Montreal, QC H3A 1B1.

MINOR PROGRAM IN PSYCHOLOGY

A Minor program in Psychology is available to students registered in any B.Sc. program (other than Psychology). This program is intended to complement a student’s primary field of study by providing a focused introduction to specialized topics in psychology. Students may declare their intent to follow a Minor program at the beginning of their U2 year. They must then consult with the Chief Academic Advisor of the Department of Psychology in order to obtain approval for their course selection. A separate Minor program exists for students registered in a program in the Faculty of Arts. Please consult the Psychology listing in the Faculty of Arts section for more information.

The Minor program for Science students requires the completion of 24 credits, of which no more than 6 may overlap with the primary program. All courses in the Minor program must be passed with a minimum grade of C. A prerequisite to the program is Psychology 204-204 or equivalent, see “Course Overlap” on page 335.

Complementary Courses (24 credits)

at least 3, but no more than 6, credits selected from:

204-211 (3) Learning and Motivation
204-212 (3) Perception
204-213 (3) Cognition
204-215 (3) Social Psychology

18-21 credits selected from among Psychology courses at the 300 level or above

FACULTY, MAJOR, HONOURS PROGRAMS IN PSYCHOLOGY

Recommended Background

It is expected that most students who enter a Major, Honours or Faculty Program in Psychology will have taken introductory psychology, biology and statistics at the collegial level. Recommended CEGEP courses include: Psychology 350-101 or 350-102, one of Biology 101-301, 101-401, 101-911 or 101-921 and either Mathematics 201-307 or 201-337 or the combination of Quantitative Methods 360-300 with Mathematics 201-300. Students must obtain a minimum grade of 75% in their CEGEP level statistics course(s). In the first year those students who have not taken the recommended collegial level statistics course(s), or those who have obtained a grade below 75%, must take 204-204 in addition to the other courses in their program. Those who have not taken the recommended collegial level biology must take 177-111A or 112B, and those who have not taken introductory Psychology in college must take 204-100A.

Areas of Specialization:

The study of psychology covers many fields. To develop a breadth of understanding in psychology, students are expected to obtain knowledge beyond the introductory level in several areas of psychology. To ensure this requirement is met, Psychology courses are divided into six areas of specialization in the lists below:

Cognitive Psychology

204-310 (3) Human Intelligence
204-316 (3) Psychology of Deafness
204-334 (3) Computer Simulation - Psych. Processes
204-335 (3) Formal Models of Psych Processes
204-340 (3) The Psychology of Language
204-352 (3) Laboratory in Cognitive Psychology
204-401 (3) Theories of Cognition
204-413 (3) Cognitive Development
204-428 (3) Human Communication and its Disorders
204-437 (3) Reading Ability and Disability
204-472 (3) Scientific Thinking and Reasoning
204-501 (3) Auditory Perception
204-513 (3) Seminar on the Mental Lexicon
204-530 (3) Applied Topics in Deafness
204-532 (3) Cognitive Science

Health Psychology and Psychopathology

204-337 (3) Intro: Abnormal Psychology 1
204-338 (3) Intro: Abnormal Psychology 2
204-408 (3) Principles of Cognitive Behaviour Therapy
204-412 (3) Deviations in Child Development
204-429 (3) Health Psychology
204-436 (3) Human Sexuality and Its Problems
204-491 (6) Advanced Study in Behavioural Disorder
204-533 (3) International Health Psychology

Behavioural Neuroscience

204-308 (3) Physiological Psychology I: Fundamentals
204-311 (3) Human Behaviour and the Brain
204-318 (3) Physiological Psychology II: Motivation and Learning
204-342 (3) Hormones and Behaviour
204-353 (3) Laboratory in Human Perception
204-410 (3) Special Topics in Neuropsychology
204-422 (3) Neurochemical Basis of Behaviour
204-427 (3) Sensorimotor Behaviour
204-431 (3) Environment and the Developing Brain
204-470 (3) Memory and Brain
204-505 (3) The Psychology of Pain
204-526 (3) Advances in Visual Perception

Social and Personality

204-331 (3) Inter-Group Relations
204-332 (3) Introduction to Personality
204-333 (3) Personality and Social Psychology
204-351 (3) Research Methods in Social Psychology
204-354 (3) Interpersonal Relationships
204-471 (3) Human Motivation

Developmental

204-304 (3) Child Development
204-343 (3) Language Acquisition in Children
204-414 (3) Social Development
204-416 (3) Advanced Topics in Child Development
204-438 (3) The Child Witness
204-511 (3) Infant Competence
204-561 (3) Methods in Developmental Psycholinguistics

Research and Measurement

204-336 (3) Measurement of Psych. Processes
204-400 (3) Contemporary Psychology Theory
B.Sc. HONOURS PROGRAM IN PSYCHOLOGY (54 credits)

Honours in Psychology prepares students for graduate study, and so emphasizes practice in the research techniques which are used in graduate school and professionally later on. Students are accepted into Honours at the beginning of their U2 year, and the two-year sequence of Honours courses continues through U3. Admission to Honours is selective. There is normally room for 25-30 new Honours students each year. Students with a cumulative grade point average of 2.8 or better are eligible to apply; however during the past several years it has been possible to accept a maximum of 30 students with averages above 3.5 based on a 27-30 graded credit program over 2 terms. Once in the Honours program, the student must obtain a GPA of 3.0 in the U2 year in order to continue in the program for U3. Students in the Honours program are required to complete a minimum of 27 graded credits per academic year.

Applications can be obtained from the Undergraduate Office of the Department of Psychology, Room N7/9A, Stewart Biological Sciences Building. The applications must be completed and returned to the Undergraduate Office by August 20, 1998. Candidates will be advised of the Department’s decision through a notice posted in front of the Undergraduate Adviser’s Office, N7/9, shortly after classes begin in September.

Students should note that awarding of the Honours degree will depend on both cumulative grade point average and a minimum grade of B on 204-380D, 480D, 481D. “First Class Honours” is awarded to students who obtain a minimum cumulative grade point average of 3.5 and a minimum CGPA of 3.5 in the three Honours courses of which 12 out of 18 credits (2 courses) received at least an A-grade. “Honours” is awarded to students with a minimum cumulative grade point average of 3.0 and a minimum CGPA of 3.0 on these three courses. Moreover, the awarding of the Honours degree normally requires completion of two full years of study, U2 and U3, in the Psychology Department. Exceptionally good students may be admitted for the U3 year only on the basis of their marks and research experience, however these students must complete 6 credits in each of three areas of specialization.

U1 Required Courses (12 credits)
204-211 (3) Learning and Motivation
204-212 (3) Perception
204-213 (3) Cognition
204-215 (3) Social Psychology

Note: 204-100A may be taken as a co-requisite with these basic courses.

Complementary Courses (42 credits)
12 credits of Psychology courses: select 6 credits from each of two of the six areas of specialization
12 credits of Psychology courses, selected from:
courses at the 300 level or above, at least 6 of which must be at the 400 level or higher
18 credits, 9 of which must be at the 300 level or higher, selected from:
any departments within the University other than Psychology, consistent with regulations of the Faculty of Science.
NOTE: Prerequisites: A basic introductory course in psychology is a prerequisite for all Psychology courses with the following exceptions: 204-100A, 204-204, 204-211, 204-212, 204-213, 204-215, 204-305. All courses are open to students other than Major and Honours students in Psychology provided the prerequisites are met and unless otherwise specified. Due to sabbatic leaves and other considerations some courses may not be given in a particular year.

For more detailed information about courses and programs in Psychology see the Psychology Undergraduate Handbook which is on sale in the Departmental Advising Office, N7/9 Stewart Biological Sciences Building.

204-100A INTRODUCTION TO PSYCHOLOGY. (3) (2 lectures; 1 seminar) (Not open to students who have passed Psychology 101 or 102 in CEGEP.) Introduction to the scientific study of mind and behavior. Learning, perception, motivation and thinking are explained in a way which emphasizes the continuity of human behavior and the behavior of other species, and which emphasizes the role of the central nervous system in organizing and regulating behavior.

Professor Donderi

204-204A,B INTRODUCTION TO PSYCHOLOGICAL STATISTICS. (3) (2 lectures, 1 conference) (Not open to students who have passed one of the following courses in CEGEP with a minimum grade of 75%: Mathematics 307, 337 or the combination of Quantitative Methods 300 with Mathematics 300.) (Note: This course is a prerequisite for 204-305, 204-435B, 204-46B, 204-310A, 204-336B.) The statistical analysis of research data; frequency distributions; graphic representation; measures of central tendency and variability; elementary sampling theory and tests of significance. Credit for other statistics courses may preclude credit for this course and conversely. See “Course Overlap” on page 335.

Professor Amsel (A) Professor Ostry (B)

204-211B LEARNING AND MOTIVATION. (3) (2 lectures) (Prerequisite: 204-100A or equivalent.) An introduction to contemporary research on learning and motivation from a behavioural, biological and evolutionary perspective. Topics include: internal and external influences on behaviour, classical and instrumental conditioning, attention, biological constraints on learning and motivation, and cognitive processes. Much of the material will be drawn from the literature on research with animals.

Section 01 Limited to Psychology Major and Honours students Section 02 Limited to Psychology Minor students (CAPPED) Section 03 Limited to non-Psychology students (CAPPED)

Professor A. Baker

204-212A PERCEPTION. (3) (2 lectures, 1 conference) Perception is the organization of sensory input into a representation of the environment. Topics include: survey of sensory coding mechanisms (visual, auditory, tactile, olfactory, gustatory), object recognition, spatial localization, perceptual constancies and higher level influences.

Section 01 Limited to Psychology Major and Honours students Section 02 Limited to Psychology Minor students (CAPPED) Section 03 Limited to non-Psychology students (CAPPED)

Professor Chaudhuri

204-213B COGNITION. (3) (2 lectures, 1 conference) An introduction to the study of higher mental processes. Topics such as: attention, memory, development of thought and language, problem solving, reasoning, concept formation, imagery, artificial intelligence.

Section 01 Limited to Psychology Major and Honours students Section 02 Limited to Psychology Minor students (CAPPED) Section 03 Limited to non-Psychology students (CAPPED)

Professor Gropen

204-215A SOCIAL PSYCHOLOGY. (3) (3 lectures) (Not open to students who have taken 204-330A, 280-221 or 166-216) The course offers students an overview of the major topics in social psychology. Three levels of analysis are explored beginning with individual processes (e.g., attitudes, attribution), then interpersonal process-
204-318B PHYSIOLOGICAL PSYCHOLOGY II: MOTIVATION AND LEARNING. (3) (2 lectures, 1 conference) (Prerequisite: 204-308A or 177-306A, or 552-201, or 552-202 or 552-209 or 552-210 or 552-211D or 552-311A.) Physiological bases of motivation including feeding and drinking, sexual and parental behaviour. Physiological processes in reinforcement and learning.

Professor Franklin

204-331B INTER-GROUP RELATIONS. (3) (2 lectures) (Prerequisite: 204-215A) The course focuses on the social psychology of societal groups such as racial minorities, aboriginal groups and women. The ideological biases of current theories is first established. This is followed by a review of current theories and finally current controversies are explored including new forms of racism and affirmative action.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

204-332B INTRODUCTION TO PERSONALITY. (3) (3 lectures) (Prerequisite: 204-100A) This course examines some of the major theories of personality, e.g., those of Freud, Rogers, and Bandura. Empirical research inspired by these theories will also be examined. Topics include the nature of human motivation, the role of the self-concept, and the consistency and stability of personality.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

204-333A PERSONALITY AND SOCIAL PSYCHOLOGY. (3) (2 lectures) (Prerequisite: 204-215A) Human behavior is a product of both factors residing within the person and factors residing in one's environment (other individuals, relationships, groups, and momentary situations). The course will consider traditional approaches to person-situation interactions and a more dynamic approach based on recent research on goals and social cognition.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

Professor Zuroff

204-333B PERSONALITY AND SOCIAL PSYCHOLOGY. (3) (3 lectures) (Prerequisites: 204-213 or permission of instructor.) Human behavior is a product of both factors residing within the person and factors residing in one's environment (other individuals, relationships, groups, and momentary situations). The course will consider traditional approaches to person-situation interactions and a more dynamic approach based on recent research on goals and social cognition.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

Professor Lydon

204-334A COMPUTER SIMULATION - PSYCH. PROCESS. (3) (3 hour lecture) (Prerequisites: 204-212, 204-213 and 308-202A,B; or permission of instructor.) (Limited enrolment.)

204-335A FORMAL MODELS OF PSYCH. PROCESSES. (3) (3 hour lecture) (Prerequisites: A basic understanding of mathematics, e.g. the contents of 189-112A,B, and of computer science, e.g. the contents of 308-202A,B or permission of instructor.)

204-336B MEASUREMENT OF PSYCH. PROCESSES. (3) (3 lectures) (Prerequisites: 204-204 and Introductory Calculus)

204-337A INTRO: ABNORMAL PSYCHOLOGY 1. (3) (2 lectures, 1 conference) (Note: This course is prerequisite for 204-338B.) A survey of the genetic, physiological and environmental origins of intellectual and emotional disorders.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

Professor Pihl

204-338B INTRO: ABNORMAL PSYCHOLOGY 2. (3) (2 lectures and 1 conference) (Prerequisite: 204-337A) (Note: This course is prerequisite for 204-491D.) An introduction to psychotic behaviour problems, character disorders and behaviour modification.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

Professor Pihl

204-340A THE PSYCHOLOGY OF LANGUAGE. (3) (2 1/2 lecture) (Prerequisite: An introductory course in Psychology or Linguistics.) A survey of issues in psycholinguistics, focusing on the nature and processing of language (e.g., how we understand speech sounds, words, sentences, and discourse). Also surveyed: language and thought, the biological foundations of language, and first language acquisition.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

Professor Gropen

204-341B PSYCHOLOGY OF BILINGUALISM. (3) (2 lectures) (Prerequisites: Introductory Psychology, and 204-340 or introduction to linguistics; or permission of instructor.) This course will examine issues in bilingualism from both individual and societal perspectives. Specific issues to be examined include: second language acquisition in children and adults, critical period hypothesis, cognitive consequences and correlates of bilingualism, social psychological aspects of bilingualism, and bilingual education.

Section 01 Limited to Psychology Major and Honours students
Section 02 Limited to Psychology Minor students (CAPPED)
Section 03 Limited to non-Psychology students (CAPPED)

Professor Genesee

204-342B HORMONES AND BEHAVIOUR. (3) (2 lectures, 1 conference) (Prerequisite: 177-111A, 177-112B, or 177-115B or equivalent)

204-343B LANGUAGE ACQUISITION IN CHILDREN. (3) (2 lectures plus conference)

204-351A RESEARCH METHODS IN SOCIAL PSYCHOLOGY. (3) (1 hour lecture, 6 hour lab and/or field work) (Prerequisite: 204-215A. Corequisite: 204-305. U2 level and above, and permission of instructor. Password required.) Designed to introduce students to the issues, strategies, and applications of various research methodologies in social psychology. Through demonstrations, exercises, and pilot studies, students will gain experience with lab and field methods using both correlational and experimental procedures. Classic and contemporary approaches will be examined.

Note: Students will be admitted on the basis of a written application on forms available from the Department (Room N7/9). Applications must be submitted by August 20.

Professor Lydon

204-352B LABORATORY IN COGNITIVE PSYCHOLOGY. (3) (1 hour lecture, weekly lab) (Prerequisite: 204-213 and permission of instructor. Password required.)

204-353A LABORATORY IN HUMAN PERCEPTION. (3) (1 hour lecture plus 3 hour lab) (Prerequisites: 204-212, U2 level or above, and permission of instructor. Password required.) Students will be introduced to standard psychophysical procedures and data analysis techniques, and will have the opportunity to design and carry out their own experiments. Research topics include: visual acuity, form and motion perception, and visual search. Evaluation based on individually written reports on lab experiments. Note: Students will be admitted on the basis of a written application on forms available from the Department (Room N7/9). Applications must be submitted by August 20.

Professor Wilkinson

204-354B INTERPERSONAL RELATIONSHIPS. (3) (Prerequisite: 204-215A and 204-304, 204-333 highly recommended.)

204-380D HONOURS RESEARCH PROJECT AND SEMINAR. (6) (3 hour seminar) (For U2 honours students only.) Students prepare reports on various experimental areas. They also develop original investigations in collaboration with staff members. Students present reports on progress and write a final research report.

Professors Ostry and Sherwin

204-401B THEORIES OF COGNITION. (3) (2 lectures) (Prerequisite: 204-213 or permission of instructor.)

204-403A MODERN PSYCHOLOGY IN HISTORICAL PERSPECTIVE. (3) (2 lectures) A survey of the social and ideological influences on psychology from its philosophical beginnings through the period of the schools to its modern situation.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Pleszewski

204-406B PSYCHOLOGICAL TESTS AND MEASUREMENT. (3) (2 lectures, 1 conference) (Prerequisites: 204-204 or equivalent.)
204-408A PRINCIPLES OF COGNITIVE BEHAVIOUR THERAPY. (3) (2 lectures, 1 conference) (Prerequisites: 204-337A and 204-211 or permission of instructor.) An introduction to the theory, research and practice of cognitive behaviour therapy. The experimental approach to understanding human behaviour is used to follow basic principles of learning and their clinical application. Certain psychiatric disorders such as alcoholism and depression are highlighted to illustrate how a behaviour therapist conceptualizes problems and formulates treatments. Professor Bradley

204-410B SPECIAL TOPICS IN NEUROPSYCHOLOGY. (3) (2 lectures, 1 conference) (Prerequisites: 204-311A or 204-308A. Knowledge of basic neuropsychology at the level covered in 204-311A is assumed.) This course will trace developments in human brain mapping and in cognitive neuroscience via readings from primary sources. Topics include the neural bases for perception, language, and memory, and their relationship to structural and functional brain organization. Emphasis is placed on integrating knowledge from behavioral lesion experiments and functional activation studies. Professor Zatorre

204-412A DEVIATIONS IN CHILD DEVELOPMENT. (3) (2 lectures, 1 conference) (Prerequisite: 204-304A or 204-337A or permission of instructor. Students will also require a basic knowledge of research design.) Deviations in the perceptual, cognitive, social and emotional development of children. Emphasis is placed on research to explore constitutional and environmental causes and symptoms associated with such disorders as conduct disorder, attention deficit hyperactivity disorder, anxiety-withdrawal disorders, and childhood autism.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Douglas

204-413A COGNITIVE DEVELOPMENT. (3) (3 hours) (Prerequisite: 204-304A or 204-213 or equivalent.)

204-414A SOCIAL DEVELOPMENT. (3) (Prerequisites: 204-304A and 204-305) Advanced study of the development of social behaviour and social cognition in children. Topics include: socialization, attachment, aggression, exploration, role taking, communication, family and peer relations, self and person perception. The development of these social processes within the framework of three general theories of development: psychoanalytic, learning, and cognitive-developmental.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Aboud

204-416B ADVANCED TOPICS IN CHILD DEVELOPMENT. (3) (3 lectures) (Prerequisite: 204-304A or permission of instructor.)

204-422B NEUROCHEMICAL BASIS OF BEHAVIOUR. (3) (2 lectures, 1 conference) (Prerequisite: 204-308A or 204-342B or 552-201 or 552-202 or 552-209 or 552-210 or 552-211D or permission of instructor.)

204-427B SENSORMOTOR BEHAVIOUR. (3) (2 lectures) (Prerequisite: 204-308A or permission of instructor.)

204-428B HUMAN COMMUNICATION AND ITS DISORDERS. (3) (2 lectures) (Prerequisite: 204-340A, 104-200A, or permission of instructor.)

204-429B HEALTH PSYCHOLOGY. (3) (2 lectures, 1 conference) (Prerequisite: 204-337A or, in the case of advanced undergraduates, permission of instructor.) A survey of health psychology including a review of psychological factors involved in the development of physical illness. Assessment and intervention strategies for problems such as cardiovascular disease, cancer, diabetes, and headaches.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Ditto

204-431A THE ENVIRONMENT AND THE DEVELOPING BRAIN. (3) (2 1/2 lectures) (Prerequisite: 204-212 or 204-311A or 204-308A or 204-304A) The effects of normal and abnormal environmental conditions on the development of brain and behaviour. The role of early “neural plasticity” in normal development and the detrimental effects of abnormal conditions will be considered. Topics covered include: basic neuro-embryology, prenatal malnutrition, fetal alcohol syndrome, maternal smoking, chemical toxins, traumatic brain damage.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Shapiro

204-435B CORRELATIONAL TECHNIQUES. (3) (3 lectures) (Prerequisites: 204-204 and 204-305 or equivalent.) The analysis of relations among a number of variables that are particularly common in social, developmental, clinical, and organizational psychology. Exploration of the data for meaningful relations using techniques such as multiple regression, factor analysis and discriminant function analysis.

Professor Ramsay

204-436A HUMAN SEXUALITY AND ITS PROBLEMS. (3) (Prerequisites: either 204-337A or 204-418A or permission of the instructor.) This course will deal with variations in sexual behaviour and focus on topics typically referred to as gender identity, sexual orientation, sexual dysfunction and sexual deviation. Current research and theories attempting to understand these phenomena will be emphasized.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Bruck

204-437B READING ABILITY AND DISABILITY. (3) (Prerequisites: 204-213B and 204-340A) An introduction to psycholinguistic research on reading. Topics include: the acquisition of reading skill; theories of skilled reading; relations between reading and other language skills, individual differences in reading skill; reading disability; teaching of reading.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Binik

204-438A THE CHILD WITNESS. (3) (Prerequisites: 204-213B and 204-304A) This course examines psychological theories, and data that shed light on the practical issues that arise when children enter the legal arena. Selected topics include: memory development, suggestibility, theory of mind, childhood amnesia, and repression. Cases involving child witnesses are presented to illustrate the application of scientific data.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Bruck

204-450D RESEARCH PROJECT AND SEMINAR. (6 credits) (Prerequisites: 204-204, 204-305 or 204-435B, and permission of instructor.) (Only for Major or special students in U3 who intend to proceed to graduate school.) Under supervision of an advisor approved by the Department, students design and carry out a research project. Students report their research in seminars throughout the year and in a final written report. Note: Students will be admitted on the basis of a written application on forms available from the Department (Room N7/9). Applications must be submitted by August 20.

Professors A. Baker and O'Driscoll

204-451A HUMAN FACTORS RESEARCH AND TECHNIQUES. (3) (2 lectures; 1 lab) (Prerequisites: 204-204, 204-211, 204-212, 204-213, 204-215 and 204-305 or permission of instructor.) The application of psychology to the analysis and design of systems and products to increase efficiency and reduce the probability and risk of human error. Topics include: workload and vigilance, control-display relationships, task analysis, and workstation design.

Professor Donderi

204-470A MEMORY AND BRAIN. (3) (3 hour lectures) (Prerequisites: 204-308A and 204-318B or 552-311A or 177-306A) Memory and amnesia will be studied with an emphasis on the neural mechanisms of information storage in the brain. Topics include: Human memory, developmental plasticity, synaptic plasticity, memory modulators, emotion and memory, short- and long-term memory, sleep, and aging.
204-471B HUMAN MOTIVATION. (3) (3 hour lectures) (Prerequisite: 204-215) The course focuses on integrating current goal-based and need-based theories of human motivation. Particular attention will be given to Czikszentmihalyi’s (1990) Theory of Optimal Experience and Deci and Ryan’s (1991) Self-Determination Theory. The relevance of course material to applied issues in the domains of education, sports, and management is highlighted. 

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Koestner

204-472B SCIENTIFIC THINKING AND REASONING. (3) (2 lectures, 1 conference) (Prerequisites: U3 students only; 177-210A or at least 2 courses in the Faculty of Science at the 200 level.) (Open to Arts and Science students.)

204-480D FOUNDATIONS OF MODERN PSYCHOLOGY. (6) (2 lectures) (For Honours students only.) Critical examination of the assumptions, concepts, ethics, empirical methods, and integrative ideas of modern psychology. Lectures, student presentations, and discussions. Professor Bregman (A term) Professor Genesee (B term)

204-481D HONOURS THESIS RESEARCH. (6) (9 hours. Research) (U3 Honours students only) Under the supervision of an advisor approved by the Department, students design and carry out a research project and report their results in the form of an undergraduate thesis. Professor Melzack (Coordinator)

204-491D ADVANCED STUDY IN BEHAVIOURAL DISORDERS. (6) (1-2 hours lecture or tutorial per week plus a field experience requirement.) (Prerequisites: 204-337A and 204-338B and permission of instructor.) A critical examination of topics in abnormal and clinical psychology. Emphasis will be on analysis of theoretical positions and empirical findings as they relate to both etiology and treatment. Note: Students will be admitted on the basis of a written application on forms available from the Department (Room N7/9). Applications must be submitted by August 20.

Professor Zaccia

204-492A/493B SEMINARS IN SPECIAL TOPICS. (3 credits each) (Restricted to U3 students.) These seminars are offered by special arrangement between interested Psychology staff and students. A student may not register in more than one of these seminars in an academic year. Note: A written proposal detailing the plans for the seminar must be approved by the Department Curriculum Committee before the student is permitted to register for this course. This proposal must be received by the Departmental Curriculum Committee well before the beginning of the term for which the seminar is proposed. Consult the Department Handbook for additional information.

Staff

204-495B PSYCHOLOGY RESEARCH PROJECT. (3) (Prerequisites: 30 credits of the Psychology program including 204-305A/B or equivalent statistics course and CGPA above 3.0.) (Not open to students registered in 204-380D, 204-481D or 204-450D.) Under the supervision of Psychology faculty, students carry out a research project and write a paper describing their results and relating it to the relevant literature. Registration is by special arrangement with Psychology staff, and project proposals must be approved by the Department before registration. For more information see the Psychology Department Handbook.

Staff

204-501B AUDITORY PERCEPTION. (3) (2 lectures) (Prerequisites: 204-212A or equivalent, or permission of instructor.)

204-505A THE PSYCHOLOGY OF PAIN. (3) (2 lectures; 1 conference) (Prerequisites: 204-308A or equivalent course in physiological psychology or physiology.) An introduction to pain research and theory, with special emphasis on the role of psychological factors in pain perception. The psychological, physiological and clinical evidence on pain is reviewed and new therapies for pain are discussed.

Section 01 Limited to Psychology students
Section 02 Limited to non-Psychology students (CAPPED)

Professor Melzack

204-510A STATISTICAL ANALYSIS OF TESTS. (3) (3 lectures) (Prerequisites: 204-305 or 204-435B, 204-406 or permission of instructor.) This course aims to introduce students interested in developing or appraising tests to the important statistical problems and modern techniques associated with testing data. Testing situations discussed will range from one-shot classroom tests through special purpose scales to the highly refined large scale tests such as the SAT.

Professor Ramsay

204-511B INFANT COMPETENCE. (3) (1, 3 hour seminar) (Prerequisites: 204-351 or 352 or 380D or 450D and permission of instructor.) Basic research on the nature of infant competence – both the development of mental representations/operations and expressive/communicative ability – will be examined. Implications for clinical assessment and intervention including information processing procedures as an alternative to conventional tests and treatment procedures for developmental delays will be covered.

Professor Zelazo

204-526A ADVANCES IN VISUAL PERCEPTION. (3) (2 lectures) We examine in detail the structure of the visual system, and its function as reflected in the perceptual abilities and behaviour of the organism. Parallels are also drawn with other sensory systems to demonstrate general principles of sensory coding.

Professors Mullen and Kingdom

204-530A APPLIED TOPICS IN DEAFNESS. (3) (Prerequisite: 204-340 or 204-316 or equivalent. Co-requisite: 204-343 and permission of instructor.) (Undergraduate enrolment limited.)

204-531B STRUCTURAL EQUATION MODELS. (3) (2 lectures) (Prerequisite: 204-435B, 204-651B, or equivalent, or permission of instructor.) The course introduces basic concepts underlying structural equation models (SEM). SEM, which combine regression analysis and factor analysis, are quite useful and are currently very popular in analyzing data that arise in social, developmental and clinical psychology. The students are expected to get first-hand experiences in fitting SEM, and learn how to interpret and report the results from SEM. (Awaiting University Approval)

Professor Takane

204-532A COGNITIVE SCIENCE. (3) (Prerequisites: Admission to the Cognitive Science Minor or permission of instructor. Students should ideally have some cognitive science background in at least two disciplines.) The multi-disciplinary study of intelligent systems. Problems in vision, memory, categorization, choice, problem solving, cognitive development, syntax, language acquisition, and rationality. Rule-based and connectionist approaches.

Professor Shultz

204-533A INTERNATIONAL HEALTH PSYCHOLOGY. (3) (Prerequisite: 204-305 and 204-215 or 204-429 or 204-304 or 151-227 or permission of instructor.) The focus will be on health and illness in developing countries, in particular, on health problems (malnutrition, alcohol abuse, mental illness, family planning, and HIV) where psychosocial factors play a large role in the problem and the solution. Attempted solutions based on community participation, health education, non-governmental and international agencies will be discussed. (Awaiting University Approval)

Professor Aboud

204-540A COMPUTATIONAL MODELLING OF REASONING. (3) (3 hours) (Prerequisite: one course in cognitive psychology)

204-561B METHODS IN DEVELOPMENTAL PSYCHOLINGUISTICS. (3) (3 hour lectures) (Prerequisites: 204-340A, 204-343B and 204-305 or permission of instructor.) Enrollment limited. An examination of various emphasis on the role of psychological factors in the development of language and communication. The following approaches are discussed along with the representative studies: A case study approach, observational-correlational approach versus experimental-manipulative approach, cross sectional design versus longitudinal design, ethnographic approach.
The training and certification of school teachers has traditionally been the responsibility of the Faculty of Education and normally requires the completion of a Bachelor of Education. The program described in this section does not replace the existing teacher training programs but is intended as a very rigorous but rewarding alternative.

The Faculties of Education and of Science have introduced a new program specifically aimed at forming teacher/scientists. The Concurrent B.Sc./B.Ed. Program is designed to provide students with the opportunity to obtain a Bachelor of Science degree and a Bachelor of Education degree after a minimum of 135 credits of study. The Science and Education components of the Concurrent program are rigidly structured and closely integrated so as to satisfy the academic requirements of both degrees.

Concurrency is an essential characteristic of this program: the Science and Education components cannot be taken separately and later combined. Normally students will be admitted to both components of the Concurrent Program simultaneously. Students who have completed more than 30 credits in a B.Sc. or a B.Ed. program, exclusive of the Freshman Year for out-of-province students, will not be allowed to opt into the Concurrent Program. Both components of the Concurrent Program must be taken simultaneously, and both degrees will be granted during the same convocation period. It will not be possible to receive one degree first, and the other subsequently.

Students in the Concurrent Program may change to either a conventional B.Sc. or a conventional B.Ed program, but may not subsequently switch back to the Concurrent Program.

To be admitted, candidates must satisfy the admission requirements of both faculties.

Students who wish to be registered in the Concurrent Program must contact one of the coordinators through the Student Affairs Office of either faculty.

**CONCURRENT B.SC./B.ED.PROGRAM (135 credits)**

The two components of the Concurrent Program are the B.Ed. General Secondary Two-Subject Option Program and one of the B.Sc. Major Programs in Two Subjects. These two components are described in what follows, including an identification of the elements that are counted towards the requirements of both degrees. These provisions are exceptional and apply exclusively to the Concurrent Program.

The following two-subject combinations have been approved for the Concurrent Program:

- biology and chemistry
- biology and geography
- chemistry and physics
- mathematics and chemistry
- mathematics and physics.

**BACHELOR OF EDUCATION GENERAL SECONDARY TWO-SUBJECT OPTION PROGRAM (120 credits)**

The aim of the B.Ed. in Secondary Education is to prepare teachers for the secondary school level through a program of academic studies in two subject areas and professional studies centred on school-based practicum components supported by courses in pedagogy, curriculum and educational foundations. In the case of the Concurrent Program the two academic subjects must correspond to one of the five combinations listed above.

A full description of the B.Ed. Secondary Program can be found in the Faculty of Education section of this Calendar. In summary, it consists of the following:

- **Academic components (57 credits):** in the present case these courses will be selected from the lists of required and complementary courses in the B.Sc. component of the Concurrent Program, and will count towards both degrees.
- **Professional components (57 credits):** these include professional seminars, field experiences, foundation courses, pedagogy courses, and pedagogical support courses. The following 18 credits can be included as electives in the B.Sc. component of the Concurrent program, and will count towards both degrees: 411-405, 414-309, 416-300, 423-400, 455-402, and 455-410.
- **Electives (6 credits).**

**BACHELOR OF SCIENCE, MAJOR PROGRAM IN TWO SUBJECTS FOR TEACHERS (90 credits)**

These B.Sc. programs are designed specifically as the Science component of the Concurrent B.Sc./B.Ed. Program. Five combinations of two science subjects are approved for the Concurrent Program. These combinations are chosen to reflect compulsory subjects taught in secondary schools and common pairings of subjects taught by secondary school teachers. They also honour the requirement of the Ministère de l’éducation to train teachers in two subjects, with the possibility of a third subject which supports or is related to the other two, since mathematics is a necessary support for physics and chemistry.

The general structure of these B.Sc. programs is as follows:

- **Required and complementary courses (64-66 credits).** The details of these major programs are given below. Note that 57 of these credits can be counted towards the academic component of the B.Ed. program, but only for students in the Concurrent Program.
- **Elective courses (24-26 credits).** These are electives from the B.Sc. perspective, but they must be suitably chosen if the student wishes to complete the Concurrent Program with the minimum of 135 credits. The following Education courses can count towards both the B.Sc. and the B.Ed. components of the Concurrent Program.

### MAJOR PROGRAM IN BIOLOGY AND CHEMISTRY FOR TEACHERS (65 credits)

**Required Science courses (56 credits)**

- 177-210 (3) Perspectives of Science
- 189-222 (3) Calculus III
- 189-203 (3) Principles of Statistics I

**Biological List A**

- 189-221 (3) Principles of Biochemistry

**Chemical List A**

- 189-222 (3) Calculus III
- 189-203 (3) Principles of Statistics I

**Complementary Science courses (9 credits)**

- 189-222 (3) Calculus III
- 189-203 (3) Principles of Statistics I

### MAJOR PROGRAM IN BIOLOGY AND GEOGRAPHY FOR TEACHERS (66 credits)

**Required Science courses (42 credits)**

- 177-210 (3) Perspectives of Science
- 189-203 (3) Principles of Statistics I

**Biological List A**

- 189-221 (3) Principles of Biochemistry

**Geographical List A**

- 189-222 (3) Calculus III
- 189-203 (3) Principles of Statistics I
Complementary Science courses (24 credits)
Biology List C
Geography List B
Geoscience List

MAJOR PROGRAM IN CHEMISTRY AND PHYSICS
FOR TEACHERS (65 credits)
Required Science courses (62 credits)
177-210 (3) Perspectives of Science
Mathematics List B
Chemistry List A
Physics List A
Complementary Science courses (3 credits)
Geoscience List

MAJOR PROGRAM IN MATHEMATICS AND CHEMISTRY
FOR TEACHERS (64-65 credits)
Required Science courses (47 credits)
177-210 (3) Perspectives of Science
Mathematics List A
Chemistry List A
Complementary Science courses (17-18 credits)
Mathematics List C
Chemistry List B

MAJOR PROGRAM IN MATHEMATICS AND PHYSICS
FOR TEACHERS (66 credits)
Required Science courses (57 credits)
177-210 (3) Perspectives of Science
Mathematics List A
Physics List A and List B
Complementary Science courses (9 credits)
Mathematics List C

COURSE LISTS USED IN THE VARIOUS OPTIONS

Biology List A: (24 credits)
177-200 (3) Molecular Biology
177-201 (3) Cell Biology and Metabolism
177-204 (3) Evolution
177-205 (3) Biology of Organisms
177-206 (3) Methods in Biology of Organisms
177-202 (3) Basic Genetics
177-274 (3) General Genetics
177-301 (3) Cell and Molecular Laboratory
177-308 (3) Ecology

Biology List B: (6 credits)
to be selected from the following:
177-370 (3) Human Genetics Applied
552-201 (3) Human Physiology: Control Systems
or 552-209 (3) Mammalian Physiology I

Biology List C: (6 credits)
to be selected from the following:
177-455 (3) Conservation Biology
177-331 (3) Ecology / Behaviour Field Course
or 177-334 (3) Applied Tropical Ecology
or 177-336 (3) Marine Aquaculture
or 177-337 (3) Ecology and Behaviour of Fishes

Chemistry List A: (23 credits)
180-150 (3) The World of Chemistry I
or 180-160 (3) The World of Chemistry II
or 180-170 (3) The World of Chemistry III
180-281 (3) Inorganic Chemistry I
180-381 (3) Chemistry of Transition Elements
180-212/222* (4) Organic Chemistry
180-257 (4) Analytical Chemistry
180-203/213* (3) Physical Chemistry
180-350 (3) Earth, Air, Fire, Water
or 180-307 (3) Environmental Analysis
*students who have the CEGEP equivalent of any one of these courses must replace it with one course chosen from the block
180-273 through 180-404 in List B (for 180-203/213) or from the block 180-302 through 180-402 (for 180-212/222).

Chemistry List B: (8 or 9 credits)
to be selected from the following, subject to the requirement that at least one course must include a laboratory.
180-273 (1) Chemical Kinetics
180-345 (3) Molecular Properties & Structure I
180-355 (3) Molecular Properties & Structure II
180-385 (2) Statistical Mechanics
180-363 (2) Physical Chemistry Lab. II
180-393 (2) Physical Chemistry Lab. II
180-556 (3) Advanced Quantum Mechanics
180-404 (3) Biophysical Chemistry
180-367 (3) Instrumental Analysis I
180-377 (3) Instrumental Analysis II
180-567 (3) Chemometrics: Analysis of Chemical Data
180-302 (3) Organic Chemistry III
180-362 (2,3) Advanced Organic Chemistry Lab.
180-402 (3) Advanced Bio-Orgnic Chemistry
180-531 (3) Chemistry of Inorganic Materials
180-455 (3) Polymer Chemistry
180-591 (3) Advanced Coordination Chemistry
180-543 (2) Chemistry of Pulp & Paper
180-392 (3) Integrated Inorganic/Organic laboratory
186-210 (3) Introduction to Mineralogy
or 186-220 (3) Principles of Geochemistry
or 186-580 (3) Aqueous Geochemistry
or 186-542 (3) Chemical Oceanography

Geography List A: (12 credits)
183-203 (3) Environmental Systems
183-216 (3) Geography of World Economy
183-272 (3) Landforms & Environmental Systems
183-201 (3) Geographical Information Systems I

Geography List B: (15 credits)
to be selected from the following:
183-200 (3) Geographical Perspectives on World Environmental Problems
183-302 (3) Environmental Analysis and Management: Problems and Policy
183-305 (3) Soils and Environment
183-321 (3) Climatic Environments
183-322 (3) Environmental Hydrology
183-350 (3) Ecological Biogeography
183-372 (3) Running Water Environments
183-408 (3) Geography of Unequal Development
183-410 (3) Geography of Underdevelopment: Current Problems
183-306 (3) Geographical Information Systems II
or 183-308 (3) Remote Sensing
183-395 (3) Field studies - Physical Geography
or 183-398 (3) Field studies in Human Geography
or 183-494 (3) Field studies in Geography: Urban
or 183-496 (3) Regional Geographical Excursion: Barbados
or 183-497 (3) Field studies in Geography: Coastal Marsh Plant Ecology
or 183-499 (3) Subarctic field studies in Geography: Schefferville

Geoscience List: (3 credits)
to be selected from the following:
186-200 (3) The Terrestrial Planets
186-201 (3) Understanding Planet Earth
186-320 (3) Elementary Earth Physics
195-210 (3) Introduction to Atmospheric Science
195-220 (3) Introduction to Oceanic Sciences
195-330 (3) Physical Meteorology

Mathematics List A: (21 credits)
189-222 (3) Calculus III
189-235 (3) Basic Algebra I
Mathematics List B: (15 credits)
198-203 (3) Principles of Statistics I
198-222 (3) Calculus III
198-223 (3) Linear Algebra
198-314 (3) Advanced Calculus
198-315 (3) Ordinary Differential Equations

Mathematics List C: (9 credits)
to be selected from the following
198-242 (3) Analysis I
198-243 (3) Real Analysis
198-317 (3) Numerical Analysis
198-318 (3) Mathematical Logic
198-338 (3) History and Philosophy of Mathematics
198-348 (3) Topics in Geometry
308-202 (3) Introduction to Computing I
308-203 (3) Introduction to Computing II

Physics List A: (21 credits)
198-230 (3) Dynamics of Simple Systems
198-232 (3) Heat and Waves
198-241 (3) Signal Processing
198-259 (3) Lab in Mechanics, Heat & Optics
198-340 (3) Electricity and Magnetism
198-342 (3) Electromagnetic Waves
198-434 (3) Optics
198-446 (3) Quantum Physics

Physics List B: (12 credits)
198-240 (3) Computers for Physics
198-342* (3) Electromagnetic Waves
198-436 (3) Modern Physics
198-439 (3) Laboratory in Modern Physics

* Both of 198-342 and 198-434 are required for the Mathematics and Physics option.

12. Academic Staff

ABBOTT, F.V.; B.Sc.(Trent), M.Sc., Ph.D.(McG.); Psychology; Psychiatry
ABOU D, F.E.; B.A.(Tor.), M.A., Ph.D.(McG.); Psychology
ACHESON, N.H.; A.B.(Harv.), Ph.D.(Rockefeller); Microbiology and Immunology
AGUAYO, B.; M.D.(Cordoba), F.R.S.C.; Neurology and Neurosurgery; Physiology
AHMEDALI, T.; B.Sc., M.Sc.(Phb); Earth and Planetary Sciences
ALAOUI-JAMALI, M.; D.V.M.(Rabat, Morocco), Ph.D.(René DESCARTES, Paris); Medicine
ALBERT, P.; Ph.D.(Harv.); Pharmacology and Therapeutics
ALI, S.; B.Sc.(C’dia), Ph.D.(McG.); Medicine, Experimental Medicine
ALI KHAN, Z.; B.Sc.(Bilar), M.Sc.(Karachi), Ph.D.(Tulane); Microbiology and Immunology
ALLARD, N.; B.A.(W.Ont.), M.A.(Guelph); Psychology
ALMAZAN, G.; Ph.D.(McG.); Pharmacology and Therapeutics
ALONSO, J.; M.Sc.(Barcelona), Ph.D.(Madrid); Neurology and Neurosurgery
ALPERT, E.; A.B.(U.City of N.Y.), M.D.(SUNY, Syracuse); Medicine
ALTONIAN, Z.; B.Sc., M.Sc.(Cairo), Ph.D.(McM.); Physics
AMSEL, R.; B.Sc., M.Sc.(McG.); Psychology
ANDERMAN, E.; Ph.D., M.D.(McG.); Neurology and Neurosurgery
ANDERSON, W., B.Eng.; Ph.D.(McG.); Mathematics and Statistics
ANDREWS, M.P.; B.Sc., M.Sc., Ph.D.(Tor.); Chemistry
ANTEL, J.; M.D., B.Sc.(Man.), F.R.C.P.(C); Microbiology and Immunology; Neurology and Neurosurgery
ARANDA, J.; M.D.(Manila Central), Ph.D.(McG.); Pharmacology and Therapeutics
ARRYROPoulos, D.; B.Sc.(South Bank Poly.), Ph.D.(McG.); Chemistry
ARIKANI-HAMED, J.; B.Eng.(Tehran), Ph.D.(M.I.T.); Earth and Planetary Sciences
ARMSTRONG, W.R.; M.A., Ph.D.(Vic., Wellington), M.Sc.(Lond.); Geography
ARNOLD, D.; B.Sc.(McG.), M.D.(Cornell), F.R.C.P.(C); Neurology and Neurosurgery
AUTEXIER, CHANTAL; B.Sc.(C’dia), Ph.D.(McG.); Anatomy and Cell Biology
AVIS, D.M.; B.Sc.(Wat.), Ph.D.(Stan.); Computer Science
AVOLI, M.; M.D.(Rome), Ph.D.(McG.); Neurology and Neurosurgery; Physiology
BAINES, M.G.; B.Sc., M.Sc., Ph.D.(Queen’s); Microbiology and Immunology
Baker, A.G.; B.A.(U.B.C.), M.A., Ph.D.(Dal.); Psychology
Baker, C.; B.Sc.(Vir.Polytec.Instit. & State Univ.), Ph.D.(U.of C., San Diego); Psychology
Baker, D.; B.A.(Chic.), Ph.D.(Penn.); Earth and Planetary Sciences
BANAN, D.; M.D.C.M.(McG.), F.R.C.P.(C); Medicine; Experimental Medicine
Barker, P.; Ph.D.(Alta.), B.Sc.(S.Fraser); Neurology and Neurosurgery
Barr, M.; A.B., Ph.D.(Penn.); Mathematics and Statistics
Bartlette, J.; B.Sc., M.Sc., Ph.D.(Montr.); Physics
Batemant, A.; B.Sc., Ph.D.(Lond.); Medicine; Biochemistry
Bates, J.; B.Sc.(Cant.), Ph.D.(Otago); Medicine; Physiology
Batist, G.; B.Sc.(Col.), M.D., C.M.(McG.), F.A.C.P.; Pharmacology and Therapeutics
Beauchemin, Nicole; B.Sc., M.Sc., Ph.D.(Montr.); McGill Cancer Ctr; Biochemistry
Beaudet, A.; M.Sc., Ph.D., M.D.(Montr.); Neurology and Neurosurgery; Anatomy and Cell Biology
Becklake, M.R.; B.Ch.Hon., M.D.(Witw.), F.R.C.P.; Medicine
Bell, G.A.C.; B.A., Ph.D.(Oxon.); Biology
Bennett, G.C.; B.A., B.Sc.(Sir G.Wms.), M.Sc., Ph.D.(McG.); Anatomy and Cell Biology
Bennett, H.P.J.; B.A.(York), Ph.D.(Brun.); Medicine
Benoit, R.; M.D.(Montr.); Medicine
Bergeron, J.J.M.; B.Sc.(McG.), Ph.D., D.Phil.(Oxon.); Anatomy and Cell Biology, Biochemistry
Bernard, N.; B.Sc.(Mcg.), Ph.D.(Duke); Medicine
Bnik, I.M.; B.A.(N.Y.U.), B.H.L.(Jewish Theological Seminary), M.A., Ph.D.(Penn.); Psychology
Black, S.L.; B.Sc.(Tulsa), A.M., Ph.D.(Harv.); Chemistry
Blaschuk, C.; B.Sc.(Winn.), M.Sc.(Manit.), Ph.D.(Tor.); Anatomy and Cell Biology, Urology
Blosstein, R.H.; B.Sc., M.Sc., Ph.D.(McG.); Biochemistry
Boks, P.; B.Sc., Ph.D.(McG.); Psychiatry
Borel, C.; B.Sc.(Ott.), Ph.D.(McG.); Neurology and Neurosurgery; Physiology
Bradley, I.F.; B.Sc., M.Sc.(Tor.), Ph.D.(Wat.); Biochemistry
Branchant, P.H.; B.Sc., M.Sc., Ph.D.(Tor.); Biochemistry
Braun, Peter E.; M.Sc.(U.B.C.), Ph.D.(Calf.); Biochemistry
Brawer, J.; B.S.(Tsufs), Ph.D.(Harv.); Anatomy and Cell Biology
Bray, G.; B.Sc.(Med.), M.D.(Man.), F.R.C.P.(C); Neurology and Neurosurgery; Medicine
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LOVEJOY, S.; B.A.(Cantab.), Ph.D.(Mcg.); Physics
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<th>Name</th>
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<td>Tropper, C.</td>
<td>B.Sc.(McG.), Ph.D.(Brooklyn Poly.)</td>
<td>Computer Science</td>
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<td>Biochemistry, Medicine; Microbiology and Immunology</td>
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<td>Williams-Jones, A.E.</td>
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<td>Wolfe, Leonhard S.</td>
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