



**Faculty of Science, including School of Computer  
Science**

**Programs, Courses and University Regulations**

**2018-2019**



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## 1 About the Faculty of Science

The Faculty of Science aims to be a leader in finding solutions critical to economic and human development, including key questions in the environmental sciences, new materials, and new technologies.

To help us achieve these goals, the Faculty has recruited the best scientific minds of this generation and is committed to ensuring that our undergraduate and graduate students receive an education that prepares them for a lifetime of accomplishment. Not only will these new recruits perform key research work, they will also take on an equally important task: teaching the scientists and leaders of tomorrow. Over the next decade, many of these dynamic young academics will become world leaders in their disciplines. The process has already begun in fields as diverse as neuroscience, astrophysics, green chemistry, and earth system science.

Moreover, the Faculty is transforming the way science is taught, with an increased emphasis on student/professor interaction and outreach. This approach emphasizes hands-on research at the undergraduate level and a more personal, one-on-one style between professors and students that traditionally did not begin until the graduate level. The Faculty opened its Office for Undergraduate Research in Science enables students to participate in research projects from the start of their degree, exposing them to the process and products of scholarship.

The Faculty counts undergraduate students as one of its key strengths. The calibre of McGill's undergraduates is very high—they boast the highest average entrance grades in Canada—and the Faculty understands that these brilliant young minds are the key to its future.

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## 2 History of the Faculty of Science

The study of science at McGill goes back almost two centuries, when the lower campus was a rough and muddy cow pasture and the University struggled to establish itself. In 1855, the job of principal was given to a Nova Scotia-born geologist, John William Dawson. When he arrived at McGill, Dawson laid out plans for walks and roads, and at his own expense arranged the planting of trees on the entrance avenue. More importantly, Dawson worked diligently to transform McGill from a poorly equipped provincial college into one of the best scientific institutions in the world. In 1882, he successfully lobbied for the creation of the Royal Society of Canada and brought international renown to McGill.

In the century and a half since Dawson steered the Faculty of Science onto the path of excellence, the Faculty has received numerous honours for its groundbreaking research, including Nobel prizes to ten Science alumni or Faculty members, as well as over 100 fellowships in the Royal Society of Canada. More importantly, McGill's scientists have made the world a better place in which to live and have provided answers to the deepest mysteries facing humanity. Examples of McGill's breakthroughs include the world's first effective anti-retroviral HIV drug, the theory explaining photosynthesis, and the discovery of the fastest-spinning pulsar in the known universe.

McGill's Faculty of Science has a long tradition of discovery and innovation that no other Canadian university, and only a handful of U.S. schools can match. Our long tradition of scientific leadership, and the illustrious roster of McGill researchers who changed the world—Sir Ernest Rutherford, Harriet Brooks, Ronald Melzack, Bernard Belleau, Leo Yaffe, and Vicky Kaspi, to name only a few—are key attributes.

Founded upon a deep commitment to excellence, the Faculty of Science continues to attract the best scientists in the world. We remain committed to Dawson's vision of bringing the best to the world, whether it's investigating ways to heal the Earth's fragile ecosystem, finding cleaner, greener ways to synthesize vital chemicals, or pushing back the boundaries of our understanding of the Universe.

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## 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 spearhead projects that change people's understanding of the world teach regularly at the undergraduate level. Also, research-based independent study courses offer you the opportunity to contribute to your 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. All B.Sc. programs can include an internship component. This is on top of the many undergraduate students the Faculty hires for Work Study projects and other research programs. As a McGill Science student, you have an opportunity to get involved in the structuring of your own education.

The Faculty of Science offers programs leading to the degree of Bachelor of Science (B.Sc.). Admission is selective; fulfilment of the minimum requirements does not guarantee acceptance. Admission criteria are described in the *Undergraduate Admissions Guide*, found at [www.mcgill.ca/applying](http://www.mcgill.ca/applying).

There are also two Diploma programs offered in Science. The *Diploma in Environment*, in [McGill School of Environment > Undergraduate > Browse Academic Programs > : Diploma \(Dip.\) Environment \(30 credits\)](#), is a 30-credit program available to holders of a B.Sc. or B.A. or equivalent. 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 [section 13.3: Atmospheric and Oceanic Sciences \(ATOC\) > section 13.3.9: Diploma \(Dip.\) Meteorology \(30 credits\)](#). All credits for these diplomas must be completed at McGill.

In addition to the Major program in Software Engineering offered in the Faculty of Science, there is also a Bachelor of Software Engineering program offered jointly with the Faculty of Engineering (refer to [Faculty of Engineering > Undergraduate > Browse Academic Units & Programs > : Electrical and Computer Engineering](#)).

Finally, the Faculties of Arts and Science jointly offer the Bachelor of Arts and Science (B.A. & Sc.), which is described in [Bachelor of Arts & Science](#) .

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## 4 About the Faculty of Science (Undergraduate)

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### 4.1 Location

Dawson Hall  
853 Sherbrooke Street West  
Montreal QC H3A 0G5  
Canada  
Telephone: 514-398-5442  
Faculty website: [www.mcgill.ca/science](http://www.mcgill.ca/science)  
Science Office for Undergraduate Student Advising (SOUSA): [www.mcgill.ca/science/student](http://www.mcgill.ca/science/student)

The Science Office for Undergraduate Student Advising (SOUSA) and the Office of the Director of Advising Services of the Faculty of Science are located in Dawson Hall, room 405. SOUSA serves students in the B.Sc. and B.A. & Sc. degrees.

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### 4.2 McGill's Faculty of Science

- **McGill's second-largest faculty:** 15 schools and departments, including the Redpath Museum, Canada's oldest museum of natural history focusing on teaching, research, and outreach; 20 research centres and institutes
- **Students:** 4,419 undergraduate, 1,031 graduate, and 123 postdoctoral researchers, for a total of 5,573 students
- **264 faculty members**, including tenured and tenure-track professors
- Has produced **ten Nobel laureates**: seven were Faculty of Science graduates, while two winners were Science faculty members.
- **Canadian leader** in astrophysics and cosmology, climate change and extreme weather, green chemistry, life sciences (developmental biology), earth systems science, biodiversity and conservation, nanoscience, social neuroscience, sustainability science, and artificial intelligence
- Offers students a variety of **Field Study** opportunities, which take students from the traditional classroom environment to a world of strong interdisciplinary, international and research-based education and to work with native populations, governmental agencies, and NGOs in places as far-ranging as East Africa, Barbados, Panama, and the Arctic
- Offers the **Reginald Fessenden Professorships and Prizes in Science Innovation**, the first such endowed program in Canada, to encourage and support the commercialization of research in science conducted by world-class scholars
- **McGill's most multidisciplinary faculty**, which conducts teaching and research in collaboration with many of the University's other faculties, including Medicine, Engineering, Music, Arts, Education, and Management
- State-of-the-art facilities including the **\$120 million McGill Life Sciences Research Complex**, consisting of the **Francesco Bellini Building** and **Cancer Research Building**, which are physically linked to the McIntyre Medical and the Stewart Biology Buildings
- Established Canada's first comprehensive **Earth System Science Program**, to study and research new forms of energy and gain a better understanding of climate change and natural hazards
- The **Tomlinson Project in University-Level Science Education** conducts groundbreaking university-level science education research, and develops innovative and effective teaching methods for science instructors
- The **Office for Undergraduate Research** and the **Science Undergraduate Research Awards** encourage top students to connect with professors during their degree program and pursue research projects in fields of interest

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### 4.3 Administrative Officers

#### Dean

R. Bruce Lennox; B.Sc., M.Sc., Ph.D.(Tor.) (*Tomlinson Professor of Chemistry*)

#### Associate Dean (Academic)

Tamara Western; B.Sc.(Dal.), Ph.D.(Br. Col.)



**Director of Advising Services**

Nicole Allard; B.A.(W. Ont.), M.A.(Guelph), M.Ed.(McG.)

**Chief Academic Adviser**

Pete Barry; B.Sc.(C'dia), M.Sc.(McG.)

**Associate Dean (Graduate Education)**

Laura Nilson; B.A.(Colgate), Ph.D.(Yale)

**Associate Dean (Research)**

Doina Precup; B.Sc.(Tech. Cluj-Napoca), M.Sc., Ph.D.(Mass.)

**Assistant to the Dean**

Josie D'Amico

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#### 4.4 Science Office for Undergraduate Student Advising (SOUSA)

The Science Office for Undergraduate Student Advising (SOUSA) provides ongoing advice and guidance on academic issues related to programs, degree requirements, registration, course change, withdrawal, deferred exams, supplemental exams, academic standing, inter- and intra-faculty transfer, year or term away, transfer credits, second programs, second degrees, and graduation.

Every student in the B.Sc. degree is assigned an adviser in SOUSA. The adviser's name appears near the top of your Advising Transcript on Minerva. You can contact your adviser directly, or if you do not yet have a SOUSA adviser, at [adviser.science@mcgill.ca](mailto:adviser.science@mcgill.ca).

SOUSA advisers provide assistance with degree planning and are a valuable referral source. They are a good place to start if you are not sure where to address your question. They also offer help managing academic situations during periods of personal, financial, or medical problems, by working with you to identify various possibilities and strategies for making informed decisions.

Special requests can be made, in writing, to the Director of Advising Services.

The Committee on Student Standing (CSS) will consider appeals of the Director of Advising Services' decisions. For information about CSS, see the Director of Advising Services' assistant.

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## 5 Faculty Admission Requirements

For information about admission requirements for the B.Sc., please refer to the *Undergraduate Admissions Guide*, found at [www.mcgill.ca/applying](http://www.mcgill.ca/applying).

For information about inter-faculty transfers, refer to *University Regulations and Resources* > *Undergraduate* > *Registration* > *Interfaculty Transfer* as well as the relevant information posted on the SOUSA website at [www.mcgill.ca/science/student/general/transfer](http://www.mcgill.ca/science/student/general/transfer).

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## 6 Faculty Degree Requirements

**Each student in the Faculty of Science must be aware of the Faculty regulations as stated in this publication and on the McGill, Science, and SOUSA websites.**

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 you*. It is your responsibility to seek guidance from the Science Office for Undergraduate Student Advising (SOUSA) 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, you must fulfil all Faculty and program requirements as indicated below:

**Faculty and program requirements**

[section 6.1: Minimum Credit Requirement](#)

[section 6.2: Residency Requirement](#)

Refer to *University Regulations and Resources* > *Undergraduate* > *Student Records* > *Grading and Grade Point Averages (GPA)*

[section 6.3: Time and Credit Limit for the Completion of the Degree](#)

**Faculty and program requirements**

[section 6.4: Program Requirements](#)

[section 6.5: Course Requirements](#)

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**6.1 Minimum Credit Requirement**

The minimum credit requirement for your degree is determined at the time of acceptance and is specified in your letter of admission.

Students are normally admitted to a four-year degree requiring the completion of 120 credits.

**6.1.1 Advanced Standing**

Advanced Standing of up to 30 credits may be granted to students who obtain satisfactory results in International Baccalaureate, French Baccalaureate, Advanced Levels, Advanced Placement tests, or the Diploma of Collegial Studies (DCS). Quebec students with a DCS in Science are granted 30 credits Advanced Standing and will have normally completed the equivalent of, and are therefore exempt from, the basic science courses in biology, chemistry, mathematics, and physics. Students with satisfactory results in International Baccalaureate, French Baccalaureate, Advanced Levels, and Advanced Placement tests may be exempt from some or all of the basic science courses. You will not be given additional credit toward your degree for any McGill course where the content overlaps substantially with any other course for which you have already received credit, such as for Advanced Standing results.

AP Examination results with a score of 4 or 5 **must** be declared by you at the time of initial registration at the University.

For more information about Advanced Standing, consult: [www.mcgill.ca/students/transferecredit](http://www.mcgill.ca/students/transferecredit).

**6.1.2 Equivalencies for Non-Basic Science Courses**

Note that equivalencies for some non-basic science courses, such as CHEM 212 and CHEM 222 and PSYC 204, are granted on a per-CEGEP basis. In some cases, a grade greater than the minimum passing grade may be required. For more information about equivalencies for non-basic Science courses, please consult: [www.mcgill.ca/students/transferecredit/prospective/cegep](http://www.mcgill.ca/students/transferecredit/prospective/cegep).

If the CEGEP and/or course is not listed on this website, you should refer to the SOUSA website and follow the instructions for Advanced Standing for students admitted to McGill from CEGEP: [www.mcgill.ca/science/student/newstudents/u1/orientation](http://www.mcgill.ca/science/student/newstudents/u1/orientation).

**6.1.3 Readmission after Interruption of Studies for a Period of Five Consecutive Years or More**

If you are readmitted after interrupting your studies for a period of five consecutive years or more, you 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 Director of Advising Services, in consultation with the appropriate department, may approve a lower minimum for students who had completed 60 credits or more before interrupting their studies.

If you are readmitted after a period of absence, you are subject to the program and degree requirements in effect at the time of readmission. The Director of Advising Services, in consultation with the department, may approve exemption from any new requirements.

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**6.2 Residency Requirement**

To obtain a B.Sc. degree, you must satisfy the following residency requirements: a minimum of 60 credits of courses used to satisfy the B.Sc. degree requirements must be taken and passed at McGill, exclusive of any courses completed as part of the Science Freshman program; see [section 13.1: B.Sc. Freshman Program](#). At least two-thirds of all departmental program requirements (Honours, Major, Core Science Components, or Minor) must normally be completed at McGill not including courses completed in a prior McGill degree. Exceptionally, students in major concentrations or interfaculty or honours programs who pursue an approved Study Away or Exchange program may, with prior approval from both their department and the Director of Advising Services, Faculty of Science, be exempted from the two-thirds rule. In addition, some departments may require that their students complete specific components of their program at McGill.

The residency requirement for diploma programs is 30 credits completed at McGill.

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**6.3 Time and Credit Limit for the Completion of the Degree**

If you need 96 or fewer credits to complete your degree requirements, you are expected to complete your degree in no more than eight terms after your initial registration for the degree.

If you are a student in the Freshman Program, you become subject to these regulations one year after your initial registration. If you want to exceed this time limit, you must seek permission of the Director of Advising Services of the Faculty of Science.

If you are registered in the B.Sc., you are expected to complete the requirements of your program and your degree within 120 credits. You will receive credit for all courses (subject to degree regulations) taken up to and including the semester in which you obtain 120 credits. If you want to remain at McGill beyond

that semester, you must also seek permission of the Director of Advising Services, Faculty of Science. Permission for exceeding the time and/or credit limits will normally be granted only for valid academic reasons, such as a change of program (subject to departmental approval) and part-time status. If permission is granted, you will receive credit only for required and complementary courses necessary to complete your program requirements.

Students who have been granted Advanced Standing for the International Baccalaureate, Advanced Placement examinations, GCE A-Levels, French Baccalaureate, and other qualifications may complete 120 credits following admission, as per the university regulations described in [University Regulations and Resources](#) > *Student Records* > : *Advanced Standing Transfer Credits*.

## 6.4 Program Requirements

The Faculty of Science offers a vast array of study and research opportunities at the undergraduate level, and it is very important that you familiarize yourself with all the alternatives open to you before deciding on a program of study. For an overview of programs offered in the B.Sc., see the Faculty of Science Programs of Study at [www.mcgill.ca/science/programs](http://www.mcgill.ca/science/programs).

### 6.4.1 Liberal, Major, and Honours Programs

As a Science student, if you need 96 or fewer credits to complete your degree requirements, you are required to select your courses in each term with a view to timely completion of your degree and program requirements. You must register in one of the following types of departmental programs leading to the degree of Bachelor of Science:

#### 6.4.1.1 Liberal Programs

*Liberal programs* provide students with the opportunity to study the core of one science discipline along with a breadth component from another area of science or from many other disciplines. In a liberal program, you must complete a Core Science Component (CSC) (45–50 credits), plus a Breadth Component (at least 18 credits). The requirements for the Core Science Components are given under departmental sections of this publication whenever applicable.

For the Breadth Component, you must complete one of the following:

- Minor Program (18–24 credits) – one of the programs listed in [section 10.2: Minor Programs](#).
- Arts Minor or Major Concentration (18 or 36 credits) – one of the programs listed in [section 10.5: Arts Major and Minor Concentrations Open to Science Students](#).
- A Core Science Component in a second area (45–50 credits) – at least 24 credits must be distinct from the courses used to satisfy the primary Core Science Component. Note that a second Core Science Component can be selected from any of the Science groups.

#### 6.4.1.2 Major Programs

*Major programs* are more specialized than liberal programs and are usually centred on a specific discipline or department.

#### 6.4.1.3 Honours Programs

*Honours programs* typically involve an even higher degree of specialization, often include supervised research, and require students to maintain a high academic standard. Although honours programs are specially designed to prepare you for graduate studies, graduates of the other degree programs may also be admissible to many graduate schools. If you intend to pursue graduate studies in your discipline, you should consult a departmental adviser regarding the appropriate selection of courses in your field.

### 6.4.2 Minor and Minor Concentration Programs

In addition to the liberal, major, and honours degree programs, as a student in the Faculty of Science, you may select a minor or approved minor concentration program. These are coherent sequences of courses in a given discipline or interdisciplinary area that may be taken in addition to the courses required for the degree program.

Science minors consist of up to 24 credits.

Arts minor concentrations consist of 18 credits.

A minimum of 18 new credits must be completed in the Minor or Minor concentration.

For a list of "Minor Programs," see [section 10.2: Minor Programs](#); for minor concentrations that are approved for Science students, see [section 10.5: Arts Major and Minor Concentrations Open to Science Students](#).

### 6.4.3 Other Second Programs

In addition to a major or honours program, you may pursue a second major or honours program, or an Arts major concentration program. Each major or honours program must contain a minimum of 36 credits that are distinct from the courses used to satisfy the other program.

## 6.4.4 Special Designations

The Faculty of Science recognizes Bachelor of Science (B.Sc.) students who have gone beyond a typical B.Sc. experience by awarding certain special designations to their student record and degree at graduation.

### 6.4.4.1 B.Sc. Global Designation

For details on the B.Sc. Global Designation, students should refer to [www.mcgill.ca/science/programs/bsc-global](http://www.mcgill.ca/science/programs/bsc-global).

### 6.4.4.2 Internship Program Designation

All B.Sc. programs can include an internship component. For more details, students should refer to [section 12: Science Internships and Field Studies](#) and [www.mcgill.ca/science/student/internships-field](http://www.mcgill.ca/science/student/internships-field).

## 6.4.5 McGill School of Environment

The Faculty of Science is one of the four faculties in partnership with the McGill School of Environment. For more information, see [McGill School of Environment](#).

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## 6.5 Course Requirements

All required and complementary courses used to fulfil program requirements, including the basic Science requirements, must be completed with a grade of C or better. If you fail to obtain a Satisfactory grade in a required course, you 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; you should consult your academic adviser.

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

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

### 6.5.1 Course Overlap

You will not receive additional credit toward your degree for any course that overlaps in content with a course for which you have already received credit at McGill, CEGEP, at another university, or Advanced Placement exams, Advanced Level results, International Baccalaureate Diploma, or French Baccalaureate. It is your responsibility to consult with a faculty adviser in [Arts OASIS](#), the [Science Office for Undergraduate Advising](#) (SOUSA), or the department offering the course as to whether or not credit can be obtained and to be aware of exclusion clauses specified in the course description in this publication. Please refer to the following website for specific information about Advanced Standing credits and McGill course exemptions: [www.mcgill.ca/students/transferecredit](http://www.mcgill.ca/students/transferecredit).

Sometimes the same course is offered by two different departments. Such courses are called "double-prefix" courses. When such courses are offered simultaneously, you should take the course offered by the department in which you are obtaining your degree. For example, in the case of double-prefix courses CHEM XYZ and PHYS XYZ, Chemistry students take CHEM XYZ and the Physics students take PHYS XYZ. If a double-prefix course is offered by different departments in alternate years, you may take whichever course best fits your schedule.



**Note for Arts Students:** Credit for computer courses offered by the School of Computer Science is governed by rules specified in each individual course description.



**Note for Science and Bachelor of Arts and Science students:**

Credit for statistics courses offered by faculties other than Arts and Science requires the permission of the Director of Advising Services, Science, except for students in the B.Sc. Major in Environment, who may take required statistics courses in the Faculty of Agricultural and Environmental Sciences necessary to satisfy their program requirements.

Credit for computer courses offered by faculties other than Science requires the permission of the Director of Advising Services and will be granted only under exceptional circumstances.

#### For Arts, Science, and Bachelor of Arts and Science students

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

- Credit will be given for **only one** of the following introductory statistics courses: AEMA 310, BIOL 373, ECON 227D1/D2, ECON 257D1/D2, GEOG 202, MATH 203, MGCR 271, MGCR 273, POTH 204, PSYC 204, SOCI 350.

- Credit will be given for **only one** of the following intermediate statistics courses: AEMA 411, ECON 227D1/D2, ECON 257D1/D2, GEOG 351, MATH 204, PSYC 305, SOCI 461, with the exception that you may receive credit for both PSYC 305 and ECON 227D1/D2 or ECON 257D1/D2.
- Students who have already received credit for MATH 324 or MATH 357 will **not** receive credit for any of the following: AEMA 310, AEMA 411, BIOL 373, ECON 227D1/D2, ECON 257D1/D2, GEOG 202, GEOG 351, MATH 203, MATH 204, MGCR 271, MGCR 273, PSYC 204, PSYC 305, SOCI 350.
- For 500-level statistics courses not listed above, students must consult a program adviser to ensure that no significant overlap exists. Where such overlap exists with a course for which the student has already received credit, credit for the 500-level course will not be allowed.
- PSYC 204 may not be taken if a grade of 75% was received in an equivalent course completed at CEGEP.

### 6.5.2 Courses Outside the Faculties of Arts and Science

As a student in the Faculty of Science, you should consult the statement of regulations for taking courses outside the Faculties of Arts and of Science (see below). A list of approved/not-approved courses in other faculties is posted on the SOUSA website ([www.mcgill.ca/science/student/continuingstudents/bsc/outside](http://www.mcgill.ca/science/student/continuingstudents/bsc/outside)). You may take courses on the approved list and may not, under any circumstances, take courses on the not-approved list for credit. Requests for permission to take courses that are not on either list should be addressed to the Director of Advising Services.

The regulations are as follows:

- You may take only 6 credits per year, up to 18 credits in all, of courses outside the Faculties of Arts and of Science.
- Courses offered “in the Faculty of Science” or “in the Faculty of Arts” are found in the eCalendar *All Courses* search, when filtered by “Faculty of Science” or by “Faculty of Arts.”
- Courses in other faculties that are considered as taught by Science (e.g., BIOT, EXMD, and PHAR) are so designated as offered by the “Faculty of Science” in the eCalendar *All Courses* search.
- Courses in Music are considered as outside the Faculties of Arts and of Science, except MUAR courses, which are considered Arts courses.
- All courses listed in the Religious Studies (RELG) section are considered courses in Arts and Science except for courses restricted to B.Th. or S.T.M. students and courses that require permission from the Chair of the B.Th. Committee.
- Students should consult the list of restricted courses outside of the Faculties of Arts and of Science on the SOUSA website ([www.mcgill.ca/science/student](http://www.mcgill.ca/science/student)).
- You must have the necessary prerequisites and permission of the instructor for such courses.
- Credit for computer and statistics courses offered by faculties other than Arts and Science require the permission of the Director of Advising Services and will be granted only under exceptional circumstances.
- If you use Minerva to register for a course, and it exceeds the specified limitations or it is not approved, the course will be flagged for no credit after the course change period.
- Credit will not be given for any “how to” courses offered by other faculties that are intended to provide you 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.
- As a student in the **McGill School of Environment**, you may exceed the 18-credit limit for courses outside the Faculties of Arts and of Science, provided that all such courses are necessary to complete your program of study.
- As a student in the **Major in Software Engineering**, you may exceed the 18-credit limit for courses outside the Faculties of Arts and of Science, provided that all such courses are necessary to complete your program of study.
- As a student in the B.Sc. Liberal Program taking a **Major Concentration in Music**, you may exceed the 18-credit limit for courses outside the Faculties of Arts and of Science, provided that all such courses are necessary to complete your program of study, up to a maximum of 36 Music credits.
- The 18-credit limit applies to students taking the **Minor in Nutrition**; equivalent courses in Science should be taken instead of courses in the Faculty of Agricultural and Environmental Sciences.

### 6.5.3 Correspondence, Distance Education, or Web-based Courses

As a Science student, you may obtain transfer credit for correspondence, distance education, or web-based courses if you receive prior approval from the appropriate McGill department for the course content **and** prior approval from the Director of Advising Services, Science, for the method of delivery and evaluation. Courses taught through distance education from institutions other than McGill will only be considered for transfer credits under the following conditions:

- The course is given by a government-accredited, degree-granting institution acceptable to McGill.
- The course counts for credit toward degrees granted at the institution giving the course.
- The combined total of regular course credits and distance education course credits do not exceed the permitted maximum number of credits per term according to Faculty regulations.
- Courses taught through distance education may not be used to complete program requirements, except on an individual basis when serious, documented circumstances warrant it.

### 6.5.4 Courses in English as a Second Language (ESL)

ESL courses are only open to students whose primary language is not English and who have studied for fewer than five years in English-language secondary institutions. As a student in the B.Sc., you may take a maximum of 12 credits, including academic writing courses for non-anglophones, from the list of ESL courses published at [www.mcgill.ca/science/student/continuingstudents/bsc/outside](http://www.mcgill.ca/science/student/continuingstudents/bsc/outside).

### 6.5.5 First-Year Seminars: Registration

Registration for First-Year Seminars is limited to students in their first year of study at McGill, i.e., newly admitted students in U0 or U1. These courses are designed to provide a closer interaction with professors and better working relations with peers than is available in large introductory courses. 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. The maximum number of students in any seminar is 25, although some are limited to fewer than that.

You may take only one First-Year Seminar. If you register for more than one, you will be obliged to withdraw from all but one of them. Please consult the departmental listings for course descriptions and availability.

#### First-Year Seminars

CHEM 199	FYS: Why Chemistry?
EPSC 199	FYS: Earth & Planetary Exploration
PSYC 199	FYS: Mind-Body Medicine
PSYT 199	FYS: Mental Illness and the Brain

The First-Year Seminars offered by the Faculty of Arts are also open to Science students. For a complete listing, please consult [Faculty of Arts > Undergraduate > Browse Academic Units & Programs > : First-Year Seminars](#).

### 6.5.6 Course Credit Weight

The credit assigned to a particular course should reflect the amount of effort it demands of you. Normally, one credit will represent three hours total work per week for one term—including a combination of lecture hours, other contact hours, such as laboratory periods, tutorials, and problem periods, as well as personal study time.

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## 7 Advising

If you need 96 or fewer credits to complete your degree requirements, you must consult an academic adviser in your proposed department of study to obtain advice and approval of your course selection. Quebec students with a Diploma of Collegial Studies in Science have normally taken the equivalent of, and are therefore exempt from, the 100-level basic science courses in Biology, Chemistry, Mathematics, and Physics. Such students may also be exempt from some 200-level courses. If you are a student with satisfactory results in International Baccalaureate, French Baccalaureate, Advanced Levels, and Advanced Placement tests, you may also be exempt from some or all of the Science Freshman courses. To facilitate program planning, you must present your transcript(s) and letter of admission. For a detailed description of advising and registration procedures, you should refer to [University Regulations & Resources > Undergraduate > : Undergraduate Advising](#) and [: Registration](#); the [website for newly admitted undergraduate students](#); the SOUSA website at [www.mcgill.ca/science/student/newstudents/u1](http://www.mcgill.ca/science/student/newstudents/u1); and your department's website.

If you need 97–120 credits to complete your degree requirements, you will normally be registered in a Freshman program until you complete your first year. You must consult a SOUSA adviser in the Science Office for Undergraduate Student Advising to obtain advice and approval of your course selection. For a detailed description of advising and registration procedures as a Freshman student, refer to the [website for newly admitted undergraduate students](#), and to the SOUSA website at [www.mcgill.ca/science/student/newstudents/u0](http://www.mcgill.ca/science/student/newstudents/u0).

Advising for all returning students takes place in March for the upcoming academic year. For more information, refer to the SOUSA website at [www.mcgill.ca/science/student/continuingstudents](http://www.mcgill.ca/science/student/continuingstudents).

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## 8 Freshman Interest Groups

Freshman Interest Groups (FIGs) are groups of approximately 15 U0 students and U1 students in their first semester, in the B.Sc. or B.A. & Sc., led by a professor in the Faculty of Science or Faculty of Medicine and an upper-year undergraduate student. They meet once every two weeks in the Fall semester to discuss a wide range of topics, such as science in the news, program choices, undergraduate research opportunities, or just aspects of life in Montreal. The purpose of a FIG is to ease the transition to McGill and Montreal and to provide you an opportunity to interact with a professor and with other U0 students in a small group. FIGs carry no credit and there is no charge. For more information and to see how to register, refer to [www.mcgill.ca/science/student/fig](http://www.mcgill.ca/science/student/fig).

## 9 Examinations

Students should refer to [University Regulations and Resources > Undergraduate > Examinations: General Information](#) for information about final examinations and deferred examinations. Note that for the Faculty of Science, [University Regulations and Resources > Undergraduate > Examinations: General Information > Final Examinations > : Final Examinations: University Regulations Concerning Final Examinations](#) applies to courses up to and including the 500 level.

The exam schedules are posted on the McGill website, [www.mcgill.ca/students/exams](http://www.mcgill.ca/students/exams), normally one month after the start of classes for the Tentative Exam Schedule, and two months after the start of classes for the Final Examination Schedule.

Students are warned not to make travel arrangements to leave Montreal prior to the scheduled end of any examination period.

## 10 Overview of Programs Offered

### Programs Offered

[section 10.1: Bachelor of Science Program Groups](#), which may include Liberal Program – Core Science Components, Major Programs, Joint Major Programs, Honours Programs, and Joint Honours Programs

[section 10.2: Minor Programs](#)

[section 10.3: Bachelor of Arts and Science](#)

[section 10.4: Internships, Field Studies, and Global Designation](#)

[section 10.5: Arts Major and Minor Concentrations Open to Science Students](#)

### 10.1 Bachelor of Science Program Groups

Science students admitted after September 2009 are limited to choosing liberal, majors, or honours programs within the Science group to which they were admitted, but may continue to choose freely from all available minor programs. Students pursuing a Liberal Science Program – Core Science Component (CSC) may also select a second CSC from any group. See [section 6.4.1: Liberal, Major, and Honours Programs](#).

The groups within the B.Sc. are:

- [section 10.1.1: Biological, Biomedical & Life Sciences Group](#)
- [section 10.1.2: Bio-Physical-Computational Sciences Group](#)
- [section 10.1.3: Neuroscience Group](#)
- [section 10.1.4: Physical, Earth, Math & Computer Science Group](#)

A list of specific programs in each group is available via the above links. To change to a major or honours program in another Science group, students must make an Intra-Faculty Transfer application.

See: [www.mcgill.ca/science/student/general/transfer](http://www.mcgill.ca/science/student/general/transfer).

#### 10.1.1 Biological, Biomedical & Life Sciences Group

##### 10.1.1.1 Liberal Program – Core Science Components

- Anatomy and Cell Biology: [section 13.2.4: Bachelor of Science \(B.Sc.\) - Liberal Program - Core Science Component Anatomy and Cell Biology \(48 credits\)](#)
- Biochemistry: [section 13.4.4: Bachelor of Science \(B.Sc.\) - Liberal Program - Core Science Component Biochemistry \(47 credits\)](#)
- Biology: [section 13.5.7: Bachelor of Science \(B.Sc.\) - Liberal Program - Core Science Component Biology \(47 credits\)](#)
- Microbiology and Immunology: [section 13.23.4: Bachelor of Science \(B.Sc.\) - Liberal Program - Core Science Component Microbiology and Immunology \(50 credits\)](#)
- Physiology: [section 13.31.4: Bachelor of Science \(B.Sc.\) - Liberal Program - Core Science Component Physiology \(50 credits\)](#)
- Psychology: [section 13.33.7: Bachelor of Science \(B.Sc.\) - Liberal Program - Core Science Component Psychology \(45 credits\)](#)

**10.1.1.2 Major Programs**

- Anatomy and Cell Biology: [section 13.2.5: Bachelor of Science \(B.Sc.\) - Major Anatomy and Cell Biology \(67 credits\)](#)
- Biochemistry: [section 13.4.5: Bachelor of Science \(B.Sc.\) - Major Biochemistry \(64 credits\)](#)
- Biology: [section 13.5.8: Bachelor of Science \(B.Sc.\) - Major Biology \(59 credits\)](#)
- Biology – Quantitative Biology: [section 13.5.9: Bachelor of Science \(B.Sc.\) - Major Biology - Quantitative Biology \(73 credits\)](#)
- Microbiology and Immunology: [section 13.23.5: Bachelor of Science \(B.Sc.\) - Major Microbiology and Immunology \(66 credits\)](#)
- Pharmacology: [section 13.29.5: Bachelor of Science \(B.Sc.\) - Major Pharmacology \(67 credits\)](#)
- Physiology: [section 13.31.5: Bachelor of Science \(B.Sc.\) - Major Physiology \(65 credits\)](#)
- Psychology: [section 13.33.8: Bachelor of Science \(B.Sc.\) - Major Psychology \(54 credits\)](#)

**10.1.1.3 Honours Programs**

- Anatomy and Cell Biology: [section 13.2.6: Bachelor of Science \(B.Sc.\) - Honours Anatomy and Cell Biology \(73 credits\)](#)
- Biochemistry: [section 13.4.6: Bachelor of Science \(B.Sc.\) - Honours Biochemistry \(73 credits\)](#)
- Biology: [section 13.5.11: Bachelor of Science \(B.Sc.\) - Honours Biology \(72 credits\)](#)
- Biology – Quantitative Biology: [section 13.5.12: Bachelor of Science \(B.Sc.\) - Honours Biology - Quantitative Biology \(79 credits\)](#)
- Immunology (Interdepartmental): [section 13.18.3: Bachelor of Science \(B.Sc.\) - Honours Immunology \(Interdepartmental\) \(75 credits\)](#)
- Microbiology and Immunology: [section 13.23.6: Bachelor of Science \(B.Sc.\) - Honours Microbiology and Immunology \(72 credits\)](#)
- Pharmacology – application required, see departmental section for information: [section 13.29.6: Bachelor of Science \(B.Sc.\) - Honours Pharmacology \(76 credits\)](#)
- Physiology: [section 13.31.8: Bachelor of Science \(B.Sc.\) - Honours Physiology \(75 credits\)](#)
- Psychology: [section 13.33.9: Bachelor of Science \(B.Sc.\) - Honours Psychology \(60 credits\)](#)

**10.1.2 Bio-Physical-Computational Sciences Group****10.1.2.1 Major Programs**

- Biology and Mathematics: [section 13.5.10: Bachelor of Science \(B.Sc.\) - Major Biology and Mathematics \(76 credits\)](#)
- Computer Science and Biology: [section 13.9.11: Bachelor of Science \(B.Sc.\) - Major Computer Science and Biology \(74 credits\)](#)
- Physiology and Mathematics: [section 13.31.6: Bachelor of Science \(B.Sc.\) - Major Physiology and Mathematics \(79 credits\)](#)
- Physiology and Physics: [section 13.31.7: Bachelor of Science \(B.Sc.\) - Major Physiology and Physics \(82 credits\)](#)

**10.1.2.2 Honours Program**

- Computer Science and Biology: [section 13.9.15: Bachelor of Science \(B.Sc.\) - Honours Computer Science and Biology \(77 credits\)](#)

**10.1.3 Neuroscience Group****10.1.3.1 Major Program**

- Neuroscience – application required, see [section 13.26: Neuroscience](#) for information, and [section 13.26.4: Bachelor of Science \(B.Sc.\) - Major Neuroscience \(65 credits\)](#)

**10.1.3.2 Honours Program**

- Neuroscience – application required, see [section 13.26: Neuroscience](#) for information, and [section 13.26.5: Bachelor of Science \(B.Sc.\) - Honours Neuroscience \(74 credits\)](#)

**10.1.4 Physical, Earth, Math & Computer Science Group****10.1.4.1 Liberal Program – Core Science Components**

- Atmospheric Science: [section 13.3.5: Bachelor of Science \(B.Sc.\) - Liberal Program - Core Science Component Atmospheric and Oceanic Sciences \(48 credits\)](#)



- Chemistry – Biological option: *section 13.7.7: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Chemistry - Biological (47 credits)*
- Chemistry – General option: *section 13.7.8: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Chemistry - General (49 credits)*
- Computer Science: *section 13.9.8: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Computer Science (45 credits)*
- Earth and Planetary Sciences: *section 13.10.7: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Earth and Planetary Sciences (45 credits)*
- Geography: *section 13.17.7: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Geography (49 credits)*
- Mathematics: *section 13.22.9: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Mathematics (45 credits)*
- Physics: *section 13.30.8: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Physics (48 credits)*
- Software Engineering: *section 13.9.9: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Software Engineering (49 credits)*
- Statistics: *section 13.22.10: Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Statistics (48 credits)*

#### 10.1.4.2 Major Programs

- Atmospheric Science: *section 13.3.6: Bachelor of Science (B.Sc.) - Major Atmospheric Science (62 credits)*
- Chemistry: *section 13.7.9: Bachelor of Science (B.Sc.) - Major Chemistry (59 credits)*
- Chemistry – Atmosphere and Environment option: *section 13.7.10: Bachelor of Science (B.Sc.) - Major Chemistry - Atmosphere and Environment (63 credits)*
- Chemistry – Bio-organic option: *section 13.7.11: Bachelor of Science (B.Sc.) - Major Chemistry - Bio-organic (63 credits)*
- Chemistry – Biophysical option: *section 13.7.12: Bachelor of Science (B.Sc.) - Major Chemistry: Biophysical Chemistry (66 credits)*
- Chemistry – Materials option: *section 13.7.13: Bachelor of Science (B.Sc.) - Major Chemistry - Materials (62 credits)*
- Chemistry – Measurement option: *section 13.7.14: Bachelor of Science (B.Sc.) - Major Chemistry - Measurement (62 credits)*
- Computer Science: *section 13.9.10: Bachelor of Science (B.Sc.) - Major Computer Science (63 credits)*
- Computer Science – Computer Games option: *section 13.9.12: Bachelor of Science (B.Sc.) - Major Computer Science - Computer Games (67 credits)*
- Earth System Science: *section 13.11.4: Bachelor of Science (B.Sc.) - Major Earth System Science (57 credits)*
- Environment – Atmospheric Environment and Air Quality domain: : *Bachelor of Science (B.Sc.) - Major Environment - Atmospheric Environment and Air Quality (60 credits)*
- Environment – Biodiversity and Conservation domain: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Biodiversity and Conservation (63 credits)*
- Environment – Earth Sciences and Economics domain: : *Bachelor of Science (B.Sc.) - Major Environment - Earth Sciences and Economics (66 credits)*
- Environment – Ecological Determinants of Health domain – Cellular: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Ecological Determinants of Health - Cellular (63 credits)*
- Environment – Ecological Determinants of Health domain – Population: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Ecological Determinants of Health- Population (63 credits)*
- Environment – Environmetrics domain: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Environmetrics (63 credits)*
- Environment – Food Production and Environment domain: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Food Production and Environment (63 credits)*
- Environment – Land Surface Processes and Environmental Change domain: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment-Land Surface Processes and Environmental Change (63 credits)*
- Environment – Renewable Resource Management domain: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Renewable Resource Management (63 credits)*
- Environment – Water Environments and Ecosystems domain – Biological: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Water Environments & Ecosystems - Biological (60 credits)*
- Environment – Water Environments and Ecosystems domain – Physical: : *Bachelor of Science (Agricultural and Environmental Sciences) (B.Sc.(Ag.Env.Sc.)) or Bachelor of Science (B.Sc.) - Major Environment - Water Environments and Ecosystems - Physical (63 credits)*
- Geography: *section 13.17.8: Bachelor of Science (B.Sc.) - Major Geography (58 credits)*
- Geology: *section 13.10.8: Bachelor of Science (B.Sc.) - Major Geology (66 credits)*
- Mathematics: *section 13.22.11: Bachelor of Science (B.Sc.) - Major Mathematics (54 credits)*
- Physics – Biological option: *section 13.30.10: Bachelor of Science (B.Sc.) - Major Physics: Biological Physics (82 credits)*
- Physics: *section 13.30.9: Bachelor of Science (B.Sc.) - Major Physics (60 credits)*
- Software Engineering: *section 13.9.13: Bachelor of Science (B.Sc.) - Major Software Engineering (63 credits)*

#### 10.1.4.3 Joint Major Programs

- Atmospheric Science and Physics: *section 13.3.7: Bachelor of Science (B.Sc.) - Major Atmospheric Science and Physics (69 credits)*

- Mathematics and Computer Science – see Mathematics and Statistics: *section 13.22.12: Bachelor of Science (B.Sc.) - Major Mathematics and Computer Science (72 credits)*
- Physics and Computer Science – see Physics: *section 13.30.12: Bachelor of Science (B.Sc.) - Major Physics and Computer Science (66 credits)*
- Physics and Geophysics: *section 13.30.11: Bachelor of Science (B.Sc.) - Major Physics and Geophysics (69 credits)*
- Statistics and Computer Science: *section 13.22.13: Bachelor of Science (B.Sc.) - Major Statistics and Computer Science (72 credits)*

#### 10.1.4.4 Honours Programs

- Applied Mathematics: *section 13.22.14: Bachelor of Science (B.Sc.) - Honours Applied Mathematics (60 credits)*
- Atmospheric Science: *section 13.3.8: Bachelor of Science (B.Sc.) - Honours Atmospheric Science (74 credits)*
- Chemistry: *section 13.7.15: Bachelor of Science (B.Sc.) - Honours Chemistry (71 credits)*
- Chemistry – Bio-organic option: *section 13.7.17: Bachelor of Science (B.Sc.) - Honours Chemistry - Bio-organic (75 credits)*
- Chemistry – Atmosphere and Environment option: *section 13.7.16: Bachelor of Science (B.Sc.) - Honours Chemistry - Atmosphere and Environment (75 credits)*
- Chemistry – Materials: *section 13.7.19: Bachelor of Science (B.Sc.) - Honours Chemistry - Materials (74 credits)*
- Chemistry – Measurement: *section 13.7.20: Bachelor of Science (B.Sc.) - Honours Chemistry - Measurement (74 credits)*
- Computer Science: *section 13.9.14: Bachelor of Science (B.Sc.) - Honours Computer Science (75 credits)*
- Earth System Science: *section 13.11.5: Bachelor of Science (B.Sc.) - Honours Earth System Science (66 credits)*
- Environment: *section 13.11.6: Bachelor of Science (B.Sc.) - Honours Environment (72 credits)*
- Geography: *section 13.17.9: Bachelor of Science (B.Sc.) - Honours Geography (66 credits)*
- Geology: *section 13.10.9: Bachelor of Science (B.Sc.) - Honours Geology (75 credits)*
- Mathematics: *section 13.22.15: Bachelor of Science (B.Sc.) - Honours Mathematics (60 credits)*
- Physics: *section 13.30.13: Bachelor of Science (B.Sc.) - Honours Physics (78 credits)*
- Planetary Sciences: *section 13.10.10: Bachelor of Science (B.Sc.) - Honours Planetary Sciences (78 credits)*
- Probability and Statistics: *section 13.22.16: Bachelor of Science (B.Sc.) - Honours Probability and Statistics (65 credits)*
- Software Engineering: *section 13.9.16: Bachelor of Science (B.Sc.) - Honours Software Engineering (75 credits)*

#### 10.1.4.5 Joint Honours Programs

- Mathematics and Computer Science: *section 13.22.18: Bachelor of Science (B.Sc.) - Honours Mathematics and Computer Science (75 credits)*
- Mathematics and Physics: *section 13.30.15: Bachelor of Science (B.Sc.) - Honours Mathematics and Physics (81 credits)*
- Physics and Chemistry: *section 13.30.16: Bachelor of Science (B.Sc.) - Honours Physics and Chemistry (80 credits)*
- Statistics and Computer Science: *section 13.22.17: Bachelor of Science (B.Sc.) - Honours Statistics and Computer Science (79 credits)*

## 10.2 Minor Programs

### Minor Programs

**Atmospheric Science,** *section 13.3.4: Bachelor of Science (B.Sc.) - Minor Atmospheric Science (18 credits)*

**Biology,** *section 13.5.6: Bachelor of Science (B.Sc.) - Minor Biology (25 credits)*

**Biotechnology,** *section 13.6.5: Bachelor of Science (B.Sc.) - Minor Biotechnology (for Science Students) (24 credits)*

**Chemical Engineering,** *section 13.7.6: Bachelor of Science (B.Sc.) - Minor Chemical Engineering (24 credits)*

**Chemistry,** *section 13.7.5: Bachelor of Science (B.Sc.) - Minor Chemistry (18 credits)*

**Cognitive Science,** *section 13.8.2: Bachelor of Science (B.Sc.) - Minor Cognitive Science (24 credits)*

**Computer Science,** *section 13.9.7: Bachelor of Science (B.Sc.) - Minor Computer Science (24 credits)*

**Earth System Science,** *section 13.11.3: Bachelor of Science - Minor Earth System Science (18 credits)*

**Education for Science Students,** *section 13.35.4: Bachelor of Science (B.Sc.) - Minor Education for Science Students (18 credits)*

**Electrical Engineering,** *section 13.30.7: Bachelor of Science (B.Sc.) - Minor Electrical Engineering (24 credits)*

**Entrepreneurship for Science Students,** *section 13.12.2: Bachelor of Science (B.Sc.) - Minor Entrepreneurship for Science Students (18 credits)*

## Minor Programs

**Environment**, : [Bachelor of Science \(Agricultural and Environmental Sciences\) \(B.Sc.\(Ag.Env.Sc.\)\)](#) or [Bachelor of Science \(B.Sc.\) - Minor Environment \(18 credits\)](#)

**Field Study**, [section 13.15.1: Field Studies - Minor Field Studies \(18 credits\)](#)

**Finance for Non-Management Students**, [section 13.21.1: Bachelor of Commerce \(B.Com.\) - Minor Finance \(For Non-Management Students\) \(18 credits\)](#)

**General Science**, [section 13.16.3: Bachelor of Science \(B.Sc.\) - Minor General Science \(18 credits\)](#)

**Geochemistry**, [section 13.10.6: Bachelor of Science \(B.Sc.\) - Minor Geochemistry \(18 credits\)](#)

**Geography**, [section 13.17.5: Bachelor of Science \(B.Sc.\) - Minor Geography \(18 credits\)](#)

**Geographic Information Systems and Remote Sensing**, [section 13.17.6: Bachelor of Science \(B.Sc.\) - Minor Geographic Information Systems and Remote Sensing \(18 credits\)](#)

**Geology**, [section 13.10.5: Bachelor of Science \(B.Sc.\) - Minor Geology \(18 credits\)](#) (previously named *Earth and Planetary Sciences*)

**Human Nutrition** – see [Faculty of Agricultural & Environmental Sciences > Undergraduate > Browse Academic Programs > Minor Programs > Bachelor of Science \(Agricultural and Environmental Sciences\) \(B.Sc.\(Ag.Env.Sc.\)\) - Minor Human Nutrition \(24 credits\)](#)

**Interdisciplinary Life Sciences**, [section 13.19.3: Bachelor of Science \(B.Sc.\) - Minor Interdisciplinary Life Sciences \(24 credits\)](#)

**Kinesiology**, [section 13.20.3: Bachelor of Science \(B.Sc.\) - Minor Kinesiology \(24 credits\)](#)

**Management for Non-Management Students**, [section 13.21.2: Bachelor of Commerce \(B.Com.\) - Minor Management \(For Non-Management Students\) \(18 credits\)](#)

**Marketing for Non-Management Students**, [section 13.21.3: Bachelor of Commerce \(B.Com.\) - Minor Marketing \(For Non-Management Students\) \(18 credits\)](#)

**Mathematics**, [section 13.22.7: Bachelor of Science \(B.Sc.\) - Minor Mathematics \(24 credits\)](#)

**Musical Applications of Technology** – see [Schulich School of Music > Undergraduate > Browse Academic Units & Programs > Department of Music Research: Composition; Music Education; Music History; Theory; Faculty Program > Bachelor of Music \(B.Mus.\) - Minor Musical Applications of Technology \(18 credits\)](#)

**Musical Science and Technology** – see [Schulich School of Music > Undergraduate > Browse Academic Units & Programs > Department of Music Research: Composition; Music Education; Music History; Theory; Faculty Program > Bachelor of Music \(B.Mus.\) - Minor Musical Science and Technology \(18 credits\)](#)

**Natural History**, [section 13.34.4: Bachelor of Science \(B.Sc.\) - Minor Natural History \(24 credits\)](#)

**Neuroscience**, [section 13.26.3: Bachelor of Science \(B.Sc.\) - Minor Neuroscience \(25 credits\)](#)

**Operations Management for Non-Management Students**, [section 13.21.4: Bachelor of Commerce \(B.Com.\) - Minor Operations Management \(For Non-Management Students\) \(18 credits\)](#)

**Pharmacology**, [section 13.29.4: Bachelor of Science \(B.Sc.\) - Minor Pharmacology \(24 credits\)](#)

**Physics**, [section 13.30.6: Bachelor of Science \(B.Sc.\) - Minor Physics \(18 credits\)](#)

**Psychology**, [section 13.33.6: Bachelor of Science \(B.Sc.\) - Minor Psychology \(24 credits\)](#)

**Statistics**, [section 13.22.8: Bachelor of Science \(B.Sc.\) - Minor Statistics \(24 credits\)](#)

### Notes:

1. The Minor in Chemical Engineering is only available to students in Chemistry.
2. The Minor in Electrical Engineering is only available to students in the Major program in Physics.
3. The Minor in General Science is only available to students in B.Sc. Liberal programs.

## 10.3 Bachelor of Arts and Science

Please see [Bachelor of Arts and Science](#) for details.

## 10.4 Internships, Field Studies, and Global Designation

For opportunities to enhance your degree with hands-on experience, visit [section 12: Science Internships and Field Studies](#).

## 10.5 Arts Major and Minor Concentrations Open to Science Students

For more information, please see the relevant departmental entries in [Faculty of Arts > Undergraduate](#).

### 10.5.1 Major Concentrations

#### Major Concentrations

**African Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration African Studies \(36 credits\)](#)

**Anthropology**, : [Bachelor of Arts \(B.A.\) - Major Concentration Anthropology \(36 credits\)](#)

**Art History**, : [Bachelor of Arts \(B.A.\) - Major Concentration Art History \(36 credits\)](#)

**Canadian Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration Canadian Studies \(36 credits\)](#)

**Classics**, : [Bachelor of Arts \(B.A.\) - Major Concentration Classics \(36 credits\)](#)

**East Asian Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration East Asian Studies \(36 credits\)](#)

**Economics**, : [Bachelor of Arts \(B.A.\) - Major Concentration Economics \(36 credits\)](#)

**English - Cultural Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration English - Cultural Studies \(36 credits\)](#)

**English - Drama and Theatre**, : [Bachelor of Arts \(B.A.\) - Major Concentration English - Drama and Theatre \(36 credits\)](#)

**English - Literature**, : [Bachelor of Arts \(B.A.\) - Major Concentration English - Literature \(36 credits\)](#)

**Gender, Sexuality, Feminist, & Social Justice Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration Gender, Sexuality, Feminist, & Social Justice Studies \(36 credits\)](#)

**Geography (Urban Systems)**, : [Bachelor of Arts \(B.A.\) - Major Concentration Geography \(Urban Systems\) \(36 credits\)](#)

**German Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration German Studies \(36 credits\)](#)

**Hispanic Languages**, : [Bachelor of Arts \(B.A.\) - Major Concentration Hispanic Studies - Languages \(36 credits\)](#)

**Hispanic Literature and Culture**, : [Bachelor of Arts \(B.A.\) - Major Concentration Hispanic Studies - Literature and Culture \(36 credits\)](#)

**History**, : [Bachelor of Arts \(B.A.\) - Major Concentration History \(36 credits\)](#)

**International Development Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration International Development Studies \(36 credits\)](#)

**Italian Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration Italian Studies \(36 credits\)](#)

**Jewish Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration Jewish Studies \(36 credits\)](#)

**Langue et littérature françaises - Études et pratiques littéraires**, : [Baccalauréat ès Arts \(B.A.\) - Concentration majeure langue et littérature françaises - Études et pratiques littéraires \(36 crédits\)](#)

**Langue et littérature françaises - Traduction**, : [Baccalauréat ès Arts \(B.A.\) - Concentration majeure langue et littérature françaises - Traduction \(36 crédits\)](#)

**Latin-American Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration Latin American Studies \(36 credits\)](#)

**Linguistics**, : [Bachelor of Arts \(B.A.\) - Major Concentration Linguistics \(36 credits\)](#)

**Music** (available to students in B.Sc. Liberal only), : [Bachelor of Arts \(B.A.\) - Major Concentration Music \(36 credits\)](#)

**Philosophy**, : [Bachelor of Arts \(B.A.\) - Major Concentration Philosophy \(36 credits\)](#)

**Political Science**, : [Bachelor of Arts \(B.A.\) - Major Concentration Political Science \(36 credits\)](#)

**Russian**, : [Bachelor of Arts \(B.A.\) - Major Concentration Russian \(36 credits\)](#)

**Sociology**, : [Bachelor of Arts \(B.A.\) - Major Concentration Sociology \(36 credits\)](#)

**World Islamic and Middle East Studies**, : [Bachelor of Arts \(B.A.\) - Major Concentration World Islamic & Middle East Studies \(36 credits\)](#)

**World Religions** – see Religious Studies, : [Bachelor of Arts \(B.A.\) - Major Concentration World Religions \(36 credits\)](#)

### 10.5.2 Minor Concentrations

#### Minor Concentrations

**African Studies**, : [Bachelor of Arts \(B.A.\) - Minor Concentration African Studies \(18 credits\)](#)

**Minor Concentrations**

- Anthropology**, : *Bachelor of Arts (B.A.) - Minor Concentration Anthropology (18 credits)*
- Arabic Language**, : *Bachelor of Arts (B.A.) - Minor Concentration Arabic Language (18 credits)*
- Art History**, : *Bachelor of Arts (B.A.) - Minor Concentration Art History (18 credits)*
- Canadian Ethnic and Racial Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration Canadian Ethnic and Racial Studies (18 credits)*
- Canadian Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration Canadian Studies (18 credits)*
- Classics**, : *Bachelor of Arts (B.A.) - Minor Concentration Classics (18 credits)*
- Communication Studies** – see Art History and Communication Studies, : *Bachelor of Arts (B.A.) - Minor Concentration Communication Studies (18 credits)*
- East Asian Language and Literature**, : *Bachelor of Arts (B.A.) - Minor Concentration East Asian Language and Literature (18 credits)*
- East Asian Cultural Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration East Asian Cultural Studies (18 credits)*
- East Asian Language, Supplementary**, : *Bachelor of Arts (B.A.) - Supplementary Minor Concentration East Asian Language (18 credits)*
- Economics**, : *Bachelor of Arts (B.A.) - Minor Concentration Economics (18 credits)*
- English – Cultural Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration English - Cultural Studies (18 credits)*
- English – Drama and Theatre**, : *Bachelor of Arts (B.A.) - Minor Concentration English - Drama and Theatre (18 credits)*
- English – Literature**, : *Bachelor of Arts (B.A.) - Minor Concentration English - Literature (18 credits)*
- Gender, Sexuality, Feminist, & Social Justice Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration Gender, Sexuality, Feminist, & Social Justice Studies (18 credits)*
- Geography**, : *Bachelor of Arts (B.A.) - Minor Concentration Geography (18 credits)*
- German Language**, : *Bachelor of Arts (B.A.) - Minor Concentration German Language (18 credits)*
- German Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration German Studies (18 credits)*
- Health Geography**, : *Bachelor of Arts (B.A.) - Minor Concentration Health Geography (18 credits)*
- Hispanic Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration Hispanic Studies (18 credits)*
- History**, : *Bachelor of Arts (B.A.) - Minor Concentration History (18 credits)*
- History and Philosophy of Science**, : *Bachelor of Arts (B.A.) - Minor Concentration History and Philosophy of Science (18 credits)*
- International Development Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration International Development Studies (18 credits)*
- Italian Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration Italian Studies (18 credits)*
- Jewish Law**, : *Bachelor of Arts (B.A.) - Minor Concentration Jewish Law (18 credits)*
- Jewish Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration Jewish Studies (18 credits)*
- Langue et littérature françaises – Études et pratiques littéraires**, : *Baccalauréat ès Arts (B.A.) - Concentration mineure langue et littérature françaises - Études et pratiques littéraires (18 crédits)*
- Langue et littérature françaises – Langue française**, : *Baccalauréat ès Arts (B.A.) - Concentration mineure langue et littérature françaises - Langue française (18 crédits)*
- Langue et littérature françaises – Traduction**, : *Baccalauréat ès Arts (B.A.) - Concentration mineure langue et littérature françaises - Traduction (18 crédits)*
- Linguistics**, : *Bachelor of Arts (B.A.) - Minor Concentration Linguistics (18 credits)*
- Music**, : *Bachelor of Arts (B.A.) - Minor Concentration Music (18 credits)*
- Persian Language**, : *Bachelor of Arts (B.A.) - Minor Concentration Persian Language (18 credits)*
- Philosophy**, : *Bachelor of Arts (B.A.) - Minor Concentration Philosophy (18 credits)*
- Political Science**, : *Bachelor of Arts (B.A.) - Minor Concentration Political Science (18 credits)*
- Québec Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration Quebec Studies / La concentration Mineur en Études sur le Québec (18 credits)*
- Religion and Globalization** – see Religious Studies, : *Bachelor of Arts (B.A.) - Minor Concentration Religion and Globalization (18 credits)*
- Russian**, : *Bachelor of Arts (B.A.) - Minor Concentration Russian (18 credits)*
- Russian Culture**, : *Bachelor of Arts (B.A.) - Minor Concentration Russian Culture (18 credits)*
- Social Studies of Medicine**, : *Bachelor of Arts (B.A.) - Minor Concentration Social Studies of Medicine (18 credits)*

**Minor Concentrations**

**Sociology**, : *Bachelor of Arts (B.A.) - Minor Concentration Sociology (18 credits)*

**Turkish Language**, : *Bachelor of Arts (B.A.) - Minor Concentration Turkish Language (18 credits)*

**Urdu Language**, : *Bachelor of Arts (B.A.) - Minor Concentration Urdu Language (18 credits)*

**World Cinemas**, : *Bachelor of Arts (B.A.) - Minor Concentration World Cinemas (18 credits)*

**World Religions** – see Religious Studies, : *Bachelor of Arts (B.A.) - Minor Concentration World Religions (18 credits)*

**World Islamic & Middle East Studies**, : *Bachelor of Arts (B.A.) - Minor Concentration World Islamic & Middle East Studies (18 credits)*

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## 11 Undergraduate Research Opportunities

McGill is a research-intensive university, where research informs the curriculum. Most Science B.Sc. students take part in research during their undergraduate studies, and there are many undergraduate research opportunities at McGill in affiliated hospitals, other universities, and in the field. Many of these are organized through formal courses or programs organized by the Faculty of Science or its departments. For more information, see the following:

- [section 11.1: Research Project Courses](#)
- [: "396" Undergraduate Research Project Courses](#)
- [section 11.2: Undergraduate Student Research Awards](#) – NSERC USRA, NSERC Experience Awards (formerly Industrial Undergraduate Student Research Awards), SURA
- [section 11.3: Undergraduate Research Conference](#)
- [section 11.4: Other Opportunities](#)
- Dean's Multidisciplinary Undergraduate Research List – see description in [University Regulations and Resources](#) > [Undergraduate](#) > [Graduation](#) > [Graduation Honours](#) > : [Faculty of Science Dean's Multidisciplinary Undergraduate Research List](#)

The **Office for Undergraduate Research in Science (OURS)** coordinates several of the aforementioned programs, and can help students find out about other opportunities. Visit the OURS website at [www.mcgill.ca/science/research/ours](http://www.mcgill.ca/science/research/ours) to find out more.

Because internships and field study programs *may* include a research component, please also see:

- [section 12: Science Internships and Field Studies](#)

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### 11.1 Research Project Courses

Departments offer a variety of research-based courses that allow you to perform research under the supervision of a McGill researcher for academic credit. Depending on the unit, courses featuring undergraduate research may bear names such as: majors project, honours project, advanced lab, independent research, technical project, independent study, or research project and seminar. For more information, see the research course list online at [www.mcgill.ca/science/research/ours/researchcourses](http://www.mcgill.ca/science/research/ours/researchcourses) or browse the course listings at [www.mcgill.ca/study/courses/search](http://www.mcgill.ca/study/courses/search). Research courses can also help you qualify for the [Dean's Multidisciplinary Undergraduate Research List](#) or the [B.Sc. Global Designation](#).

#### 11.1.1 "396" Undergraduate Research Project Courses

"396" undergraduate research project courses are offered by all undergraduate science departments and schools—ANAT 396, ATOC 396, BIOC 396, BIOL 396, etc.—plus HGEN 396 and MDPH 396 (Human Genetics and Medical Physics: departments which offer mainly graduate programs), as well as COGS 396 and NSCI 396 (Cognitive Science and Neuroscience: multidisciplinary undergraduate programs). There is also a BASC 396 course for B.A. & Sc. students.

They are elective courses, which can be taken outside your own department, and can be taken after one term of undergraduate studies. Note that for Microbiology and Immunology, MIMM 396 is for *microbiology* projects whereas MIMM 397 is for *immunology*; otherwise, for all practical purposes MIMM 397 should be treated as a "396" course.

Students can consult a list of past projects and currently available projects on the Science website at [www.mcgill.ca/science/research/ours/396](http://www.mcgill.ca/science/research/ours/396) or devise a new project in consultation with a McGill professor and submit the required paperwork online.

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### 11.2 Undergraduate Student Research Awards

The following award programs fund undergraduate student research projects at McGill (and sometimes off-campus), usually in the summer.

Please also consult the Office for Undergraduate Research in Science website at [www.mcgill.ca/science/research/ours](http://www.mcgill.ca/science/research/ours) for any new programs that may have been added.

### 11.2.1 NSERC Undergraduate Student Research Awards

The **Natural Sciences and Engineering Research Council of Canada Undergraduate Student Research Awards (NSERC USRA)** in Universities program supports 16 consecutive weeks of paid full-time research under the supervision of a professor who holds an NSERC research grant. It is an excellent way to prepare for graduate studies or a future career in science. This program is offered at other universities across Canada, and a travel allowance from NSERC is available.

To apply, you must be a Canadian citizen or permanent resident of Canada. Apply through the university where you wish to hold the award. See [www.mcgill.ca/science/research/ours/nserc](http://www.mcgill.ca/science/research/ours/nserc) for more information.

### 11.2.2 NSERC Experience Awards

NSERC's Experience Awards (previously Industrial Undergraduate Student Research Awards, IUSRA) let you gain paid research work experience as part of a work term in an industrial setting that complements your studies. Students apply for these awards through one or more companies (not through McGill). For more information on forms, student eligibility, and company eligibility, please visit the [NSERC website](#) and look for *Experience Awards*.

### 11.2.3 SURA: Science Undergraduate Research Awards

Science Undergraduate Research Awards—SURAs—are for both Canadian and international McGill students registered in a B.Sc. or B.A. & Sc. science undergraduate program (B.A. students may wish to look into programs offered by the Faculty of Arts). SURAs are broadly similar to the NSERC USRA; two differences are that *international students may apply*, and supervision is not restricted to professors with NSERC research grants and thus SURAs can also support social science or medical science research.

See [www.mcgill.ca/science/research/ours/sura](http://www.mcgill.ca/science/research/ours/sura) for details.

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## 11.3 Undergraduate Research Conference

Each fall, the Faculty of Science holds an Undergraduate Research Conference to celebrate the research accomplishments of our undergraduate students. The conference also includes a public lecture by a Nobel laureate or other luminary on a topic related to scientific discovery.

Students who wish to present their research posters should contact their departments in the preceding winter or summer, since *departments* nominate participants for the conference.

Everyone is welcome to attend. This is an excellent opportunity to see what McGill undergraduates undertake as research projects.

For more details and the date, please see [www.mcgill.ca/science/research/ours/urc](http://www.mcgill.ca/science/research/ours/urc).

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## 11.4 Other Opportunities

Science internships and field study programs may have a research component or focus. Please see their descriptions under [section 12: Science Internships and Field Studies](#).

Individual departments and researchers offer many other research opportunities. These may be paid or unpaid, for academic credit or not for credit. Some of these opportunities are formal programs and are described in other sections of this publication ([section 11.1: Research Project Courses](#), : "396" [Undergraduate Research Project Courses](#), and [section 11.2: Undergraduate Student Research Awards](#)) or on the Office for Undergraduate Research in Science website ([www.mcgill.ca/science/research/ours](http://www.mcgill.ca/science/research/ours)); however, many opportunities arise as a result of students talking with their professors. For advice on approaching professors, and more generally on how to get involved in research, see [www.mcgill.ca/science/research/ours/how](http://www.mcgill.ca/science/research/ours/how).

In addition to opportunities available at McGill, there are several external opportunities at other institutions. Many of these are catalogued at [www.mcgill.ca/science/research/ours/opportunities](http://www.mcgill.ca/science/research/ours/opportunities). You may also want to look for additional opportunities funded or offered by the relevant research agencies, institutions, and universities of interest: for example, a provincial cancer research society, a national science funding agency, or a national psychological association.

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## 12 Science Internships and Field Studies

The [Science Internships & Field Studies Office](#) promotes field studies and internship opportunities to interested students seeking hands-on experience. The office coordinates the field study semesters offered through the Faculty of Science and provides information on internship opportunities to students who are in Science programs at McGill. Whether you decide to participate in a field study semester or apply classroom theory to practice, the [Science Internships & Field Studies Office](#) will offer you assistance in your decision.

Burnside Hall, Room 720  
805 Sherbrooke Street West  
Montreal QC H3A 0B9  
Telephone: 514-398-1063; 514-398-8365  
Email: [ifso.science@mcgill.ca](mailto:ifso.science@mcgill.ca)  
Website: [www.mcgill.ca/science/programs/internships](http://www.mcgill.ca/science/programs/internships)

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## 12.1 Internship Program: Industrial Practicum (IP) and Internship Year in Science (IYS)

The Internship Program is open to all Science undergraduate students, as well as qualified students in other undergraduate degrees or programs, including majors in Environment, Computer Science, Geography, Mathematics, and Psychology. Participating in an internship offers you the chance to add a practical element to your studies, to solidify your career goals, to gain some valuable experience, and to earn money. Internships may have a basis in research.

To be eligible to apply:

- You must be registered as a full time student before and after the IP or the IYS is completed.
- You must have completed at least 27 credits and have at least 12 credits remaining in your degree program.
- Your CGPA must be 2.7 or higher.
- International McGill students are eligible to apply to summer IP and IYS positions (unless otherwise indicated on the job posting). Restrictions apply; interested students should consult the Internship Officer.

The program features the *Industrial Practicum* (4 months) and the *Internship Year in Science* (8, 12, 16 months).

### Internship Program Designation

The Internship Program will also give you the opportunity to enhance your degree: if you are a student in the Faculty of Science and you complete two *Industrial Practica* (IP) or participate in an *Internship Year in Science* (IYS), the name of your program will change to include the Internship Program designation (e.g., Bachelor of Science – Internship Program – Biology).

For more information on IP and IYS, please see [www.mcgill.ca/science/programs/internships](http://www.mcgill.ca/science/programs/internships).

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## 12.2 Field Study and Study Abroad

McGill's Field Study Semester programs (in Africa, Arctic, Barbados, and Panama) are research-based, as are many shorter field courses offered by the Departments of Biology, Earth & Planetary Sciences, and Geography. See [Study Abroad & Field Studies > Undergraduate > : Opportunities for Field Study and Study Abroad](#) and [www.mcgill.ca/science/student/internships-field](http://www.mcgill.ca/science/student/internships-field) for more information about these programs and courses.

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## 12.3 B.Sc. Global Designation

The above internship and study abroad opportunities form part of a special B.Sc. Global designation awarded to eligible students at graduation; visit [www.mcgill.ca/science/programs/bsc-global](http://www.mcgill.ca/science/programs/bsc-global) for more information.

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# 13 Browse Academic Units & Programs

### What is a Major Program?

A major is a versatile, comprehensive primary area of study. Most major programs require about two-thirds of your total credits. With the remaining credits, you can choose electives, or you may want to use those additional credits to take a minor, which can be chosen from a wide variety of areas both within and outside Science.

### What is an Honours Program?

Honours programs typically involve an even higher degree of specialization than majors, include supervised research, and require students to maintain a high academic standard. An honours program provides solid preparation for graduate school. With an honours program, you will have fewer elective credits.

### What is a B.Sc. Liberal Program?

This is a flexible and modular program. You combine a core science component (CSC) in a Science discipline with a breadth component, which may be a minor from a wide variety of areas, a major concentration from the Faculty of Arts, or a second CSC from any group in Science. Consider the Liberal program if you do not want to overly specialize—plus, you will still have room left over for elective courses.

### What about Joint Programs?



The Faculty of Science also has quite a few joint programs. These programs combine two different disciplines, which allow you to gain expertise in two fields.

### What about Interdisciplinary Programs?

There are many ways to create interdisciplinary programs in the Faculty of Science. You can add a minor to a major or honours program, you can take a liberal program that contains both a core science component and a breadth component, or you can select an explicit interdisciplinary major. The Faculty of Science offers three such interdisciplinary programs: Earth System Science, Environment, and Neuroscience.

## 13.1 B.Sc. Freshman Program

If you need 97–120 credits (four years) to complete your degree requirements, you must register in the Science Freshman program, which is designed to provide the basic science foundation for your subsequent three-year Liberal, Major, or Honours program. For a detailed description of the Science Freshman program, you should consult [section 13.1.1: Bachelor of Science \(B.Sc.\) - Freshman Program \(30 credits\)](#) and the Science Freshman Student information available on the SOUSA website, [www.mcgill.ca/science/student/newstudents/u0](http://www.mcgill.ca/science/student/newstudents/u0).

If you have completed the Diploma of Collegial Studies, Advanced Placement exams, Advanced Levels, the International Baccalaureate, the French Baccalaureate, or McGill placement examinations, you may receive exemption and/or credit for all or part of the basic science courses in biology, chemistry, mathematics, and physics. Similarly, if you have completed courses at other universities or colleges, you may receive exemptions and/or credits. You should consult [www.mcgill.ca/students/transferecredit](http://www.mcgill.ca/students/transferecredit) for more information.

### 13.1.1 Bachelor of Science (B.Sc.) - Freshman Program (30 credits)

Students who need 97-120 credits to complete their degree requirements will normally be registered in the Science Freshman Program until they complete their first year. They must consult an adviser in the Science Office for Undergraduate Student Advising (SOUSA) to obtain advice and approval of their course selection.

Full details are available on the SOUSA website at <http://www.mcgill.ca/science/student/newstudents/u0>. Academic advising is also available by email. The address is [newstudentadvising.science@mcgill.ca](mailto:newstudentadvising.science@mcgill.ca).

Students normally complete 30 credits which must include at least seven courses from the list of Approved Freshman Science Courses, selected as follows:

#### General Math and Science Breadth

Six of the Freshman courses to satisfy one of the following:

Option 1) 2 courses from MATH and 4 courses from BIOL, CHEM or PHYS;

or

Option 2) 3 courses from MATH and 3 courses from BIOL, CHEM or PHYS.

#### Science Complementary

The seventh course is chosen from the list of Approved Freshman Science Courses.

Notes:

1. Students who have not studied all of Biology, Chemistry, and Physics at the grade 12 level or equivalent are strongly advised to include at least one course in the missing discipline in their Freshman Program.
2. Many students will complete more than seven courses from the Approved Freshman Science Courses list, particularly those who wish to leave several options open for their choice of major.
3. Students entering the Freshman Program should be aware of the department specific requirements when selecting their courses. Detailed advising information is available at <http://www.mcgill.ca/science/student/newstudents/u0/bscfreshman/specific>.
4. The maximum number of courses per term, required, complementary, and elective, is five.
5. Some medical and dental schools have specific freshman course requirements. Check the admission requirements of the school(s) to which you intend to apply.

#### List of approved Freshman Science Courses

Select the approved courses according to the instructions above.

ATOC 100	(3)	Extreme-Weather and Climate-Change Physics
BIOL 111	(3)	Principles: Organismal Biology
BIOL 112	(3)	Cell and Molecular Biology
CHEM 110	(4)	General Chemistry 1

CHEM 120*	(4)	General Chemistry 2
COMP 202	(3)	Foundations of Programming
ESYS 104	(3)	The Earth System
GEOG 205	(3)	Global Change: Past, Present and Future
MATH 133**	(3)	Linear Algebra and Geometry
MATH 134***	(3)	Enriched Linear Algebra and Geometry
PSYC 100	(3)	Introduction to Psychology

\* CHEM 120 is not open to students who have taken CHEM 115.

\*\* Not open to students who are taking or have taken MATH 134.

\*\*\* MATH 134 is an enriched version of MATH 133. MATH 134 may be used instead of MATH 133 to: (1) provide a course prerequisite; and (2) satisfy program requirements.

First calculus course, one of:

MATH 139	(4)	Calculus 1 with Precalculus
MATH 140	(3)	Calculus 1
MATH 150	(4)	Calculus A

Second calculus course, one of:

MATH 141	(4)	Calculus 2
MATH 151	(4)	Calculus B

First physics course, one of:

PHYS 101	(4)	Introductory Physics - Mechanics
PHYS 131	(4)	Mechanics and Waves

Second physics course, one of:

PHYS 102	(4)	Introductory Physics - Electromagnetism
PHYS 142	(4)	Electromagnetism and Optics

### Electives

Students wishing to take elective courses may choose them from introductory courses offered by departments in the Faculties of Science or of Arts. A list of recommended courses is found at <http://www.mcgill.ca/science/student/newstudents/u0/bscfreshman/suggested-elective-courses>. Certain courses offered by other faculties may also be taken, but some restrictions apply. Consult the SOUSA website at <http://www.mcgill.ca/science/student/continuingstudents/bsc/outside/> for more information about taking courses from other faculties.

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## 13.2 Anatomy and Cell Biology (ANAT)

### 13.2.1 Location

Strathcona Anatomy and Dentistry Building, Room M-28  
3640 University Street  
Montreal, Quebec H3A 0C7

Telephone: 514-398-6350

Website: [www.mcgill.ca/anatomy](http://www.mcgill.ca/anatomy)

### 13.2.2 About Anatomy and Cell Biology

The Department of Anatomy and Cell Biology offers courses that 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 and molecular biologists. The **Major** and **Liberal** programs offer decreasing levels of specialization in Anatomy and Cell Biology but with a broader base in other biological sciences. These programs also form a sound background for graduate studies in Anatomy and Cell Biology, or for further professional training. Students should choose their major based on their interest and also consider the **Interdisciplinary Minor** in Life 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, pharmaceutical, and biotechnological industries.

The Department is equipped to perform protein purification; recombinant DNA technology; micro-injection of molecules into single cells; cytochemical; immunocytochemical and fluorescent analysis and electron microscopy; proteomics; and genomics. The Department has a well-equipped centre for electron microscopy as well as a centre for confocal and immunofluorescence. The new cryo-electron microscope facility in the Department is unique and represents a cutting edge technology to apply fundamental discoveries to therapeutic applications.

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

### 13.2.3 Anatomy and Cell Biology (ANAT) Faculty

#### Chair

Craig Mandato

#### Emeritus Professors

Gary C. Bennett; B.A., B.Sc.(Sir G. Wms.), M.Sc., Ph.D.(McG.)

John J.M. Bergeron; B.Sc.(McG.), Ph.D.(Oxf.)

James R. Brawer; B.S.(Tufts), Ph.D.(Harv.)

Louis Hermo; B.A.(Loyola), M.Sc., Ph.D.(McG.)

Sandra C. Miller; B.Sc.(Sir G. Wms.), M.Sc., Ph.D.(McG.)

Dennis G. Osmond; C.M., B.Sc., M.B., Ch.B., D.Sc.(Brist.), M.R.C.S., L.R.C.P., F.R.S.C.

H. Warshawsky; B.Sc.(Sir G. Wms.), M.Sc., Ph.D.(McG.)

#### Professors

Chantal Autexier; B.Sc.(C' dia), Ph.D.(McG.)

Susanne Bechstedt; B.Sc.(Flor. St.), M.Sc.(Friedrich Schiller Univ.), Ph.D.(Max Planck)

Khanh Huy Bui; B.Sc.(Wales), M.Sc.(Chalmers), Ph.D.(Zürich)

Samuel David; Ph.D.(Manit.) (*joint appt. with Neurology & Neurosurgery*)

Timothy Kennedy; B.Sc.(McM.), M.Phil., Ph.D.(Col.) (*joint appt. with Neurology & Neurosurgery*)

Nathalie Lamarche-Vane; B.Sc., Ph.D.(Montr.)

Marc D. McKee; B.Sc., M.Sc., Ph.D.(McG.) (*joint appt. with Dentistry*)

Peter McPherson; B.Sc.(Manit.), Ph.D.(Iowa) (*joint appt. with Neurology and Neurosurgery*)

Carlos R. Morales; DVM.(U.N., Argentina), Ph.D.(McG.)

Joaquin Ortega; B.Sc.(Zaragoza), Ph.D.(Autonoma, Madrid)

Barry I. Posner; M.D.(Manit.), F.R.C.P.(C) (*joint appt. with Medicine*)

Dieter Reinhardt; M.S.(Kaiserslautern), Ph.D.(Munich) (*joint appt. with Dentistry*)

**Professors**

Alfredo Ribeiro-da-Silva; M.D., Ph.D.(Oporto) (*joint appt. with Pharmacology and Therapeutics*)  
 Wayne Sossin; S.B.(MIT), Ph.D.(Stan.) (*joint appt. with Neurology & Neurosurgery*)  
 Stefano Stifani; Ph.D.(Rome), Ph.D.(Alta.) (*joint appt. with Neurology & Neurosurgery*)  
 Hojatollah Vali; B.Sc., M.Sc., Ph.D.(Munich)  
 Dominique Walker; B.Sc., Ph.D.(Geneva) (*joint appt. with Psychiatry*)

**Associate Professors**

Orest W. Blaschuk; B.Sc.(Winn.), M.Sc.(Manit.), Ph.D.(Tor.) (*joint appt. with Surgery*)  
 Eugene Daniels; M.Sc., Ph.D.(Manit.)  
 Elaine Davis; B.Sc., M.Sc.(W. Ont.), Ph.D.(McG.)  
 Craig Mandato; B.Sc., Ph.D.(Wat.)  
 Geoffroy P. Noël; Ph.D.(Br. Col.)  
 John F. Presley; B.A., Ph.D.(Texas)  
 Isabelle Rouiller; Ph.D.(Hertfordshire)

**Assistant Professors**

Javier Vargas; B.Sc., M.Sc., Ph.D.(UCM, Spain)  
 Gabriel Venne; B.Sc.(Wales), M.Sc., Ph.D.(Qu.)  
 Nicole Ventura; Ph.D.(Qu.)

**Associate Members**

Daniel Bernard (*Pharmacology and Therapeutics*)  
 Claire Brown (*Physiology*)  
 Colin Chalk (*Neurology & Neurosurgery*)  
 Jean-François Cloutier (*Neurology & Neurosurgery*)  
 Claudio Cuello (*Pharmacology & Therapeutics*)  
 Giovanni DiBattista (*Medicine*)  
 Allen Ehrlicher (*Bioengineering*)  
 Alyson Fournier (*Neurology & Neurosurgery*)  
 Lisbet Haglund (*Surgery*)  
 Janet Henderson (*Medicine*)  
 Svetlana Komarova (*Dentistry*)  
 Stephane Laporte (*Endocrinology and Metabolism*)  
 Andrea Leblanc (*Neurology & Neurosurgery*)  
 Stephanie Lehoux (*Medicine*)  
 Loydie A. Majewska (*Pediatrics and Human Genetics*)  
 Heidi McBride (*Montreal Neurological Institute*)  
 Peter Metrakos (*Surgery*)  
 Makato Nagano (*Obstetrics and Gynecology*)  
 Christian Rocheleau (*Endocrinology and Metabolism*)  
 Edward S. Ruthazer (*Neurology & Neurosurgery*)  
 Peter Siegel (*Medicine & Biochemistry*)  
 Charles E. Smith; D.D.S., Ph.D.(McG.)  
 Thomas Stroh (*Neurology & Neurosurgery*)

**Associate Members**

Jason Tanny (*Pharmacology & Therapeutics*)

**Adjunct Professors**

Gregor Andelfinger; M.D.(Ulm)

Christopher Brett; Ph.D.(Johns Hop.)

Philippe Campeau; M.D.(Laval)

Michel Cayouette; Ph.D.(Laval)

Frederic Charron; B.Sc.(Montr.), Ph.D.(McG.)

Jean-Francois Cote; Ph.D.(McG.)

Daniel Cyr; B.Sc., M.Sc.(C' dia), Ph.D.(Manit.)

Jacques Drouin; B.Sc., D.Sc.(Laval)

Jennifer Estall; Ph.D.(Tor.)

Patrick Freud; B.Sc., D.C.(Parker)

Michael Greenwood; B.Sc., M.Sc.(C' dia), Ph.D.(McG.)

David Hipfner; B.Sc., Ph.D.(Qu.)

Artur Kania; Ph.D.(Baylor)

Justin Kollman; Ph.D.(Calif.-San Diego)

Stephane Lefrancois; Ph.D.(McG.)

André Nantel; B.Sc., M.Sc.(Laval), Ph.D.(Chapel Hill)

Alexei Pshezhetsky; Ph.D.(Moscow St.)

Michael Sacher; Ph.D.(McG.)

Elitza Tocheva; B.Sc., Ph.D.(Br. Col.)

**13.2.4 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Anatomy and Cell Biology (48 credits)****Revision, May 2018. Start of revision.**

Students may complete this program with a minimum of 47 credits or a maximum of 48 credits depending on their choice of complementary courses.

**Required Courses (32 credits)**

Note: ANAT 261 must be taken in U1.

\* Students who have taken the equivalent of CHEM 212 and/or MATH 203 in CEGEP (as defined at <http://www.mcgill.ca/students/courses/plan/transfer/>) are exempt and must replace these credits with elective course credits to satisfy the total credit requirement for their degree.

ANAT 212	(3)	Molecular Mechanisms of Cell Function
ANAT 214	(3)	Systemic Human Anatomy
ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Introductory Molecular and Cell Biology
BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 212*	(4)	Introductory Organic Chemistry 1
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

One of the following statistics courses:

MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

**Complementary Courses (16 credits)**

Students complete a minimum of 15 or a maximum of 16 complementary course credits selected as follows:

9 credits of advanced anatomy courses (AAC) selected from:

ANAT 314	(3)	Human Musculoskeletal Anatomy
ANAT 321	(3)	Circuitry of the Human Brain
ANAT 322	(3)	Neuroendocrinology
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
ANAT 565	(3)	Diseases-Membrane Trafficking
NEUR 310	(3)	Cellular Neurobiology

6-7 credits of biologically oriented courses (BOC) selected from:

ANAT 314	(3)	Human Musculoskeletal Anatomy
ANAT 321	(3)	Circuitry of the Human Brain
ANAT 322	(3)	Neuroendocrinology
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
ANAT 565	(3)	Diseases-Membrane Trafficking
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 320	(3)	Evolution of Brain and Behaviour
COMP 204	(3)	Computer Programming for Life Sciences
EXMD 504	(3)	Biology of Cancer
NEUR 310	(3)	Cellular Neurobiology
NEUR 502	(3)	Basic and Clinical Aspects of Neuroimmunology
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease

**Revision, May 2018. End of revision.**

**13.2.5 Bachelor of Science (B.Sc.) - Major Anatomy and Cell Biology (67 credits)****Required Courses (43 credits)**

Note: ANAT 261 must be taken in U1.

\* Students who have taken the equivalent of CHEM 212, CHEM 222, and/or MATH 203 in CEGEP (as defined at <http://www.mcgill.ca/students/courses/plan/transfer/>) are exempt and must replace these credits with elective course credits to satisfy the total credit requirement for their degree.

ANAT 212	(3)	Molecular Mechanisms of Cell Function
ANAT 214	(3)	Systemic Human Anatomy
ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Introductory Molecular and Cell Biology
BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
BIOL 301	(4)	Cell and Molecular Laboratory
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

One of the following statistics courses:

BIOL 373	(3)	Biometry
MATH 203*	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

### Complementary Courses (24 credits)

**Revision, May 2018. Start of revision.**

Complementary courses are selected as follows with a minimum of 6 credits at the 400 level or higher:

**Revision, May 2018. End of revision.**

12 credits of advanced anatomy courses (AAC) selected from:

ANAT 314	(3)	Human Musculoskeletal Anatomy
ANAT 321	(3)	Circuitry of the Human Brain
ANAT 322	(3)	Neuroendocrinology
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
ANAT 416	(3)	Development, Disease and Regeneration
ANAT 458	(3)	Membranes and Cellular Signaling
ANAT 541	(3)	Cell and Molecular Biology of Aging
ANAT 565	(3)	Diseases-Membrane Trafficking
NEUR 310	(3)	Cellular Neurobiology

12 credits of biologically oriented courses (BOC) selected from:

ANAT 314	(3)	Human Musculoskeletal Anatomy
ANAT 321	(3)	Circuitry of the Human Brain
ANAT 322	(3)	Neuroendocrinology
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
ANAT 416	(3)	Development, Disease and Regeneration

ANAT 458	(3)	Membranes and Cellular Signaling
ANAT 541	(3)	Cell and Molecular Biology of Aging
ANAT 565	(3)	Diseases-Membrane Trafficking
BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 450	(3)	Protein Structure and Function
BIOC 458	(3)	Membranes and Cellular Signaling
BIOC 503	(3)	Immunochemistry
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 370	(3)	Human Genetics Applied
BIOL 514	(3)	Neurobiology Learning and Memory
BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 544	(3)	Genetic Basis of Life Span
BIOL 546	(3)	Genetics of Model Systems
BIOL 551	(3)	Principles of Cellular Control
BIOL 575	(3)	Human Biochemical Genetics
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
BIOT 505	(3)	Selected Topics in Biotechnology
COMP 204	(3)	Computer Programming for Life Sciences
EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
EXMD 504	(3)	Biology of Cancer
EXMD 506	(3)	Advanced Applied Cardiovascular Physiology
EXMD 507	(3)	Advanced Applied Respiratory Physiology
EXMD 508	(3)	Advanced Topics in Respiration
MIMM 314	(3)	Intermediate Immunology
MIMM 323	(3)	Microbial Physiology
MIMM 324	(3)	Fundamental Virology
MIMM 387	(3)	The Business of Science
MIMM 413	(3)	Parasitology
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis
MIMM 509	(3)	Inflammatory Processes



NEUR 310	(3)	Cellular Neurobiology
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHAR 303	(3)	Principles of Toxicology
PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience
PHGY 451	(3)	Advanced Neurophysiology
PHGY 502	(3)	Exercise Physiology
PHGY 508	(3)	Advanced Renal Physiology
PHGY 513	(3)	Cellular Immunology
PHGY 515	(3)	Physiology of Blood 1
PHGY 516	(3)	Physiology of Blood 2
PHGY 517	(3)	Artificial Internal Organs
PHGY 518	(3)	Artificial Cells
PHGY 552	(3)	Cellular and Molecular Physiology
PHGY 556	(3)	Topics in Systems Neuroscience
PSYT 455	(3)	Neurochemistry
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

### 13.2.6 Bachelor of Science (B.Sc.) - Honours Anatomy and Cell Biology (73 credits)

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 3.20 at the end of U1. For promotion to the U3 year of the Honours program, or for entry into the program at this level, the student must have a CGPA of at least 3.20 at the end of their U2 year. It is expected that at the beginning of the third year, the students who wish to continue in the Honours program will be those who feel that they are seriously interested in a career in Cell Biology. The Honours degree will be recommended after successful completion of the program with a CGPA of at least 3.20.

#### Required Courses (52 credits)

Note: ANAT 261 must be taken in U1.

\* Students who have taken the equivalent of CHEM 212, CHEM 222, and/or MATH 203 in CEGEP (as defined at <http://www.mcgill.ca/students/courses/plan/transfer/>) are exempt and must replace these credits with elective course credits to satisfy the total credit requirement for their degree.

ANAT 212	(3)	Molecular Mechanisms of Cell Function
ANAT 214	(3)	Systemic Human Anatomy
ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Introductory Molecular and Cell Biology
ANAT 432	(9)	Honours Research Project
BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
BIOL 301	(4)	Cell and Molecular Laboratory
CHEM 212*	(4)	Introductory Organic Chemistry 1

CHEM 222*	(4)	Introductory Organic Chemistry 2
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

One of the following statistics courses:

BIOL 373	(3)	Biometry
MATH 203*	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

### **Complementary Courses (21 credits)**

**Revision, May 2018. Start of revision.**

Complementary courses are selected as follows with a minimum of 6 credits at the 400 level or higher:

**Revision, May 2018. End of revision.**

18 credits of advanced anatomy courses (AAC) selected from:

\* Note: Students may take either ANAT 321 OR ANAT 323.

ANAT 314	(3)	Human Musculoskeletal Anatomy
ANAT 321*	(3)	Circuitry of the Human Brain
ANAT 322	(3)	Neuroendocrinology
ANAT 323*	(3)	Clinical Neuroanatomy
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
ANAT 416	(3)	Development, Disease and Regeneration
ANAT 458	(3)	Membranes and Cellular Signaling
ANAT 541	(3)	Cell and Molecular Biology of Aging
ANAT 565	(3)	Diseases-Membrane Trafficking
NEUR 310	(3)	Cellular Neurobiology

3 credits of biologically oriented courses (BOC) selected from:

ANAT 314	(3)	Human Musculoskeletal Anatomy
ANAT 315	(3)	Clinical Human Musculoskeletal Anatomy
ANAT 322	(3)	Neuroendocrinology
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
ANAT 416	(3)	Development, Disease and Regeneration
ANAT 458	(3)	Membranes and Cellular Signaling
ANAT 541	(3)	Cell and Molecular Biology of Aging
ANAT 565	(3)	Diseases-Membrane Trafficking
BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 450	(3)	Protein Structure and Function

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BIOC 458	(3)	Membranes and Cellular Signaling
BIOC 503	(3)	Immunochemistry
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 370	(3)	Human Genetics Applied
BIOL 514	(3)	Neurobiology Learning and Memory
BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 544	(3)	Genetic Basis of Life Span
BIOL 546	(3)	Genetics of Model Systems
BIOL 551	(3)	Principles of Cellular Control
BIOL 575	(3)	Human Biochemical Genetics
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
BIOT 505	(3)	Selected Topics in Biotechnology
COMP 204	(3)	Computer Programming for Life Sciences
EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
EXMD 504	(3)	Biology of Cancer
EXMD 506	(3)	Advanced Applied Cardiovascular Physiology
EXMD 507	(3)	Advanced Applied Respiratory Physiology
EXMD 508	(3)	Advanced Topics in Respiration
MIMM 314	(3)	Intermediate Immunology
MIMM 323	(3)	Microbial Physiology
MIMM 324	(3)	Fundamental Virology
MIMM 387	(3)	The Business of Science
MIMM 413	(3)	Parasitology
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis
MIMM 509	(3)	Inflammatory Processes
NEUR 310	(3)	Cellular Neurobiology
NEUR 502	(3)	Basic and Clinical Aspects of Neuroimmunology
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHAR 303	(3)	Principles of Toxicology

PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience
PHGY 451	(3)	Advanced Neurophysiology
PHGY 502	(3)	Exercise Physiology
PHGY 508	(3)	Advanced Renal Physiology
PHGY 513	(3)	Cellular Immunology
PHGY 515	(3)	Physiology of Blood 1
PHGY 516	(3)	Physiology of Blood 2
PHGY 517	(3)	Artificial Internal Organs
PHGY 518	(3)	Artificial Cells
PHGY 552	(3)	Cellular and Molecular Physiology
PHGY 556	(3)	Topics in Systems Neuroscience
PSYT 455	(3)	Neurochemistry
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

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### 13.3 Atmospheric and Oceanic Sciences (ATOC)

#### 13.3.1 Location

Burnside Hall, Room 945  
805 Sherbrooke Street West  
Montreal QC H3A 0B9  
Telephone: 514-398-3764  
Fax: 514-398-6115  
Email: [info.aos@mcgill.ca](mailto:info.aos@mcgill.ca)  
Website: [www.mcgill.ca/meteo](http://www.mcgill.ca/meteo)

#### 13.3.2 About Atmospheric and Oceanic Sciences

The Department of Atmospheric and Oceanic Sciences offers, at the undergraduate level, a broad range of courses and degree programs in atmospheric science (meteorology). 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 changes in global climate caused by the changing chemical composition of the atmosphere. The approach to the study of climate change is quantitative in the Department of Atmospheric and Oceanic Sciences. Like other parts of physics, atmospheric science attempts to create theoretical models of its complex processes as a means of analyzing the motion and composition of the air, its thermodynamic behaviour, and its interaction with radiation and with the solid or liquid surface beneath it.

From one viewpoint, the atmosphere may be studied as a large volume of gas by the methods of fluid mechanics: winds, circulation patterns, turbulence, and energy and momentum exchanges are the ideas employed in this approach. Alternatively, the atmosphere may be studied from the point of view of its detailed physics: how water condenses in the air; how cloud droplets make rain; how sunlight warms the ground and the ground warms the air above it by radiation and convection; and how the atmosphere and ocean interact to shape the weather and climate. A comprehensive understanding requires both viewpoints, and these are reflected in the curriculum.

The Department of Atmospheric and Oceanic Sciences offers four main programs in Atmospheric Science:

- **Honours**
- **Major**

- **Minor**
- **Joint Major** in Atmospheric Science and Physics

The **Honours** program is meant for students with high standing. It is based on courses similar to those in the Major program, but provides opportunities to perform research and to take advanced courses. The **Major** program, although somewhat less intensive, satisfies the requirements for a professional career as a meteorologist, and like the Honours program equips the student to undertake postgraduate study in meteorology, atmospheric science, and related sciences (physical oceanography) at any of the leading universities. The Department also offers a special one-year Diploma program to B.Sc. or B.Eng. graduates.

An undergraduate degree in Atmospheric Science is an excellent background for professional careers in government service or private industry and/or graduate study in the physical sciences. Environment and Climate Change Canada (and the Meteorological Service of Canada in particular) has traditionally been a significant employer of graduating students at all levels, but provincial governments, private forecasting companies, environmental consulting and engineering firms, and insurance companies also employ Atmospheric Science graduates. Academic positions in teaching and research are available to M.Sc. and Ph.D. graduates. Students interested in any of the undergraduate programs should contact:

Timothy Merlis, Undergraduate Adviser  
Email: [timothy.merlis@mcgill.ca](mailto:timothy.merlis@mcgill.ca)

or the main departmental office at Room 945, Burnside Hall.

### 13.3.3 Atmospheric and Oceanic Sciences Faculty

#### Chair

J.R. Gyakum

#### Emeritus Professors

J.F. Derome; B.Sc., M.Sc.(McG.), Ph.D.(Mich.), F.R.S.C.

H.G. Leighton; B.Sc., M.Sc.(McG.), Ph.D.(Alta.)

L.A. Mysak; C.M., B.Sc.(Alta.), M.Sc.(Adel.), A.M., Ph.D.(Harv.), F.R.S.C. (*Canada Steamship Lines Professor of Meteorology*)

I. Zawadzki; B.Sc.(Buenos Aires), M.Sc., Ph.D.(McG.), F.R.S.C.

#### Professors

P. Ariya; B.Sc., Ph.D.(York) (*James McGill Professor*) (*joint appt. with Chemistry*)

P. Bartello; B.S.c., M.Sc., Ph.D.(McG.)

J.R. Gyakum; B.Sc.(Penn. St.), M.Sc., Ph.D.(MIT)

M.K. Yau; S.B., S.M., Sc.D.(MIT) (*NSERC/Hydro-Québec Industrial Research Chair in Short-term Forecasting of Precipitation*)

#### Associate Professors

F. Fabry; B.Sc., M.Sc., Ph.D.(McG.) (*joint appt. with McGill School of Environment*)

Y. Huang; B.Sc., M.Sc.(Peking), Ph.D.(Princ.)

D. Kirshbaum; B.Sc.(Ill.), M.Sc.(Johns Hop.), Ph.D.(Wash.)

D. Straub; B.Sc., M.Sc.(SW Louisiana), Ph.D.(Wash.)

B. Tremblay; B.Sc., M.Sc.(Car.), Ph.D.(McG.)

#### Assistant Professors

C. Dufour; B.Eng.(ISITV, France), M.Sc.(Sud Toulon-Var), Ph.D.(Grenoble)

T. Merlis; B.Sc.(Col.), Ph.D.(Calif. Tech.)

T. Preston; B.Sc.(Tor.), M.Sc.(W. Ont.), Ph.D.(Br. Col.) (*joint appt. with Chemistry*)

A. Zuend; Ph.D.(ETH Zurich)

#### Adjunct Professors

L. Barrie; Ph.D.(Goethe)

G. Brunet; Ph.D.(McG.)

A.P. Dastoor; Ph.D.(Indian IT)

**Adjunct Professors**

L. Fillion; Ph.D.(McG.)

P. Kollias; Ph.D.(Miami)

H. Lin; Ph.D.(McG.)

L.-P. Nadeau; Ph.D.(McG.)

**13.3.4 Bachelor of Science (B.Sc.) - Minor Atmospheric Science (18 credits)**

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

**Required Courses (3 credits)**

ATOC 214	(3)	Introduction: Physics of the Atmosphere
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**Complementary Courses (15 credits)**

3-6 credits selected from:

ATOC 215	(3)	Oceans, Weather and Climate
ATOC 219*	(3)	Introduction to Atmospheric Chemistry
CHEM 219*	(3)	Introduction to Atmospheric Chemistry

\* Note: Students may select ATOC 219 or CHEM 219 but not both.

**Complementary Course**

9-12 credits selected from:

ATOC 309	(3)	Weather Radars and Satellites
ATOC 312	(3)	Rotating Fluid Dynamics
ATOC 315	(3)	Thermodynamics and Convection
ATOC 357	(3)	Atmospheric and Oceanic Science Laboratory
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics

**13.3.5 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Atmospheric and Oceanic Sciences (48 credits)**

45-48 credits

**Required Courses (21 credits)**

ATOC 214	(3)	Introduction: Physics of the Atmosphere
ATOC 312	(3)	Rotating Fluid Dynamics
ATOC 315	(3)	Thermodynamics and Convection

MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations

**Complementary Courses (27 credits)**

24-27 credits:

Note: All students are encouraged to consult with the Undergraduate Adviser for help selecting from among the complementary courses.

3-6 credits selected from:

ATOC 215	(3)	Oceans, Weather and Climate
ATOC 219	(3)	Introduction to Atmospheric Chemistry

3 credits selected from:

ATOC 357	(3)	Atmospheric and Oceanic Science Laboratory
PHYS 257	(3)	Experimental Methods 1

3 credits selected from:

PHYS 230	(3)	Dynamics of Simple Systems
PHYS 251	(3)	Honours Classical Mechanics 1

3 credits selected from:

PHYS 232	(3)	Heat and Waves
PHYS 253	(3)	Thermal Physics

12-16 credits selected from (at least 6 of which must be ATOC):

ATOC 309	(3)	Weather Radars and Satellites
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
ATOC 546	(1)	Current Weather Discussion
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
COMP 208	(3)	Computers in Engineering
MATH 203	(3)	Principles of Statistics 1

MATH 319	(3)	Introduction to Partial Differential Equations
PHYS 333	(3)	Thermal and Statistical Physics
PHYS 340	(3)	Majors Electricity and Magnetism

### 13.3.6 Bachelor of Science (B.Sc.) - Major Atmospheric Science (62 credits)

#### Required Courses (24 credits)

ATOC 214	(3)	Introduction: Physics of the Atmosphere
ATOC 312	(3)	Rotating Fluid Dynamics
ATOC 315	(3)	Thermodynamics and Convection
COMP 208	(3)	Computers in Engineering
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations

#### Complementary Courses (38 credits)

36-38 credits

Note: Students are required to fulfill the core complementary requirements along with one of the four streams listed below. In cases of overlap, each course can only be used once toward the satisfaction of the core complementary courses or the chosen stream.

#### Core (21 credits)

3-6 credits selected from:

ATOC 215	(3)	Oceans, Weather and Climate
ATOC 219*	(3)	Introduction to Atmospheric Chemistry
CHEM 219*	(3)	Introduction to Atmospheric Chemistry

\* Note: students may select ATOC 219 or CHEM 219 but not both.

3 credits selected from:

ATOC 357	(3)	Atmospheric and Oceanic Science Laboratory
PHYS 257	(3)	Experimental Methods 1

3 credits selected from:

PHYS 230	(3)	Dynamics of Simple Systems
PHYS 251	(3)	Honours Classical Mechanics 1

3 credits selected from:

PHYS 232	(3)	Heat and Waves
PHYS 253	(3)	Thermal Physics

6-9 credits selected from:

CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
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CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 367	(3)	Instrumental Analysis 1
CHEM 575	(3)	Chemical Kinetics
MATH 203*	(3)	Principles of Statistics 1
MATH 317	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 323	(3)	Probability
MATH 324*	(3)	Statistics
PHYS 333	(3)	Thermal and Statistical Physics
PHYS 340**	(3)	Majors Electricity and Magnetism
PHYS 342***	(3)	Majors Electromagnetic Waves
PHYS 350**	(3)	Honours Electricity and Magnetism
PHYS 352***	(3)	Honours Electromagnetic Waves

\* Students cannot receive credit for both MATH 203 and MATH 324.

\*\* Students cannot receive credit for both PHYS 340 and PHYS 350.

\*\*\* Students cannot receive credit for both PHYS 342 and PHYS 352.

### Weather Analysis and Forecasting Stream (17 credits)

(16-17 credits)

13 credits from:

ATOC 309	(3)	Weather Radars and Satellites
ATOC 521	(3)	Cloud Physics
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
ATOC 546	(1)	Current Weather Discussion

3-4 credits selected from:

ATOC 404+	(3)	Climate Physics
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 531	(3)	Dynamics of Current Climates
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
GEOG 322	(3)	Environmental Hydrology
GEOG 372	(3)	Running Water Environments
MATH 555++	(4)	Fluid Dynamics
PHYS 404+	(3)	Climate Physics
PHYS 432++	(3)	Physics of Fluids

+ Students cannot receive credit for both ATOC 404 and PHYS 404.

++ Students cannot receive credit for both PHYS 432 or MATH 555.

### **Climate Science Stream (15 credits)**

6 credits from:

ATOC 404+	(3)	Climate Physics
ATOC 531	(3)	Dynamics of Current Climates
PHYS 404+	(3)	Climate Physics

+ Students cannot receive credit for both ATOC 404 and PHYS 404.

9 credits (at least 6 of which must be ATOC) selected from:

ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
EPSC 513	(3)	Climate and the Carbon Cycle
EPSC 542	(3)	Chemical Oceanography
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
GEOG 322	(3)	Environmental Hydrology
GEOG 372	(3)	Running Water Environments
MATH 323	(3)	Probability

### **Atmospheric Chemistry and Physics Stream (15 credits)**

15 credits from:

ATOC 309	(3)	Weather Radars and Satellites
ATOC 404+	(3)	Climate Physics
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
PHYS 404+	(3)	Climate Physics

+ Students cannot receive credit for both ATOC 404 and PHYS 404.

### **General Stream (17 credits)**

15-17 credits (at least 12 of which must be ATOC) selected from:

ATOC 309	(3)	Weather Radars and Satellites
ATOC 404+	(3)	Climate Physics

ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
ATOC 546	(1)	Current Weather Discussion
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 575	(3)	Chemical Kinetics
EPSC 513	(3)	Climate and the Carbon Cycle
EPSC 542	(3)	Chemical Oceanography
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
GEOG 322	(3)	Environmental Hydrology
GEOG 372	(3)	Running Water Environments
MATH 555++	(4)	Fluid Dynamics
PHYS 404+	(3)	Climate Physics
PHYS 432++	(3)	Physics of Fluids

+ Students cannot receive credit for ATOC 404 and PHYS 404.

++ Students cannot receive credit for both PHYS 432 or MATH 555.

### 13.3.7 Bachelor of Science (B.Sc.) - Major Atmospheric Science and Physics (69 credits)

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

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

#### Required Courses (57 credits)

ATOC 214	(3)	Introduction: Physics of the Atmosphere
ATOC 215	(3)	Oceans, Weather and Climate
ATOC 309	(3)	Weather Radars and Satellites
ATOC 312	(3)	Rotating Fluid Dynamics
ATOC 315	(3)	Thermodynamics and Convection
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
PHYS 230	(3)	Dynamics of Simple Systems
PHYS 232	(3)	Heat and Waves

PHYS 241	(3)	Signal Processing
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 331	(3)	Topics in Classical Mechanics
PHYS 333	(3)	Thermal and Statistical Physics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 446	(3)	Majors Quantum Physics

**Complementary Course (12 credits)**

At least 6 of the 12 complementary credits must come from ATOC courses.

ATOC 357	(3)	Atmospheric and Oceanic Science Laboratory
ATOC 404*	(3)	Climate Physics
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 404*	(3)	Climate Physics
PHYS 432	(3)	Physics of Fluids
PHYS 434	(3)	Optics
PHYS 439	(3)	Majors Laboratory in Modern Physics
PHYS 449	(3)	Majors Research Project

\* Students cannot take both ATOC 404 and PHYS 404.

**13.3.8 Bachelor of Science (B.Sc.) - Honours Atmospheric Science (74 credits)**

72-74 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 3.30. Students having completed a U1 year in a different program with high standing may be admitted to the Honours program on the recommendation of that department.

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

**Required Courses (27 credits)**

ATOC 214	(3)	Introduction: Physics of the Atmosphere
ATOC 312	(3)	Rotating Fluid Dynamics
ATOC 315	(3)	Thermodynamics and Convection
ATOC 480	(3)	Honours Research Project

COMP 208	(3)	Computers in Engineering
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations

**Complementary Courses (47 credits)**

45-47 credits

Note: Students are required to fulfill the core complementary requirements along with one of the four streams listed below. In cases of overlap, each course can only be used once toward the satisfaction of the core complementary courses or the chosen stream.

**Core (24 credits)**

3-6 credits selected from:

ATOC 215	(3)	Oceans, Weather and Climate
ATOC 219*	(3)	Introduction to Atmospheric Chemistry
CHEM 219*	(3)	Introduction to Atmospheric Chemistry

\* Students may take ATOC 219 or CHEM 219 but not both.

3 credits selected from:

ATOC 357	(3)	Atmospheric and Oceanic Science Laboratory
PHYS 257	(3)	Experimental Methods 1

3 credits selected from:

PHYS 230	(3)	Dynamics of Simple Systems
PHYS 251	(3)	Honours Classical Mechanics 1

3 credits selected from:

PHYS 232	(3)	Heat and Waves
PHYS 253	(3)	Thermal Physics

3 credits selected from:

CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
MATH 319	(3)	Introduction to Partial Differential Equations

6-9 credits selected from:

CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 367	(3)	Instrumental Analysis 1
CHEM 575	(3)	Chemical Kinetics
MATH 203*	(3)	Principles of Statistics 1
MATH 317	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations

MATH 323	(3)	Probability
MATH 324	(3)	Statistics
PHYS 333	(3)	Thermal and Statistical Physics
PHYS 340**	(3)	Majors Electricity and Magnetism
PHYS 342***	(3)	Majors Electromagnetic Waves
PHYS 350**	(3)	Honours Electricity and Magnetism
PHYS 352***	(3)	Honours Electromagnetic Waves

\* Students cannot receive credit for both MATH 203 and MATH 324.

\*\* Students cannot receive credit for both PHYS 340 and PHYS 350.

\*\*\* Students cannot receive credit for both PHYS 342 and PHYS 352.

### **Weather Analysis and Forecasting Stream (23 credits)**

(22-23 credits)

16 credits from:

ATOC 309	(3)	Weather Radars and Satellites
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 521	(3)	Cloud Physics
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
ATOC 546	(1)	Current Weather Discussion

6-7 credits selected from:

ATOC 404+	(3)	Climate Physics
ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 531	(3)	Dynamics of Current Climates
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
MATH 555++	(4)	Fluid Dynamics
PHYS 404+	(3)	Climate Physics
PHYS 432++	(3)	Physics of Fluids

+ Students cannot receive credit for both ATOC 404 and PHYS 404.

++ Students cannot receive credit for both PHYS 432 or MATH 555.

### **Climate Science Stream (22 credits)**

(21-22 credits)

15 credits from:

ATOC 404+	(3)	Climate Physics
ATOC 512	(3)	Atmospheric and Oceanic Dynamics

ATOC 531	(3)	Dynamics of Current Climates
MATH 323	(3)	Probability
MATH 324	(3)	Statistics
PHYS 404+	(3)	Climate Physics

+ Students cannot receive credit for both ATOC 404 and PHYS 404.

Students cannot receive credit for both MATH 203 and MATH 324.

6-7 credits (3 of which must be ATOC) selected from:

ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
EPSC 513	(3)	Climate and the Carbon Cycle
EPSC 542	(3)	Chemical Oceanography
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
MATH 423	(3)	Regression and Analysis of Variance
MATH 555++	(4)	Fluid Dynamics
PHYS 432++	(3)	Physics of Fluids

+ Students cannot receive credit for both PHYS 432 or MATH 555.

### Atmospheric Chemistry and Physics Stream (21 credits)

15 credits from:

ATOC 309	(3)	Weather Radars and Satellites
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods

6 credits selected from:

ATOC 404+	(3)	Climate Physics
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 558	(3)	Numerical Methods and Laboratory

CHEM 367	(3)	Instrumental Analysis 1
CHEM 575	(3)	Chemical Kinetics
EPSC 513	(3)	Climate and the Carbon Cycle
EPSC 542	(3)	Chemical Oceanography
MATH 423	(3)	Regression and Analysis of Variance
PHYS 404+	(3)	Climate Physics

+ Student cannot receive credit for both ATOC 404 and PHYS 404.

### General Stream (22 credits)

21-22 credits (at least 15 of which must be ATOC) selected from:

ATOC 309	(3)	Weather Radars and Satellites
ATOC 404+	(3)	Climate Physics
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
ATOC 546	(1)	Current Weather Discussion
ATOC 558	(3)	Numerical Methods and Laboratory
ATOC 568	(3)	Ocean Physics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 575	(3)	Chemical Kinetics
EPSC 513	(3)	Climate and the Carbon Cycle
EPSC 542	(3)	Chemical Oceanography
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
MATH 423	(3)	Regression and Analysis of Variance
MATH 555++	(4)	Fluid Dynamics
PHYS 404+	(3)	Climate Physics
PHYS 432++	(3)	Physics of Fluids

+ Students cannot receive credit for both ATOC 404 and PHYS 404.

++ Students cannot receive credit for both PHYS 432 or MATH 555.

### 13.3.9 Diploma (Dip.) 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 or other appropriate disciplines, leading to a Diploma in Meteorology. The program is designed for students with little or no previous background in meteorology who wish to direct their experience to atmospheric or environmental applications, or who need to fulfil academic prerequisites in meteorology to qualify for employment. For further information, consult the Administrative Officer, Burnside Hall, Room 946.

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



**Required Courses (15 credits)**

ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 521	(3)	Cloud Physics
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2

**Complementary Courses (15 credits)**

6 credits selected from the courses below.

\* Students take either ATOC 519 or CHEM 519.

ATOC 309	(3)	Weather Radars and Satellites
ATOC 315	(3)	Thermodynamics and Convection
ATOC 519*	(3)	Advances in Chemistry of Atmosphere
CHEM 519*	(3)	Advances in Chemistry of Atmosphere

9 credits ordinarily selected from:

\* Students take either PHYS 432 or MATH 555.

ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
MATH 317	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 555*	(4)	Fluid Dynamics
PHYS 331	(3)	Topics in Classical Mechanics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 432*	(3)	Physics of Fluids

**13.3.10 Atmospheric and Oceanic Sciences (ATOC) Related Programs****13.3.10.1 Internship Year in Science (IYS)**

IYS is a pregraduate work experience program available to eligible students and normally taken between their U2 and U3 years. For more information, see [section 12: Science Internships and Field Studies](#).

The following programs are also available with an internship component:

- Major in Atmospheric Science
- Honours in Atmospheric Science

**13.3.10.2 Earth System Science Interdepartmental Major**

This program is offered by the Department of Atmospheric and Oceanic Sciences; Earth and Planetary Sciences; and Geography.

Students in the Department of Atmospheric and Oceanic Sciences interested in this program should contact Professor Bruno Tremblay ([bruno.tremblay@mcgill.ca](mailto:bruno.tremblay@mcgill.ca)). For more information, see [section 13.11: Earth System Science \(ESYS\)](#).

## 13.4 Biochemistry (BIOC)

### 13.4.1 Location

McIntyre Medical Building  
3655 Promenade Sir-William-Osler, Room 905  
Montreal QC H3G 1Y6  
Student Affairs Officer/Adviser, Christine Laberge  
Telephone: 514-398-2423  
Email: [christine.laberge@mcgill.ca](mailto:christine.laberge@mcgill.ca)  
Website: [www.mcgill.ca/biochemistry](http://www.mcgill.ca/biochemistry)

### 13.4.2 About Biochemistry

#### What is Biochemistry?

Biochemistry is the application of chemistry to the study of biological processes at the cellular and molecular level. It emerged as a distinct discipline around the beginning of the 20th century when scientists combined chemistry, physiology, and biology to investigate the chemistry of living systems.

- *The study of life in its chemical processes:* Biochemistry is both a life science and a chemical science—it explores the chemistry of living organisms and the molecular basis for the changes occurring in living cells. It uses the methods of chemistry, physics, molecular biology and immunology to study the structure and behaviour of the complex molecules found in biological material and the ways these molecules interact to form cells, tissues, and whole organisms. Biochemistry graduates are interested, for example, in mechanisms of brain function, cellular multiplication and differentiation, communication within and between cells and organs, and the chemical bases of inheritance and disease. The biochemistry student seeks to determine how specific molecules such as proteins, nucleic acids, lipids, vitamins, and hormones function in such processes. Particular emphasis is placed on regulation of chemical reactions in living cells.
- *An essential science:* Biochemistry has become the foundation for understanding all biological processes. It has provided explanations for the causes of many diseases in humans, animals, and plants. It can frequently suggest ways by which such diseases may be treated or cured.
- *A practical science:* Because biochemistry seeks to unravel the complex chemical reactions that occur in a wide variety of life forms, it provides the basis for practical advances in medicine, veterinary medicine, agriculture, and biotechnology. It underlies and includes such exciting new fields as molecular genetics and bioengineering. The knowledge and methods developed by biochemistry scientists are applied to in all fields of medicine, in agriculture, and in many chemical- and health-related industries. Biochemistry is also unique in providing teaching and research in both protein structure/function and genetic engineering, the two basic components of the rapidly expanding field of biotechnology.
- *A varied science:* As the broadest of the basic sciences, biochemistry includes many subspecialties such as neurochemistry, bioorganic chemistry, clinical biochemistry, physical biochemistry, molecular genetics, biochemical pharmacology, and immunochemistry. Recent advances in these areas have created links among technology, chemical engineering, and biochemistry.

The Department of Biochemistry offers three undergraduate programs:

- **Liberal Program**

This is the most flexible of departmental programs offered, providing students with a useful concentration in Biochemistry, while allowing them to pursue a minor in another speciality or to broaden their education in the sciences.

- **Major**

The Major program becomes more specialized in Biochemistry during the final two years. This program requires skills and insight from all areas of chemistry, and from other areas such as biology, physiology, microbiology and immunology, statistics, and pharmacology. For students aiming for a professional career in the biological sciences or in medicine, these programs can lead to postgraduate studies and research careers in hospital, university, or industrial laboratories.

- **Honours**

The Honours program in Biochemistry combines the substantial background given by the Major program with a challenging opportunity to carry out laboratory research projects in the U3 year. These courses provide students with research experience under the supervision of a professor in the Department. Honours students intending to pursue an M.Sc. in Biochemistry may be interested in the B.Sc./M.Sc. track, which offers a streamlined path to a graduate degree.

Our Major and Honours programs provide a sound background for students aiming for a professional career in biochemistry. The less specialized Liberal program allows students to select courses in other fields of interest. The Liberal program provides students with the opportunity to study the core of one science discipline along with a breadth component from another area of science or from many other disciplines; for more information, see [Faculty of Science > Undergraduate > Faculty Degree Requirements > Program Requirements > section 6.4.1: Liberal, Major, and Honours Programs](#).

During the first year, each program provides introductory lecture and laboratory courses in biochemistry, as well as basic courses in cell and molecular biology and organic and physical chemistry. In the second and third years, the programs offer an expanded focus in biochemistry through lecture courses, a second laboratory course in biochemistry, and opportunities to carry out research projects in faculty members' laboratories through our BIOC 396, BIOC 462 and BIOC 491 courses. Students can also take a variety of complementary courses in other biological, biomedical, and chemical disciplines in their second and third years.

Increasingly complex technology requires training in both chemistry and biology. As well, the combination of chemistry, molecular biology, enzymology, and genetic engineering in our programs provides the essential background and training in biotechnology. With this, our graduates can work in a variety of positions in industry and health. These range from R&D in the chemical and pharmaceutical industries, to testing and research in government and hospital laboratories, to management. Many graduates take higher degrees in research and attain academic positions in universities and colleges.

Additional information is available on the [Department of Biochemistry website](#).

### 13.4.3 Biochemistry Faculty

#### Chair

Albert Berghuis

#### Emeritus Professors

Rhoda Blostein; B.Sc., M.Sc., Ph.D.(McG.), F.R.S.C.

Philip E. Branton; B.Sc., M.Sc., Ph.D.(Tor.), F.R.S.C. (*Gilman Cheney Professor of Biochemistry*)

Peter E. Braun; B.Sc., M.Sc.(Br. Col.), Ph.D.(Calif., Berk.)

Robert E. MacKenzie; B.Sc.(Agr.)(McG.), M.N.S., Ph.D.(Cornell)

Edward A. Meighen; B.Sc.(Alta.), Ph.D.(Calif., Berk.)

Walter E. Mushynski; B.Sc., Ph.D.(McG.)

Gordon C. Shore; B.Sc.(Guelph), Ph.D.(McG.)

John R. Silvius; B.Sc., Ph.D.(Alta.)

Clifford P. Stanners; B.Sc.(McM.), M.A., Ph.D.(Tor.)

Maria Zannis-Hadjopoulos; B.Sc., M.Sc., Ph.D.(McG.) (*joint appt. with Oncology and Medicine*)

#### Professors

Nicole Beauchemin; B.Sc., M.Sc., Ph.D.(Montr.) (*joint appt. with Oncology and Medicine*)

Albert Berghuis; B.Sc., M.Sc.(Rijks Univ. Groningen, The Netherlands), Ph.D.(Br. Col.)

Maxime Bouchard; B.Sc., Ph.D.(Laval)

Imed Gallouzi; Maitrise, D.E.A., Ph.D.(Montpellier, France)

Kalle Gehring; B.A.(Brown), M.Sc.(Mich.), Ph.D.(Calif., Berk.) (*Chercheur National du FRSQ*)

Vincent Giguère; B.Sc., Ph.D.(Laval) (*joint appt. with Oncology and Medicine*)

Philippe Gros; B.Sc., M.Sc.(Montr.), Ph.D.(McG.), F.R.S.C. (*James McGill Professor*)

Alba Guarné; B.Sc., M.Sc., Ph.D.(Barcelona)

Roderick R. McInnes; B.Sc., M.D.(Dal.), Ph.D.(McG.)

William Muller; B.Sc., Ph.D.(McG.) (*Canada Research Chair in Molecular Oncology*)

Alain Nepveu; B.Sc., M.Sc.(Montr.), Ph.D.(Sher.) (*James McGill Professor*) (*joint appt. with Oncology and Medicine*)

Morag Park; B.Sc., Ph.D.(Glas.), F.R.S.C. (*Diane and Sal Guerrero Chair in Cancer Genetics*) (*James McGill Professor*) (*joint appt. with Oncology and Medicine*)

Arnim Pause; B.Sc., M.Sc.(Konstanz), Ph.D.(McG.)

Jerry Pelletier; B.Sc., Ph.D.(McG.) (*James McGill Professor*)

Nahum Sonenberg; M.Sc., Ph.D.(Weizmann Inst.), F.R.S.C., F.R.S. (*James McGill Professor*) (*Gilman Cheney Chair in Biochemistry*)

David Y. Thomas; B.Sc.(Brist.), M.Sc., Ph.D.(Univ. College, Lond.), F.R.S.C. (*Canada Research Chair in Molecular Genetics*)

Michel L. Tremblay; B.Sc., M.Sc.(Sher.), Ph.D.(McM.), F.R.S.C. (*Jeanne and Jean-Louis Levesque Chair in Cancer Research*)

#### Associate Professors

Josée Dostie; B.Sc.(Sher.), Ph.D.(McG.) (*CIHR New Investigators Award; Chercheure-boursière du FRSQ*)

Thomas Duchaine; B.Sc., Ph.D.(Montr.) (*Chercheur-boursier du FRSQ*)

Bhushan Nagar; B.Sc., Ph.D.(Tor.)

Martin Schmeing; B.Sc.(McG.), Ph.D.(Yale) (*Canada Research Chair in Macromolecular Machines*)

**Associate Professors**

Jose G. Teodoro; B.Sc.(W. Ont.), Ph.D.(McG.) (*CIHR New Investigators Award; Chercheur-boursier du FRSQ*)

Jason C. Young; B.Sc.(Tor.), Ph.D.(McM.)

**Assistant Professors**

Uri David Akavia; B.Sc., M.Sc., Ph.D.(Tel Aviv)

Maxime Denis; B.Sc., Ph.D.(Montr.)

Sidong Huang; B.A.(Boston), Ph.D.(Calif.) (*Canada Research Chair in Functional Genomics*)

Lawrence Kazak; Ph.D.(Camb.)

William Pastor; Ph.D.(Harv.)

Ian Watson; B.Sc., Ph.D.(Tor.) (*Canada Research Chair in Functional Genomics of Melanoma*)

**Associate Members**

Gary Brouhard (*Dept. of Biology*)

Robert S. Kiss (*Dept. of Medicine*)

Gergely Lukacs (*Dept. of Physiology*)

Janusz Rak (*Dept. of Medicine*)

Stéphane Richard (*Depts. of Medicine and Oncology*)

Selena M. Sagan (*Dept. of Microbiology & Immunology*)

Reza Salavati (*Inst. of Parasitology*)

Maya Saleh (*Dept. of Medicine*)

Erwin Schurr (*Ctr. for Host Resistance, MGH*)

Peter Siegel (*Goodman Cancer Ctr., Dept. of Medicine*)

Ivan Topisirovic (*Dept. of Oncology*)

Youla S. Tsantrizos (*Dept. of Chemistry*)

Bernard Turcotte (*Dept. of Medicine*)

Josie Ursini-Siegel (*Dept. of Oncology*)

Simon Wing (*Dept. of Medicine*)

Xiang-Jiao Yang (*Goodman Cancer Ctr., Dept. of Medicine*)

**Adjunct Professors**

Mirek Cygler (*Sask.*)

Jacques Drouin (*IRCM*)

Matthias Götte (*Alta.*)

Michael Hallett (*C'dia, Dept. of Biology*)

Enrico Purisima (*NRC/BRI*)

Julie St-Pierre (*Ott.*)

**13.4.4 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Biochemistry (47 credits)****U1 Required Courses (23 credits)**

\* Students with CEGEP-level credit for CHEM 212 and/or CHEM 222 should replace these courses with elective courses.

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOC 220	(3)	Laboratory Methods in Biochemistry and Molecular Biology 1
BIOL 200	(3)	Molecular Biology

BIOL 202	(3)	Basic Genetics
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2

**U1 Complementary Courses\*\* (6 credits)**

\*\* Complementary courses listed for U1 and U2 may be taken in later years if necessary to accommodate courses that must be taken in U1 and U2 as part of the breadth component of the program.

6 credits selected from:

BIOL 205	(3)	Biology of Organisms
MIMM 211	(3)	Introductory Microbiology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

**U2 Required Courses (12 credits)**

BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 320	(3)	Laboratory Methods in Biochemistry and Molecular Biology 2
CHEM 302	(3)	Introductory Organic Chemistry 3

**U2 Complementary Courses\*\* (3 credits)**

\*\* Complementary courses listed for U1 and U2 may be taken in later years if necessary to accommodate courses that must be taken in U1 and U2 as part of the breadth component of the program.

3 credits selected from:

BIOL 373	(3)	Biometry
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 297	(1)	Introductory Analytical Chemistry Laboratory
COMP 202	(3)	Foundations of Programming
MATH 203	(3)	Principles of Statistics 1
MATH 222	(3)	Calculus 3
PSYC 204	(3)	Introduction to Psychological Statistics

**U3 Complementary Courses (3 credits)**

3 credits selected from:

BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids

**13.4.5 Bachelor of Science (B.Sc.) - Major Biochemistry (64 credits)**

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

**U1 Required Courses (23 credits)**

\* Note: Students with CEGEP-level credit for the equivalents of CHEM 212 and/or CHEM 222 (see <http://www.mcgill.ca/students/courses/plan/transfer/> for accepted equivalents) may not take these courses at McGill and should replace them with elective courses to satisfy the total credit requirement for their degree.

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOC 220	(3)	Laboratory Methods in Biochemistry and Molecular Biology 1
BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2

**U1 Complementary Courses (6 credits)**

6 credits selected from:

BIOL 205	(3)	Biology of Organisms
MIMM 211	(3)	Introductory Microbiology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

**U2 Required Courses (20 credits)**

ANAT 262	(3)	Introductory Molecular and Cell Biology
BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 320	(3)	Laboratory Methods in Biochemistry and Molecular Biology 2
CHEM 214	(3)	Physical Chemistry/Biological Sciences 2
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 362	(2)	Advanced Organic Chemistry Laboratory

**U2 Complementary Courses (3 credits)**

3 credits selected from:

BIOL 309	(3)	Mathematical Models in Biology
BIOL 373	(3)	Biometry
CHEM 267	(3)	Introductory Chemical Analysis
COMP 202	(3)	Foundations of Programming
MATH 203	(3)	Principles of Statistics 1
MATH 222	(3)	Calculus 3
PSYC 204	(3)	Introduction to Psychological Statistics

**U3 Required Courses (6 credits)**

BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids

**U3 Complementary Courses (6 credits)**

3-6 credits selected from:

BIOC 458	(3)	Membranes and Cellular Signaling
BIOC 470	(3)	Lipids and Lipoproteins in Disease
BIOC 491	(6)	Independent Research
BIOC 503	(3)	Immunochemistry
PSYT 455	(3)	Neurochemistry

The remainder, if any, to be selected from the following list:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 304	(3)	Evolution
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 482	(3)	Organic Chemistry: Natural Products
CHEM 502	(3)	Advanced Bio-Organic Chemistry
CHEM 532	(3)	Structural Organic Chemistry
CHEM 552	(3)	Physical Organic Chemistry
CHEM 572	(3)	Synthetic Organic Chemistry
EXMD 502	(3)	Advanced Endocrinology 1
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
MIMM 324	(3)	Fundamental Virology
PHAR 300	(3)	Drug Action
PHGY 311	(3)	Channels, Synapses and Hormones

### 13.4.6 Bachelor of Science (B.Sc.) - Honours Biochemistry (73 credits)

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

Students seeking admission to the Honours program must obtain permission from the Departmental Student Affairs Officer, Christine Laberge (christine.laberge@mcgill.ca), during the Add/Drop period in September of their second year.

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

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

#### U1 Required Courses (23 credits)

\* Note: Students with CEGEP-level credit for the equivalents of CHEM 212 and/or CHEM 222 (see <http://www.mcgill.ca/students/courses/plan/transfer/> for accepted equivalents) may not take these courses at McGill and should replace them with elective courses to satisfy the total credit requirement for their degree.

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOC 220	(3)	Laboratory Methods in Biochemistry and Molecular Biology 1
BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2

**U1 Complementary Courses (6 credits)**

6 credits selected from:

BIOL 205	(3)	Biology of Organisms
MIMM 211	(3)	Introductory Microbiology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

**U2 Required Courses (20 credits)**

ANAT 262	(3)	Introductory Molecular and Cell Biology
BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 320	(3)	Laboratory Methods in Biochemistry and Molecular Biology 2
CHEM 214	(3)	Physical Chemistry/Biological Sciences 2
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 362	(2)	Advanced Organic Chemistry Laboratory

**U2 Complementary Courses (3 credits)**

3 credits selected from:

BIOL 309	(3)	Mathematical Models in Biology
BIOL 373	(3)	Biometry
CHEM 267	(3)	Introductory Chemical Analysis
COMP 202	(3)	Foundations of Programming
MATH 203	(3)	Principles of Statistics 1
MATH 222	(3)	Calculus 3
PSYC 204	(3)	Introduction to Psychological Statistics

**U3 Required Courses (15 credits)**

BIOC 404	(3)	Biophysical Methods in Biochemistry
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
BIOC 462	(6)	Research Laboratory in Biochemistry

**U3 Complementary Courses (6 credits)**

3-6 credits selected from:

BIOC 458	(3)	Membranes and Cellular Signaling
BIOC 470	(3)	Lipids and Lipoproteins in Disease
BIOC 491	(6)	Independent Research



BIOC 503	(3)	Immunochemistry
PSYT 455	(3)	Neurochemistry

The remainder, if any, to be selected from the following list:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 304	(3)	Evolution
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 482	(3)	Organic Chemistry: Natural Products
CHEM 502	(3)	Advanced Bio-Organic Chemistry
CHEM 532	(3)	Structural Organic Chemistry
CHEM 552	(3)	Physical Organic Chemistry
CHEM 572	(3)	Synthetic Organic Chemistry
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
MIMM 324	(3)	Fundamental Virology
PHAR 300	(3)	Drug Action
PHGY 311	(3)	Channels, Synapses and Hormones

### 13.4.7 Biochemistry (BIOC) Related Programs

#### 13.4.7.1 Interdepartmental Honours in Immunology

For more information, see [section 13.18: Immunology](#). This program is offered by the Departments of Biochemistry, Microbiology and Immunology, and Physiology.

Students interested in the program should contact:

Dr. C. Piccirillo  
Microbiology and Immunology  
Telephone: 514-934-1934, ext. 76143  
Email: [ciro.piccirillo@mcgill.ca](mailto:ciro.piccirillo@mcgill.ca)

OR

Dr. Monroe Cohen  
Physiology  
Telephone: 514-398-4342  
Email: [monroe.cohen@mcgill.ca](mailto:monroe.cohen@mcgill.ca)

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## 13.5 Biology (BIOL)

### 13.5.1 Location

Stewart Biology Building, Room N7/9B  
1205 avenue Docteur Penfield  
Montreal QC H3A 1B1

Telephone: 514-398-4109  
Fax: 514-398-5069  
Website: [biology.mcgill.ca](http://biology.mcgill.ca)

### 13.5.2 About Biology

Biology is the study of living things at the molecular, cellular, organismal, and ecosystem 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 individual molecules within it;
- molecular basis of inheritance;
- biochemical and genetic basis of human diseases; and
- how the brain and the nervous system control behaviour.

The study of biology also has vast practical applications. The knowledge, methods, and concepts developed through research in the various fields of biology are applied extensively in agriculture, medicine, pharmaceutical development, biotechnology, genetic engineering, environmental protection, and wildlife management.

The Department of Biology offers:

- **Liberal** program;
- **Major** program;
- **Joint Majors** with Computer Science and with Mathematics;
- **Honours** program;
- **Joint Honours** with Computer Science;
- **Minor** program;
- **Minor** in Biotechnology;
- **Minor concentration** in Science for Arts students;
- Biology **Major** and **Honours option** in Quantitative Biology;
- as well as **Major** and **Minor concentrations** in the B.A. & Sc.

The programs in Biology provide you with an introduction to the broad spectrum of Biological Sciences in contrast to more specialized programs in Biochemistry, Microbiology, Pharmacology, Physiology, and Anatomy and Cell Biology. The B.Sc. degree in Biology prepares you for a wide range of employment opportunities as well as entry to professional schools in medicine, veterinary science, dentistry, agriculture, nursing, education, and library science. It also provides solid background for those interested in careers related to environmental protection, wildlife management, biotechnology, and genetic engineering. The 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's well-equipped research laboratories are located in the Stewart Biology Building, 1205 Docteur Penfield Avenue and in the adjacent Bellini Life Sciences Building. Due to massive renovations that began in the Fall of 2017, only the North Wing of the Stewart Building is currently in use and freshman biology labs have temporarily moved into the Duff Medical Building. The Department includes many biologists who are international leaders in their research fields, but who nevertheless remain deeply committed to undergraduate education. We have outstanding infrastructure for cell, developmental, and neurobiology research, and extensive links to biomedical scientists throughout McGill and all over the world. Our ecology and evolutionary biology group is also internationally prominent and dedicated to studying aquatic and terrestrial ecosystems.

Our core undergraduate program will expose you to the broad areas of biology at all of these levels of complexity. At the same time you will be able to focus on topics related to your specific interests through complementary and elective courses. Beyond the large introductory classes, our class sizes are relatively small and you will have lots of opportunities for contact with your instructors; this is one of our strengths! Biology's teaching and research resources are extended by affiliation with the Redpath Museum, the hospitals and research institutes of the McGill University Health Centre, the Montreal Neurological Institute, the Sheldon Biotechnology Institute, and the Smithsonian Tropical Research Institute in Panama. Field courses enable you to study biology in a natural setting, in local ecosystems (e.g., at McGill's Gault Nature Reserve), and in distant ones such as Barbados, Panama, and East Africa. The Biology Department is also deeply committed to providing individual research experiences to its undergraduates. U2- and U3-level students, not just Honours program students, can carry out semester- or year-long independent study projects for course credit in Biology department research labs. Numerous summer opportunities are also available.

Undergraduate students are represented by the MBSU (McGill Biology Students Union) in the Departmental Assembly and in Standing Committees.

Our Bluebook provides more detailed information on our programs and courses than can fit in the University Calendar. The Bluebook can be downloaded or viewed at [biology.mcgill.ca/undergrad/bluebook.html](http://biology.mcgill.ca/undergrad/bluebook.html). We hope you find it useful!

Inquiries about undergraduate programs should be directed to:

Student Affairs Office

Stewart Biology Building, Room N7/9B  
 Telephone: 514-398-4109  
 Email: [nancy.nelson@mcgill.ca](mailto:nancy.nelson@mcgill.ca)  
 Website: [biology.mcgill.ca/undergrad/bscprog.html](http://biology.mcgill.ca/undergrad/bscprog.html)



**Note to those interested in the B.A. & Sc. program:** Two major concentrations in Biology as well as two minor concentrations in Biology (Organismal and Cell/Molecular Options) are available to students pursuing the B.A. & Sc. degree. These major concentrations are described in [Bachelor of Arts and Science > Undergraduate > Browse Academic Units & Programs > : Biology \(BIOL\)](#).

### 13.5.3 Preprogram Requirements

Requirements for the Major and Honours programs in Biology are:

- two courses in elementary Biology;
- two courses in general Chemistry;
- two courses in Mathematics (as per the Freshman requirements);
- two courses in Physics (mechanics and electromagnetism).

Students entering the B.A. & Sc., the Liberal program, and the Biology Science Minor have the same biology, chemistry, and mathematics requirements. The physics requirements will vary according to their future direction. Note that satisfying the minimum Freshman science requirements does not necessarily qualify students for medical or dental school admissions requirements.

Students planning to take one of the joint majors or the Quantitative Biology Major or Honours options should consult:

Undergraduate Adviser  
 Stewart Biology Building, Room N7/9B  
 Telephone: 514-398-4109

to ensure they are taking the appropriate prerequisites.

### 13.5.4 Biology Concentrations



**Note:** The concentrations set out below are only guidelines for specialized training. *They do not constitute sets of requirements.*



**Note:** *Courses used to satisfy the complementary course components of the Major program must be at the 300+ level. Any 200 level courses listed below must be taken as electives.*



**Note:** Please see guidelines and policies for taking courses outside Arts and Science at [www.mcgill.ca/science/student/continuingstudents/bsc/outside](http://www.mcgill.ca/science/student/continuingstudents/bsc/outside).

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, key and suggested courses are listed by discipline.

#### 13.5.4.1 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; and others on evolutionary origins.

**Key courses:** BIOL 304, BIOL 305, BIOL 306, BIOL 307, BIOL 320, BIOL 331, or BIOL 334D1/D2 or another field course with a significant behavioural component, BIOL 373, BIOL 507.

**Other suggested courses:** BIOL 377, BIOL 466, BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2.

Most courses from the fields of behaviour, ecology, and evolutionary biology will be relevant for this concentration. Some courses that focus on a particular taxonomic group such as birds (Natural Resource Sciences WILD 420), amphibians and reptiles (BIOL 427), and marine mammals (BIOL 335) include a significant amount of information on behaviour.

#### 13.5.4.2 Biological Diversity and Systematics

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

**Key courses:** BIOL 304, BIOL 305, BIOL 373.

**Other suggested courses:** BIOL 240, BIOL 310, BIOL 320, BIOL 324, BIOL 331, BIOL 334D1/D2, BIOL 335, BIOL 342, BIOL 350/ENTO 350, BIOL 352, BIOL 377, BIOL 418, BIOL 427, BIOL 428, BIOL 429, BIOL 463, BIOL 465, BIOL 466 or BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, BIOL 515, BIOL 540, BIOL 569, BIOL 573, BIOL 594, REDM 400, REDM 405.

**Macdonald campus:** PLNT 358, WILD 307, WILD 350, WILD 420, WILD 424.

### 13.5.4.3 Conservation Biology Concentration

Conservation biology is the study and protection of biological diversity. It is a scientific discipline closely connecting ecology and evolutionary biology with applications in public policy and management. Conservation biology focuses on keeping normal evolutionary processes working within a functional ecological context and deals with issues of how the wide variety of organisms and ecosystems can be maintained and prevented from declining. It considers population and habitat viability and complexity in the face of threats and perturbations. Cognizance of biological diversity, knowledge, expertise in both ecology and evolutionary biology, and appreciation for the political, social, and economic contexts of the biodiversity crisis underlie all work in conservation biology.

**Key courses:** BIOL 308, BIOL 310, BIOL 373, BIOL 465, plus at least one of the following field courses: BIOL 331 or BIOL 334D1/D2 or BIOL 335 or BIOL 428 or BIOL 429 or BIOL 553.

**Other suggested courses:** BIOL 304, BIOL 305, BIOL 307, BIOL 324, BIOL 342, BIOL 350, BIOL 377, BIOL 413, BIOL 427, BIOL 466, BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, BIOL 510, BIOL 515, BIOL 540, BIOL 594, ECON 225, ECON 326, GEOG 470, REDM 400.

**Macdonald campus:** PLNT 358, WILD 350, WILD 420, WILD 421.

### 13.5.4.4 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 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 modeling. 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 BIOL 331 and/or other field courses should be considered as vital to all concentrations in this area.

#### 13.5.4.4.1 General and Applied Ecology Concentration

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

**Key courses:** BIOL 305, BIOL 308, BIOL 331 or BIOL 334D1/D2, BIOL 342, BIOL 350, BIOL 373, COMP 204, COMP 273.

**Other suggested courses:** BIOL 307, BIOL 324, BIOL 377, BIOL 418, BIOL 427, BIOL 428, BIOL 429, BIOL 432, BIOL 441, BIOL 465, BIOL 466, BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, BIOL 510, BIOL 515, BIOL 540, BIOL 594, GEOG 302, REDM 405.

**Macdonald campus:** PLNT 460.

#### 13.5.4.4.2 Aquatic Ecology Concentration

This concentration is designed to introduce the principles of ecology as they pertain to aquatic ecosystems and aquatic biota. Since it is essential to know how knowledge is obtained, as well as what has been learned, one of the courses (Limnology) involves field work, and one (Biological Oceanography) involves a laboratory component; these courses stress the techniques used to study aquatic ecology. In addition, the concentration includes a field course in ecology. There are also a variety of courses in aquatic disciplines offered in other departments that complement the Biology Department's aquatic ecology courses.

**Key courses:** BIOL 305, BIOL 308, BIOL 331 or another field course, BIOL 342, BIOL 373, BIOL 418, BIOL 427, BIOL 432 (or ENVB 315), BIOL 441, BIOL 465, BIOL 515, COMP 204, COMP 273.

**Other suggested courses:** BIOL 307, BIOL 429, BIOL 466, BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, BIOL 540, GEOG 305, GEOG 306, GEOG 308, GEOG 322, REDM 405.

#### 13.5.4.4.3 Marine Biology Concentration

This concentration is designed to offer students a broad introduction to marine biology and marine ecology, which will form the basis for graduate studies in these fields or for employment in aquatic biology and oceanography.

**Key courses:** BIOL 305, BIOL 308, BIOL 335, BIOL 342, BIOL 373, BIOL 441, BIOL 515.

**Other suggested courses:** ATOC 512, ATOC 550, BIOL 331, BIOL 334D1/D2, BIOL 418, BIOL 429, BIOL 432, BIOL 465, BIOL 540, EPSC 542.

For students intending to proceed to graduate work, one independent studies course (BIOL 466, BIOL 467, BIOL 468D1/D2, or BIOL 469D1/D2) is recommended. Because of the importance of numerical analyses in all fields of ecology, courses in Biometry (*e.g.*, BIOL 373) and Computer Science (COMP 202 or COMP 273) are recommended.

### 13.5.4.5 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:** BIOL 304, BIOL 305, BIOL 307, BIOL 320, BIOL 324, BIOL 331, BIOL 352, BIOL 373, BIOL 377, BIOL 463, BIOL 466 or BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, BIOL 569, BIOL 573, BIOL 594.

**Other suggested courses in Organismal Biology:** BIOL 335, BIOL 350, BIOL 427, BIOL 428, BIOL 463.

**Macdonald campus:** PLNT 358, WILD 420.

**Genetics and Development:** BIOL 300, BIOL 303.

**Ecology and Behaviour:** BIOL 309, BIOL 429, BIOL 507, BIOL 515, REDM 405.

#### 13.5.4.6 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:** BIOL 301, BIOL 370, BIOL 373, BIOL 416, BIOL 520, BIOL 568, BIOL 575.

**Other suggested courses:** BIOC 311, BIOL 314, BIOL 377, BIOL 466, BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, CHEM 203 or both CHEM 204 and CHEM 214, CHEM 222, HGEN 396, MIMM 314.

#### 13.5.4.7 Molecular Genetics and Development Concentration

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

**Key courses:** BIOL 300, BIOL 301, BIOL 303, BIOL 373, BIOL 569; CHEM 203 or CHEM 204 combined with CHEM 214, CHEM 212, CHEM 222.

**Other suggested courses:** BIOL 313, BIOL 314, BIOL 316, BIOL 370, BIOL 416, BIOL 466, BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, BIOL 518, BIOL 520, BIOL 524, BIOL 544, BIOL 546.

#### 13.5.4.8 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 that can range from the mundane (*e.g.*, regulation of heart rate) to the magnificent (*e.g.*, musical composition). The neurobiology discipline, 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 examining 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:** BIOL 306, BIOL 320, BIOL 373, BIOL 389, BIOL 507, BIOL 514, BIOL 530, BIOL 532, BIOL 580, BIOL 588.

**Other suggested courses:** ANAT 321, ANAT 322, BIOL 300, BIOL 303, BIOL 466, BIOL 467, BIOL 468D1/D2, BIOL 469D1/D2, NEUR 310, NSCI 200, NSCI 201, PHAR 562, PHGY 311, PHGY 314, PHGY 425, PHGY 451, PHGY 556, PSYC 311, PSYC 318, PSYC 342, PSYC 410, PSYC 470, PSYT 455, PSYT 500.

### 13.5.5 Biology Faculty

#### Chair

Gregor Fussmann

#### Graduate Program Director

Frédéric Guichard

#### Emeritus Professors

Gregory G. Brown; B.Sc.(Notre Dame), Ph.D.(CUNY)

A. Howard Bussey; B.Sc., Ph.D.(Brist.), F.R.S.C.

Robert L. Carroll; B.S.(Mich.), M.A., Ph.D.(Harv.), F.R.S.C.

Ronald Chase; A.B.(Stan.), Ph.D.(MIT)

Rajinder S. Dhindsa; B.Sc., M.Sc.(Punj.), Ph.D.(Wash.)

Jacob Kalf; M.S.A.(Tor.), Ph.D.(Ind.)

**Emeritus Professors**

Donald L. Kramer; B.Sc.(Boston Coll.), Ph.D.(Br. Col.)  
 Martin J. Lechowicz; B.A.(Mich. St.), M.S., Ph.D.(Wisc.)  
 John B. Lewis; B.Sc., M.Sc., Ph.D.(McG.)  
 Barid B. Mukherjee; B.Sc., M.Sc.(Calc.), M.Sc.(Brigham Young), Ph.D.(Utah)  
 Gerald S. Pollack; M.A., Ph.D.(Princ.)  
 Ronald Poole; B.Sc., Ph.D.(Birm.)  
 Derek Roff; F.R.S.C.  
 Rolf Sattler

**Professors**

Ehab Abouheif; M.Sc.(C'dia), Ph.D.(Duke)  
 Graham A.C. Bell; B.A., D.Phil.(Oxf.), F.R.S.C. (*James McGill Professor*) (*on sabbatical*)  
 Lauren Chapman; B.Sc.(Alta.), Ph.D.(McG.) (*Canada Research Chair in Respiratory Ecology and Aquatic Conservation*)  
 Gregor Fussmann; Dipl.(Berlin), Ph.D.(Max Planck)  
 Andrew Gonzalez; B.Sc.(Nott.), Ph.D.(Imperial Coll., Lond.) (*Canada Research Chair in Biodiversity Science*) (*on sabbatical*)  
 Frédéric Guichard; B.Sc.(Montr.), Ph.D.(Laval)  
 Siegfried Hekimi; M.Sc., Ph.D.(Geneva) (*Strathcona Chair in Zoology; Robert Archibald & Catherine Louise Campbell Chair in Developmental Biology*)  
 Andrew Hendry; B.Sc.(Vic., BC), M.Sc., Ph.D.(Wash.) (*joint appt. with Redpath Museum*)  
 Paul F. Lasko; A.B.(Harv.), Ph.D.(MIT) (*James McGill Professor*) (*Associate Member in Anatomy and Cell Biology, the Goodman Cancer Centre*)  
 Louis Lefebvre; B.Sc., M.A., Ph.D.(Montr.)  
 Laura Nilson; B.A.(Colgate), Ph.D.(Yale)  
 Catherine Potvin; B.Sc., M.Sc.(Montr.), Ph.D.(Duke)  
 Neil M. Price; B.Sc.(New Br.), Ph.D.(Br. Col.)  
 Richard Roy; B.Sc.(Bishop's), Ph.D.(Laval) (*on sabbatical*)  
 Daniel J. Schoen; B.Sc., M.Sc.(Mich.), Ph.D.(Calif.) (*Macdonald Professor of Botany*) (*on sabbatical*)

**Associate Professors**

Gary Brouhard; M.S.E., Ph.D.(Mich.) (*Associate Member in Physics*)  
 Thomas E. Bureau; B.Sc.(Calif.), Ph.D.(Texas) (*on sabbatical*)  
 Melania Cristescu; B.Sc., M.Sc.(Ovidius Univ. Constanta, Romania), Ph.D.(Guelph)  
 David Dankort; B.Sc., Ph.D.(MeM.)  
 Joseph A. Dent; B.Sc.(Mich.), Ph.D.(Colo.)  
 Irene Gregory-Eaves; B.Sc.(Vic., BC), M.Sc., Ph.D.(Qu.)  
 Paul Harrison; B.Sc.(NUI), Ph.D.(Lond.)  
 Brian Leung; B.Sc.(Br. Col.), Ph.D.(Car.)  
 Nam-Sung Moon; B.Sc., Ph.D.(McG.)  
 Simon Reader; B.A.(Colgate), Ph.D.(Yale)  
 Jon Sakata; B.A.(Cornell), Ph.D.(Texas-Austin, Institute for Neuroscience) (*on sabbatical*)  
 Frieder Schoeck; Dipl.(Erhagen), Ph.D.(Max Planck)  
 Jacalyn Vogel; M.Sc.(E. Ill.), Ph.D.(Kansas)  
 Alanna Watt; B.Sc.(C'dia), Ph.D.(Brandeis)  
 Tamara Western; B.Sc.(Dal.), Ph.D.(Br. Col.) (*Associate Dean [Academic], Faculty of Science*)  
 Sarah Woolley; B.Sc.(Duke), Ph.D.(Texas-Austin) (*on sabbatical*)

**Associate Professors**

Monique Zetka; B.Sc., Ph.D.(Br. Col.)

Hugo Zheng; M.Sc.(Helsinki), Ph.D.(Oxf. Brookes)

**Assistant Professors**

Mélanie Guigueno; M.Sc.(Manit.), Ph.D.(Western) (*beginning Jan. 2019*)

Anna Hargreaves; B.Sc.(Trent), MSc.(Calg.), Ph.D.(Qu.)

Arnold Hayer; M.Sc.(ESBS, France), Ph.D.(ETH Zurich)

Michael Hendricks; B.A.(Bowdoin), Ph.D.(Sing.)

Tomoko Ohyama; B.Sc., M.Sc.(Keio), Ph.D.(Baylor)

Rodrigo Reyes Lamothe; Lic.(UNAM), M.Sc.(C' dia), D.Phil.(Oxf.)

Jennifer Sunday; B.Sc.(Br. Col.), Ph.D.(Simon Fraser)

Stephanie C. Weber; B.Sc.(Duke), Ph.D.(Stan.)

**Associate Members**

*Biochemistry*: Maxime Bouchard

*Centre for Research in Neuroscience*: Sal Carbonetto, Yong Rao, Donald Van Meyel

*Environment*: Colin Chapman

*Glen site*: Hugh J. Clarke, Daniel Dufort, Teruko Taketo

*MCH*: Rima Rozen

*Medical Genetics, Chair*: David Rosenblatt

*MNI*: Kenneth Hastings

*Physics*: Paul Francois

*Redpath Museum*: Rowan Barrett, David Green, Hans Larsson, Virginie Millien, Anthony Ricciardi

**Adjunct Professors**

*BELLUS Health Inc.*: Francesco Bellini

*Humboldt Univ., Berlin*: Rudiger Krahe

*IRCM*: Frédéric Charron, David Hipfner

*NRC Lab*: Malcolm S. Whiteway

*STRI*: Andrew Altieri, Hector Guzman, William Owen McMillan, Mark Torchin

*Univ. of British Columbia*: Jonathan Davies

*Univ. of the West Indies*: Henri Valles

**13.5.6 Bachelor of Science (B.Sc.) - Minor Biology (25 credits)**

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

See Nancy Nelson, Stewart Biology Building, 514-398-4109, email: nancy.nelson@mcgill.ca.

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

**Required Courses (15 credits)**

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics

BIOL 205	(3)	Biology of Organisms
BIOL 215	(3)	Introduction to Ecology and Evolution

**Complementary Courses (10 credits)**

Students complete a minimum of 9 or a maximum of 10 complementary course credits depending on their choice of complementary courses.

To include:

CHEM 212*	(4)	Introductory Organic Chemistry 1
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Plus an additional two courses from the Biology department's course offerings, at the 300 level or above.

\* Students who have already taken CHEM 212 or its equivalent will choose another appropriate course, to be approved by the Biology Adviser.

**13.5.7 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Biology (47 credits)**

Students may complete this program with a minimum of 45 credits or a maximum of 47 credits depending on their choice of complementary courses.

**Required Courses (19 credits)**

\* If a student has already taken CHEM 212 or its equivalent, the 4 credits can be made up with a 3-credit complementary.

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics
BIOL 205	(3)	Biology of Organisms
BIOL 215	(3)	Introduction to Ecology and Evolution
CHEM 212*	(4)	Introductory Organic Chemistry 1

**Complementary Courses (28 credits)**

Students complete a minimum of 27 credits or a maximum of 28 complementary course credits selected as follows:

3 or 4 credits selected from:

BIOL 206	(3)	Methods in Biology of Organisms
BIOL 301	(4)	Cell and Molecular Laboratory

**24 credits of Biology courses**

9 credits of which, in consultation with the Biology Program Adviser, can be replaced with appropriate Science courses from other departments.

No more than 6 of the 24 credits can be taken at the 200 level.

**13.5.8 Bachelor of Science (B.Sc.) - Major Biology (59 credits)**

The Major requires 58 or 59 credits depending on a student's choice of complementary courses.

Students in the Major program are permitted to take a maximum of 9 credits of research courses.

**Required Courses**

25-26 credits:

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics



BIOL 205	(3)	Biology of Organisms
BIOL 206	(3)	Methods in Biology of Organisms
BIOL 215	(3)	Introduction to Ecology and Evolution
BIOL 301	(4)	Cell and Molecular Laboratory
CHEM 212*	(4)	Introductory Organic Chemistry 1

\* If a student has already taken CHEM 212 or its equivalent, the credits can be made up with a 3- or 4-credit complementary course to be approved by the Biology Adviser.

### Core Complementary Courses (12 credits)

12 credits selected from:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 304	(3)	Evolution
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 308	(3)	Ecological Dynamics

### Other Complementary Courses (21 credits)

21 other credits of Biology courses at the 300+ level, of which 6 credits must be at the 400+ level. With permission of the Biology Adviser, up to 9 credits may be taken from other Science department courses (300+-level).

## 13.5.9 Bachelor of Science (B.Sc.) - Major Biology - Quantitative Biology (73 credits)

Interdisciplinary research that draws from the natural and physical sciences is an important aspect of modern biology. The Quantitative Biology option is designed for students with a deep interest in biology who wish to gain a strong grounding in physical sciences and their application to biological questions. The program has two options: an ecology and evolutionary biology stream, and a physical biology stream. Both streams provide a balance of theory and experimental components.

Students may complete this program with a minimum of 68 credits or a maximum of 73 credits depending on whether MATH 222 and CHEM 212 are completed.

### Advising notes for U0 students

It is highly recommended that freshman BIOL, CHEM, MATH, and PHYS courses be selected with the Program Adviser to ensure they meet the core requirements of the Quantitative Biology option.

This program is recommended for U1 students achieving a CGPA of 3.20 or better; and entering CEGEP students with a Math/Science R-score of 28.0 or better.

### Required Courses (43 credits)

#### Bio-Physical Sciences Core (31 credits)

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
COMP 202**	(3)	Foundations of Programming
MATH 222*	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
MATH 324	(3)	Statistics

\*Students who have taken the equivalent of CHEM 212 or MATH 222 can make up the credits with a complementary 3 or 4 credit course in consultation with a stream adviser.

\*\*Students who have sufficient knowledge of programming should take COMP 250 Introduction to Computer Science rather than COMP 202.

**Biology (6 credits)**

BIOL 202	(3)	Basic Genetics
BIOL 215	(3)	Introduction to Ecology and Evolution

**Physics (6 credits)**

PHYS 230	(3)	Dynamics of Simple Systems
PHYS 232	(3)	Heat and Waves

**Course Requirements for Quantitative Biology Streams (21 credits)**

21 credits from one of the following two streams:

**Stream 1: Theoretical Ecology and Evolutionary Biology (21 credits)**

Biology

BIOL 205	(3)	Biology of Organisms
BIOL 206	(3)	Methods in Biology of Organisms
BIOL 304	(3)	Evolution
BIOL 308	(3)	Ecological Dynamics

Field Courses - 3 credits from the following list or any other field course with permission:

BIOL 240	(3)	Monteregian Flora
BIOL 331	(3)	Ecology/Behaviour Field Course
BIOL 334	(3)	Applied Tropical Ecology
BIOL 432	(3)	Limnology

6 credits chosen from the following list of courses at the 400 level or above:

\* Students choose either both BIOL 596 and BIOL 597, or BIOL 598.

BIOL 432	(3)	Limnology
BIOL 434	(3)	Theoretical Ecology
BIOL 435	(3)	Natural Selection
BIOL 465	(3)	Conservation Biology
BIOL 509	(3)	Methods in Molecular Ecology
BIOL 510	(3)	Advances in Community Ecology
BIOL 515	(3)	Advances in Aquatic Ecology
BIOL 540	(3)	Ecology of Species Invasions
BIOL 594	(3)	Advanced Evolutionary Ecology
BIOL 596*	(1)	Advanced Experimental Design
BIOL 597*	(2)	Advanced Biostatistics
BIOL 598*	(3)	Advanced Design and Statistics

**Stream 2: Physical Biology (21 credits)**

BIOL 319	(3)	Introduction to Biophysics
PHYS 329	(3)	Statistical Physics with Biophysical Applications
PHYS 446	(3)	Majors Quantum Physics

300-level complementary courses: 6 credits from the following:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 309	(3)	Mathematical Models in Biology
BIOL 313	(3)	Eukaryotic Cell Biology

500-level complementary courses: 6 credits from the following:

BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 530	(3)	Advances in Neuroethology
BIOL 551	(3)	Principles of Cellular Control
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology

**Complementary Courses**

Quantitative Biology - Theoretical Ecology and Evolutionary Biology, and Physical Biology streams

9 credits from the following:

Recommendations for either Theoretical Ecology and Evolutionary Biology or Physical Biology streams

BIOL 466	(3)	Independent Research Project 1
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 350*	(3)	Numerical Computing
COMP 364	(3)	Computer Tools for Life Sciences
MATH 235**	(3)	Algebra 1
MATH 240**	(3)	Discrete Structures 1
MATH 314	(3)	Advanced Calculus
MATH 317*	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 327	(3)	Matrix Numerical Analysis
MATH 348	(3)	Euclidean Geometry
MATH 437	(3)	Mathematical Methods in Biology
MATH 447	(3)	Introduction to Stochastic Processes

\* Students may take COMP 350 OR MATH 317.

\*\*MATH 235 or MATH 240 are required for COMP 251.

#### Recommendations for Physical Biology stream

BIEN 310	(3)	Introduction to Biomolecular Engineering
BIEN 320	(3)	Molecular, Cellular and Tissue Biomechanics
BIEN 340	(3)	Transport Processes in Biological Systems
BIEN 510	(3)	Engineered Nanomaterials for Biomedical Applications
BIEN 530	(3)	Imaging and Bioanalytical Instrumentation
CHEM 222	(4)	Introductory Organic Chemistry 2
PHYS 242*	(2)	Electricity and Magnetism
PHYS 257	(3)	Experimental Methods 1
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 434	(3)	Optics
PHYS 519	(3)	Advanced Biophysics
PHYS 534	(3)	Nanoscience and Nanotechnology

\* PHYS 242 is required for PHYS 342 and PHYS 434.

#### Recommendations for Theoretical Ecology and Evolutionary Biology stream

BIOL 310	(3)	Biodiversity and Ecosystems
BIOL 324	(3)	Ecological Genetics
MATH 242	(3)	Analysis 1
MATH 340	(3)	Discrete Structures 2
MATH 423	(3)	Regression and Analysis of Variance
MATH 524	(4)	Nonparametric Statistics
MATH 525	(4)	Sampling Theory and Applications
PHYS 329	(3)	Statistical Physics with Biophysical Applications

### 13.5.10 Bachelor of Science (B.Sc.) - Major Biology and Mathematics (76 credits)

This program is built on a selection of mathematics and biology courses that recognize mathematical biology as a field of research, with three streams within biology: Ecology and Evolutionary Ecology, Molecular Evolution, and Neurosciences.

Advising notes for U0 students:

It is highly recommended that freshman BIOL, CHEM, MATH, and PHYS courses be selected with the Program Adviser to ensure they meet the core requirements of the program.

This program is recommended for U1 students achieving a CGPA of 3.2 or better, and entering CEGEP students with a Math/Science R-score of 28.0 or better.

#### Required Courses (37 credits)

##### Bio-Physical Sciences Core

28 credits

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1

COMP 202**	(3)	Foundations of Programming
MATH 222*	(3)	Calculus 3
MATH 223***	(3)	Linear Algebra
MATH 247***	(3)	Honours Applied Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability

\* If a student has already taken CHEM 212 or its equivalent, or MATH 222 or its equivalent, the credits can be made up with a complementary course in consultation with the Program Adviser.

\*\* Students who have sufficient knowledge in a programming language should take COMP 250 (3 credits) "Introduction to Computer Science" rather than COMP 202.

\*\*\* Students may take either MATH 223 or MATH 247.

### Biology and Mathematics Core

9 credits

BIOL 215	(3)	Introduction to Ecology and Evolution
MATH 242	(3)	Analysis 1
MATH 243	(3)	Analysis 2

### Complementary Courses (39 credits)

For the 39 credits, students complete 21 credits of BIOL, NEUR, PHGY, PSYC courses including one of three streams (Ecology and Evolutionary Ecology, Molecular Evolution, Neurosciences) and 18 credits of MATH courses.

### Math or Biology Research Course

Note: Students selecting a BIOL course count this toward their 21 credits of BIOL, NEUR, PHGY, PSYC courses while students selecting a MATH course count this toward their 18 credits of MATH courses.

3-6 credits from the following Math or Biology research courses:

BIOL 466	(3)	Independent Research Project 1
BIOL 467	(3)	Independent Research Project 2
BIOL 468	(6)	Independent Research Project 3
MATH 410	(3)	Majors Project

Of the remaining complementary courses, at least 6 credits must be at the 400 level or above.

### Math Courses

15 credits (if MATH 410 was selected as a research course) or 18 credits of MATH courses chosen from Stream 1 or 2 and from "Remaining Math Courses" as follows:

#### Stream 1: Theory

12 credits from the following courses:

\* Students may take either MATH 317 or MATH 327.

MATH 314	(3)	Advanced Calculus
MATH 317*	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 327*	(3)	Matrix Numerical Analysis

**Stream 2: Statistics**

9 credits from the following:

MATH 324	(3)	Statistics
MATH 423	(3)	Regression and Analysis of Variance
MATH 447	(3)	Introduction to Stochastic Processes

**Remaining Math Courses**

Remaining 3-9 credits of MATH courses may be chosen from any of the two preceding sequences and/or from the following list:

MATH 204	(3)	Principles of Statistics 2
MATH 340	(3)	Discrete Structures 2
MATH 437	(3)	Mathematical Methods in Biology
MATH 523	(4)	Generalized Linear Models
MATH 524	(4)	Nonparametric Statistics
MATH 525	(4)	Sampling Theory and Applications

**BIOL, NEUR, PHGY, PHYS, PSYC Courses**

18 credits (if 3 credit BIOL course was selected as a research course) or 15 credits (if 6 credit BIOL research course was selected) of BIOL, NEUR, PHGY, PHYS, PSYC courses including one of three streams.

Note: Some courses in the streams may have prerequisites.

**Ecology and Evolutionary Ecology Stream**

At least 15 credits selected as follows:

3 credits of:

BIOL 206	(3)	Methods in Biology of Organisms
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3 credits from the following field courses or any other field course with permission:

BIOL 240	(3)	Monteregian Flora
BIOL 331	(3)	Ecology/Behaviour Field Course
BIOL 334D1	(1.5)	Applied Tropical Ecology
BIOL 334D2	(1.5)	Applied Tropical Ecology
BIOL 432	(3)	Limnology
BIOL 573	(3)	Vertebrate Palaeontology Field Course

At least 9 credits chosen from the following list

BIOL 202	(3)	Basic Genetics
BIOL 205	(3)	Biology of Organisms
BIOL 304	(3)	Evolution
BIOL 305	(3)	Animal Diversity
BIOL 308	(3)	Ecological Dynamics
BIOL 310	(3)	Biodiversity and Ecosystems
BIOL 324	(3)	Ecological Genetics

BIOL 434	(3)	Theoretical Ecology
BIOL 509	(3)	Methods in Molecular Ecology
BIOL 569	(3)	Developmental Evolution
BIOL 594	(3)	Advanced Evolutionary Ecology

### Molecular Evolution Stream

At least 15 credits selected as follows:

3 credits

BIOL 202	(3)	Basic Genetics
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At least 12 credits selected from the following list:

BIOL 303	(3)	Developmental Biology
BIOL 304	(3)	Evolution
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 569	(3)	Developmental Evolution
BIOL 592	(3)	Integrated Bioinformatics

### Neurosciences Stream

At least 15 credits selected as follows:

3 credits from:

BIOL 306	(3)	Neural Basis of Behaviour
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At least 12 credits selected from:

BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 389	(3)	Laboratory in Neurobiology
BIOL 530	(3)	Advances in Neuroethology
BIOL 580	(3)	Genetic Approaches to Neural Systems
NEUR 310	(3)	Cellular Neurobiology
NEUR 507	(3)	Topics in Radionuclide Imaging
NEUR 570	(3)	Human Brain Imaging
PHGY 314	(3)	Integrative Neuroscience
PHGY 425	(3)	Analyzing Physiological Systems
PHGY 552	(3)	Cellular and Molecular Physiology
PSYC 427	(3)	Sensorimotor Neuroscience
PSYT 455	(3)	Neurochemistry
PSYT 502	(3)	Brain Evolution and Psychiatry

### Remaining BIOL, NEUR, PHGY, PSYC

For the remaining BIOL, NEUR, PHGY, PSYC complementary course credits, if any, students top up their credits to the necessary 18-21 credits with any course listed in the above three streams. Other relevant courses may be substituted with the approval of the Program Adviser.

### 13.5.11 Bachelor of Science (B.Sc.) - Honours Biology (72 credits)

Students may complete this program with a minimum of 71 credits or a maximum of 72 credits depending on their choice of complementary courses.

The Honours program in Biology is designed expressly as a preparation for graduate studies and research, and provides students with an enriched training in biology and some research experience in a chosen area. Acceptance into the Honours program at the end of U2 requires a CGPA of 3.50 and approval of a 9- or 12-credit Independent Studies proposal (see listing of BIOL 479 and BIOL 480 for details). Students also complete a 4-credit Honours Seminar course, BIOL 499. For an Honours degree, a minimum CGPA of 3.50 in the U3 year and adherence to the program as outlined below are the additional requirements.

First Class Honours will be awarded to students graduating with a GPA of 3.75 or better, and having successfully completed the Honours program.

#### U1 Required Courses (33 credits)

32-33 credits:

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics
BIOL 205	(3)	Biology of Organisms
BIOL 206	(3)	Methods in Biology of Organisms
BIOL 215	(3)	Introduction to Ecology and Evolution
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 373*	(3)	Biometry
BIOL 499D1	(2)	Honours Seminar in Biology
BIOL 499D2	(2)	Honours Seminar in Biology
CHEM 212**	(4)	Introductory Organic Chemistry 1

\* If a student has already taken an equivalent statistics course, the credits can be made up with a 3-credit Biology complementary course.

\*\* If a student has already taken CHEM 212 or its equivalent, the credits can be made up with a 3- or 4-credit course to be approved by the Biology Adviser.

#### Complementary Courses (39 credits)

Honours (9-12 courses)

BIOL 479D1	(4.5)	Honours Research Project 1
BIOL 479D2	(4.5)	Honours Research Project 1

OR

BIOL 480D1	(6)	Honours Research Project 2
BIOL 480D2	(6)	Honours Research Project 2

Core

12 credits selected from:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 304	(3)	Evolution
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 308	(3)	Ecological Dynamics



Other (15-18 credits)

18 credits of Biology courses at the 300+ level if taking BIOL 479, and 15 credits if taking BIOL 480. With permission of the Biology Adviser, up to 6 credits may be taken from other science department courses (300+ level). Up to 6 credits of previous independent research courses may be included.

### 13.5.12 Bachelor of Science (B.Sc.) - Honours Biology - Quantitative Biology (79 credits)

79 credits

Interdisciplinary research that draws from the natural and physical sciences is an important aspect of modern biology. The Quantitative Biology (QB) Honours option is designed for students with a deep interest in biology who wish to gain a strong grounding in physical sciences and their application to biological questions through both coursework and a research project. The QB B.Sc. Honours option has two streams: a theoretical ecology and evolutionary biology stream and a physical biology stream. Both streams provide a balance of theory and experimental components that along with a research component will provide outstanding preparation for graduate training. Students must attain a 3.50 CGPA to enter and to complete the Honours program. First Class Honours will be awarded to students in the QB Honours option graduating with a CGPA of 3.75 or greater.

Students may complete this program with a minimum of 74 credits or a maximum of 79 credits depending on whether MATH 222 and CHEM 212 are completed.

#### Advising notes for U0 students

It is highly recommended that freshman BIOL, CHEM, MATH, and PHYS courses be selected with the Program Adviser to ensure they meet the core requirements of the Quantitative Biology option.

This program is recommended for U1 students achieving a CGPA of 3.20 or better; and entering CEGEP students with a Math/Science R-score of 28.0 or better.

#### Required Courses (49 credits)

##### Bio-Physical Sciences Core (31 credits)

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
COMP 202**	(3)	Foundations of Programming
MATH 222***	(3)	Calculus 3
MATH 223***	(3)	Linear Algebra
MATH 247**	(3)	Honours Applied Linear Algebra
MATH 315+	(3)	Ordinary Differential Equations
MATH 323++	(3)	Probability
MATH 324+++	(3)	Statistics
MATH 325+	(3)	Honours Ordinary Differential Equations
MATH 356++	(3)	Honours Probability
MATH 357+++	(3)	Honours Statistics

\* Students who have taken the equivalent of CHEM 212 or MATH 222 can make up the credits with complementary 3 or 4 credit courses in consultation with a stream adviser.

\*\* Students who have sufficient knowledge of programming should take COMP 250 Introduction to Computer Science rather than COMP 202.

\*\*\* Students take MATH 223 or MATH 247.

+ Students take MATH 315 or MATH 325.

++ Students take MATH 323 or MATH 356.

+++ Students take MATH 324 or MATH 357.

Note: 6 credits of either MATH or PHYS courses to be taken at the honours level. Honours equivalents of core Math and Physics courses are listed. All 500-level Math courses are considered as honours courses and can be applied to the 6 credit requirement.

#### Biology (6 credits)

BIOL 202	(3)	Basic Genetics
BIOL 215	(3)	Introduction to Ecology and Evolution

**Research Component (6 credits)**

BIOL 468	(6)	Independent Research Project 3
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**Physics (6 credits)**

6 credits from:

PHYS 230*	(3)	Dynamics of Simple Systems
PHYS 232**	(3)	Heat and Waves
PHYS 251*	(3)	Honours Classical Mechanics 1
PHYS 253**	(3)	Thermal Physics

\* Students take PHYS 230 or PHYS 251.

\*\* Students take PHYS 232 or PHYS 253.

**Course Requirements for Quantitative Biology Streams**

21 credits from one of the following two streams:

**Stream 1: Theoretical Ecology and Evolutionary Biology (21 credits)**

Biology

12 credits from the following:

BIOL 205	(3)	Biology of Organisms
BIOL 206	(3)	Methods in Biology of Organisms
BIOL 304	(3)	Evolution
BIOL 308	(3)	Ecological Dynamics

Field Courses

3 credits from the following list or any other field course with permission:

BIOL 240	(3)	Monteregian Flora
BIOL 331	(3)	Ecology/Behaviour Field Course
BIOL 334	(3)	Applied Tropical Ecology
BIOL 432	(3)	Limnology

6 credits chosen from the following list of courses at the 400 level or above:

\* Students choose either both BIOL 596 and BIOL 597, or BIOL 598.

BIOL 432	(3)	Limnology
BIOL 434	(3)	Theoretical Ecology
BIOL 435	(3)	Natural Selection
BIOL 465	(3)	Conservation Biology
BIOL 509	(3)	Methods in Molecular Ecology
BIOL 510	(3)	Advances in Community Ecology
BIOL 515	(3)	Advances in Aquatic Ecology

BIOL 540	(3)	Ecology of Species Invasions
BIOL 594	(3)	Advanced Evolutionary Ecology
BIOL 596*	(1)	Advanced Experimental Design
BIOL 597*	(2)	Advanced Biostatistics
BIOL 598*	(3)	Advanced Design and Statistics

**Stream 2: Physical Biology**

21 credits

9 credits from:

BIOL 319*	(3)	Introduction to Biophysics
PHYS 319*	(3)	Introduction to Biophysics
PHYS 329	(3)	Statistical Physics with Biophysical Applications
PHYS 446	(3)	Majors Quantum Physics

\* Students choose either BIOL 319 or PHYS 319

300-level complementary courses

6 credits from the following:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 309	(3)	Mathematical Models in Biology
BIOL 313	(3)	Eukaryotic Cell Biology

500-level complementary courses

6 credits from the following:

BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 530	(3)	Advances in Neuroethology
BIOL 551	(3)	Principles of Cellular Control
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology

**Complementary Courses (9 credits)**

Recommendations for either Theoretical Ecology and Evolutionary Biology or Physical Biology streams

COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 350*	(3)	Numerical Computing
COMP 364	(3)	Computer Tools for Life Sciences
MATH 235**	(3)	Algebra 1
MATH 240**	(3)	Discrete Structures 1

MATH 314	(3)	Advanced Calculus
MATH 317*	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 327	(3)	Matrix Numerical Analysis
MATH 348	(3)	Euclidean Geometry
MATH 437	(3)	Mathematical Methods in Biology
MATH 447	(3)	Introduction to Stochastic Processes

\* Students may take COMP 350 OR MATH 317.

\*\* MATH 235 or MATH 240 are required for COMP 251.

#### Recommendations for Physical Biology stream

BIEN 310	(3)	Introduction to Biomolecular Engineering
BIEN 320	(3)	Molecular, Cellular and Tissue Biomechanics
BIEN 340	(3)	Transport Processes in Biological Systems
BIEN 510	(3)	Engineered Nanomaterials for Biomedical Applications
BIEN 530	(3)	Imaging and Bioanalytical Instrumentation
CHEM 222	(4)	Introductory Organic Chemistry 2
PHYS 242*	(2)	Electricity and Magnetism
PHYS 257	(3)	Experimental Methods 1
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 413	(3)	Physical Basis of Physiology
PHYS 434	(3)	Optics
PHYS 519	(3)	Advanced Biophysics
PHYS 534	(3)	Nanoscience and Nanotechnology

\* PHYS 242 is required for PHYS 342 and PHYS 434.

#### Recommendations for Theoretical Ecology and Evolutionary Biology stream

BIOL 310	(3)	Biodiversity and Ecosystems
BIOL 324	(3)	Ecological Genetics
MATH 242	(3)	Analysis 1
MATH 340	(3)	Discrete Structures 2
MATH 423	(3)	Regression and Analysis of Variance
MATH 524	(4)	Nonparametric Statistics
MATH 525	(4)	Sampling Theory and Applications
PHYS 329	(3)	Statistical Physics with Biophysical Applications

### 13.5.13 Biology (BIOL) Related Programs and Study Semesters

#### 13.5.13.1 Joint Major in Computer Science and Biology

For more information, see [section 13.9.11: Bachelor of Science \(B.Sc.\) - Major Computer Science and Biology \(74 credits\)](#).

### 13.5.13.2 Joint Honours in Computer Science and Biology

For more information, see [section 13.9.15: Bachelor of Science \(B.Sc.\) - Honours Computer Science and Biology \(77 credits\)](#).

### 13.5.13.3 Panama Field Study Semester

The program is a joint venture between McGill University and the Smithsonian Tropical Research Institute (STRI) in Panama. For more information, see [Study Abroad & Field Studies > Undergraduate > Field Study Semesters and Off-Campus Courses > Field Study Minor > : Panama Field Study Semester](#). You can also visit the following website for details: [www.mcgill.ca/science/student/internships-field](http://www.mcgill.ca/science/student/internships-field).

### 13.5.13.4 Africa Field Study Semester

The Department of Geography, Faculty of Science, coordinates the 15-credit interdisciplinary Africa Field Study Semester; see [Study Abroad & Field Studies > Undergraduate > Field Study Semesters and Off-Campus Courses > Field Study Minor > : Africa Field Study Semester](#). You can also visit the following website for details: [www.mcgill.ca/science/student/internships-field](http://www.mcgill.ca/science/student/internships-field).

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## 13.6 Biotechnology (BIOT)

### 13.6.1 Location

Stewart Biology Building, Room N7/9B  
 1205 Dr. Penfield Avenue  
 Montreal QC H3A 1B1  
 Telephone: 514-398-4109  
 Email: [nancy.nelson@mcgill.ca](mailto:nancy.nelson@mcgill.ca)  
 Website: [biology.mcgill.ca/undergrad/minorprog\\_biotech.html](http://biology.mcgill.ca/undergrad/minorprog_biotech.html)

### 13.6.2 About Biotechnology

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

The course BIOT 505 *Selected Topics in Biotechnology* is considered as taught by the Faculty of Science.

### 13.6.3 General Regulations

To obtain the Minor in Biotechnology, students must:

- satisfy the requirements both for the departmental program and for the Minor;
- complete 24 credits, 18 of which must be exclusively for the Minor program, and outside of their primary program;
- obtain a grade of C or better in the courses presented for the Minor.

### 13.6.4 Biotechnology (BIOT) Minor Program

#### Program Supervisor

Elias Georges; B.Sc., Ph.D.(McG.) (*Institute of Parasitology*)

Telephone: 514-398-8137

Email: [elias.georges@mcgill.ca](mailto:elias.georges@mcgill.ca)

**Program Adviser**

Nancy Nelson

Stewart Biology Building, Room N7/9B

Telephone: 514-398-4109

Email: [nancy.nelson@mcgill.ca](mailto:nancy.nelson@mcgill.ca)**13.6.5 Bachelor of Science (B.Sc.) - Minor Biotechnology (for Science Students) (24 credits)**

To obtain the Minor Biotechnology, Science students must:

- a) satisfy both the requirements for the departmental program and for the Minor;
- b) complete 24 credits, 18 of which must be exclusively for the Minor program.\*

\* Approved substitutions must be made for any of the required courses which are part of the student's main program.

**Required Courses (15 credits)**

\* Students may take either BIOL 201 or BIOC 212.

BIOC 212*	(3)	Molecular Mechanisms of Cell Function
BIOL 200	(3)	Molecular Biology
BIOL 201*	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics
BIOT 505	(3)	Selected Topics in Biotechnology
MIMM 211	(3)	Introductory Microbiology

**Complementary Courses (9 credits)**

9 credits selected from courses outside the department of the student's main program. Students may select three courses from one of the lists below, or may choose three alternate courses with adviser approval.

**Biomedicine**

ANAT 541	(3)	Cell and Molecular Biology of Aging
EXMD 504	(3)	Biology of Cancer
PATH 300	(3)	Human Disease

**Chemical Engineering**

CHEE 200	(3)	Chemical Engineering Principles 1
CHEE 204	(3)	Chemical Engineering Principles 2
CHEE 474	(3)	Biochemical Engineering

**Chemistry**

CHEM 482	(3)	Organic Chemistry: Natural Products
CHEM 502	(3)	Advanced Bio-Organic Chemistry
CHEM 552	(3)	Physical Organic Chemistry

**General**

FACC 300	(3)	Engineering Economy
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**Immunology**

ANAT 261	(4)	Introduction to Dynamic Histology
BIOC 503	(3)	Immunochemistry
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
MIMM 414	(3)	Advanced Immunology
PHGY 513	(3)	Cellular Immunology

**Management**

ECON 208	(3)	Microeconomic Analysis and Applications
MGCR 211	(3)	Introduction to Financial Accounting
MGCR 341	(3)	Introduction to Finance
MGCR 352	(3)	Principles of Marketing
MGCR 472	(3)	Operations Management

**Microbiology**

MIMM 323	(3)	Microbial Physiology
MIMM 324	(3)	Fundamental Virology
MIMM 413	(3)	Parasitology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis

**Molecular Biology (Biology)**

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 551	(3)	Principles of Cellular Control

**Molecular Biology (Biochemistry)**

BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
PSYT 455	(3)	Neurochemistry

**Physiology**

EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology

PHGY 517	(3)	Artificial Internal Organs
PHGY 518	(3)	Artificial Cells

**Pollution**

CHEE 593	(3)	Industrial Water Pollution Control
CIVE 225	(4)	Environmental Engineering
CIVE 430	(3)	Water Treatment and Pollution Control
CIVE 557	(3)	Microbiology for Environmental Engineering

**13.6.6 Biotechnology (BIOT) Related Programs****13.6.6.1 Program for Students in the Faculty of Engineering**

See [Faculty of Engineering > Undergraduate > Browse Academic Units & Programs > Minor Programs > Bachelor of Engineering \(B.Eng.\) - Minor Biotechnology \(for Engineering Students\) \(24 credits\)](#) for details.

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**13.7 Chemistry (CHEM)****13.7.1 Location**

Otto Maass Chemistry Building  
801 Sherbrooke Street West  
Montreal QC H3A 0B8  
Departmental Office: Room 322  
Telephone: 514-398-6999  
Website: [www.mcgill.ca/chemistry](http://www.mcgill.ca/chemistry)

Student Advisory Office: Pulp & Paper Building, Room 118A  
Website: [www.mcgill.ca/chemistry/current-undergraduate-students/advising](http://www.mcgill.ca/chemistry/current-undergraduate-students/advising)

**13.7.2 Office for Science and Society**

The Office for Science and Society is dedicated to the promotion of critical thinking and the presentation of practical scientific information to the public, educators, and students in an accurate and responsible fashion. The Office answers queries from the public as well as from the media, with a view toward establishing scientific accuracy. The Office also offers a variety of educational and interesting presentations on scientific topics and its members contribute to a number of courses under the umbrella of "The World of Chemistry."

**Director**

Joseph A. Schwarcz; B.Sc., Ph.D.(McG.)

**Members**

Ariel Fenster; L.Sc., D.E.A.(Paris), Ph.D.(McG.)

David N. Harpp; A.B.(Middlebury), M.A.(Wesl.), Ph.D.(N. Carolina), F.C.I.C. (*William C. Macdonald Professor of Chemistry*)

**13.7.3 About Chemistry**

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, kinetics, and energetics governing chemical reactions, behaviour of materials, and molecular structure.

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 introductory level, courses in organic, inorganic, analytical, and physical chemistry are offered throughout the university years. Since chemistry is an experimental science, laboratory classes accompany most undergraduate courses. In addition, courses are offered in polymer, theoretical, green, nano, and biological chemistry to upper-year undergraduates.

There are two main programs in the Department of Chemistry: Honours and Major. There are also a number of B.Sc. Liberal and other programs available. Interested students may inquire about these at the Student Advisory Office, Room 118A, Pulp & Paper Building, or see [www.mcgill.ca/chemistry/current-undergraduate-students/advising](http://www.mcgill.ca/chemistry/current-undergraduate-students/advising).

### 13.7.4 Chemistry Faculty

#### Chair

M.J. Damha

#### Director of Graduate Studies

G. Cosa

#### Emeritus Professors

T.H. Chan; B.Sc.(Tor.), M.A., Ph.D.(Princ.), F.C.I.C., F.R.S.C.

A. Eisenberg; B.S.(Wor. Poly.), M.A., Ph.D.(Princ.), F.C.I.C.

B.C. Eu; B.Sc.(Seoul), Ph.D.(Brown)

D.G. Gray; B.Sc.(Belf.), M.Sc., Ph.D.(Manit.), F.C.I.C.

E.D. Salin; B.Sc.(Calif.), Ph.D.(Ore.), F.C.I.C.

M.A. Whitehead; B.Sc., Ph.D., D.Sc.(Lond.), F.C.I.C.

#### Professors

M.P. Andrews; B.Sc., M.Sc., Ph.D.(Tor.)

P. Ariya; B.Sc., Ph.D.(York)

B.A. Arndtsen; B.A.(Car.), Ph.D.(Stan.)

K. Auclair; B.Sc.(UQAC), Ph.D.(Alta.)

D.S. Bohle; B.A.(Reed), M.Phil., Ph.D.(Auck.)

I.S. Butler; B.Sc., Ph.D.(Brist.), F.C.I.C.

G. Cosa; B.Sc.(Argentina), Ph.D.(Ott.)

M.J. Damha; B.Sc., Ph.D.(McG.), F.C.I.C.

D.N. Harpp; A.B.(Middlebury), M.A.(Wesl.), Ph.D.(N. Carolina), F.C.I.C.

A. Kakkar; B.Sc., M.Sc.(Chan. U., India), Ph.D.(Wat.)

R.B. Lennox; B.Sc., M.Sc., Ph.D.(Tor.), F.C.I.C., F.R.S.C.

C.J. Li; B.Sc.(Zhengzhou), M.S.(Chin. Acad. Sci.), Ph.D.(McG.), F.R.S.C.

D. Perepichka; B.Sc.(Donetsk St. U, Ukraine), Ph.D.(Nat. Aca. Sci., Ukraine)

D.M. Ronis; B.Sc.(McG.), Ph.D.(MIT)

B.C. Sanctuary; B.Sc., Ph.D.(Br. Col.)

H. Sleiman; B.Sc.(A.U.B.), Ph.D.(Stan.)

**Professors**

Y.S. Tsantrizos; B.Sc., M.Sc., Ph.D.(McG.)

T.G.M. van de Ven; Kand. Doc.(Utrecht), Ph.D.(McG.)

P. Wiseman; B.Sc.(St. FX), Ph.D.(W. Ont.)

**Associate Professors**

C.J. Barrett; B.Sc., M.Sc., Ph.D.(Qu.)

A.S. Blum; B.A.(Princ.), Ph.D.(Wash.)

T. Friš i ; B.Sc.(Zagreb), Ph.D.(Iowa)

J.L. Gleason; B.Sc.(McG.), Ph.D.(Virg.)

P. Kambhampati; B.A.(Car. Coll.), Ph.D.(Texas)

J. P. Lumb; B.Sc.(Cornell), Ph.D.(Calif., Berk.)

J. Mauzeroll; B.Sc.(McG.), Ph.D.(Texas-Austin)

A. Mittermaier; B.Sc.(Guelph), Ph.D.(Tor.)

N. Moitessier; M.Sc., Ph.D.(Nancy)

A. Moores; B.Sc., Ph.D.(École Polytechnique, Paris)

J.F. Power; B.Sc., Ph.D.(C'dia)

L. Reven; B.A.(Car.), Ph.D.(Ill.)

B. Siwick; B.A.Sc. Eng. Sci., M.Sc., Ph.D.(Tor.)

**Assistant Professors**

M. Harrington; B.A.(Delaware), Ph.D.(Calif., Santa Barbara)

R. Khaliullin; B.S.(INEOS RAS, Moscow), M.S.(Mendeleev Univ., Moscow), Ph.D.(Calif., Berk.)

E. McCalla; B.Sc.(Mt. All.), M.Sc.(McG.), B.Ed.(Nfld.), Ph.D.(Dal.)

M. McKeague; B.Sc., Ph.D.(Car.)

T. Preston; B.Sc.(Tor.), M.Sc.(UWS), Ph.D.(Br. Col.)

C.J. Thibodeaux; B.Sc.(Louisiana St.), Ph.D.(Texas)

**Adjunct Professors**

N. Braidy, I. Wharf, R. Zamboni

**13.7.5 Bachelor of Science (B.Sc.) - Minor Chemistry (18 credits)****Required Courses (18 credits)**

\* Denotes courses with CEGEP equivalents.

Substitutions for these by more advanced courses may be made at the discretion of the Adviser.

CHEM 204	(3)	Physical Chemistry/Biological Sciences 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 253	(1)	Introductory Physical Chemistry 1 Laboratory
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 281	(3)	Inorganic Chemistry 1

**13.7.6 Bachelor of Science (B.Sc.) - Minor Chemical Engineering (24 credits)**

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.

**Required Courses (6 credits)**

CHEE 200	(3)	Chemical Engineering Principles 1
CHEE 204	(3)	Chemical Engineering Principles 2

**Complementary Courses (18 credits)**

At least one of:

CHEE 220	(3)	Chemical Engineering Thermodynamics
CHEE 314	(3)	Fluid Mechanics

with the remainder chosen from the following:

\* Students select either CHEE 494 or CHEE 495

CHEE 230	(3)	Environmental Aspects of Technology
CHEE 315	(3)	Heat and Mass Transfer
CHEE 351	(3)	Separation Processes
CHEE 370	(3)	Elements of Biotechnology
CHEE 380	(3)	Materials Science
CHEE 438	(3)	Engineering Principles in Pulp and Paper Processes
CHEE 452	(3)	Particulate Systems
CHEE 494*	(3)	Research Project and Seminar 1
CHEE 495*	(4)	Research Project and Seminar 2
CHEE 587	(3)	Chemical Processing: Electronics Industry
CHEE 592	(3)	Industrial Air Pollution Control
CHEE 593	(3)	Industrial Water Pollution Control
MATH 314	(3)	Advanced Calculus

**13.7.7 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Chemistry - Biological (47 credits)****Program Prerequisites**

PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

**Required Basic Core Courses (26 credits)**

The required courses in this program consist of 26 credits in chemistry and mathematics, listed below. The courses marked with an asterisk (\*) are omitted from the program of students who have successfully completed them at CEGEP. Students from outside Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

The Liberal Program: Core Science Component in Chemistry - Biological Option is not certified by the Ordre des chimistes du Québec. Students interested in pursuing a career in Chemistry in Quebec are advised to take an appropriate B.Sc. program in Chemistry.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 381	(3)	Inorganic Chemistry 2
MATH 222**	(3)	Calculus 3

### Biological Option Courses (21 credits)

18 credits:

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 482	(3)	Organic Chemistry: Natural Products
CHEM 502	(3)	Advanced Bio-Organic Chemistry

3 credits from any CHEM course at the 300 or higher level.

## 13.7.8 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Chemistry - General (49 credits)

### Program Prerequisites

PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

### Required Basic Core Courses (26 credits)

The required courses in this program consist of 26 credits in chemistry 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. Students from outside Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

The Liberal Program: Core Science Component Chemistry - General Option is not certified by the Ordre des chimistes du Québec. Students interested in pursuing a career in Chemistry in Quebec are advised to take an appropriate B.Sc. program in Chemistry.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics

CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 381	(3)	Inorganic Chemistry 2
MATH 222**	(3)	Calculus 3

**General Option Courses (17 credits)**

CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
PHYS 242	(2)	Electricity and Magnetism

**Complementary Course (6 credits)**

6 credits from:

CHEM 355	(3)	Applications of Quantum Chemistry
MATH 315	(3)	Ordinary Differential Equations

Chemistry courses at the 300+ level.

**13.7.9 Bachelor of Science (B.Sc.) - Major Chemistry (59 credits)****Program Prerequisites****PRE-PROGRAM REQUIREMENTS:**

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

**Required Courses (53 credits)**

The required courses in this program consist of 53 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is also strongly recommended. Physics PHYS 242 should be completed during U2.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1

CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 332	(3)	Biological Chemistry
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
MATH 222**	(3)	Calculus 3
PHYS 242	(2)	Electricity and Magnetism

**Complementary Courses (6 credits)**

6 credits of Chemistry (CHEM) courses at the 400 level or higher, or MATH 315 plus 3 credits of Chemistry courses at the 400 level or higher.

**13.7.10 Bachelor of Science (B.Sc.) - Major Chemistry - Atmosphere and Environment (63 credits)****Program Prerequisites**

## PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

**Required Courses (57 credits)**

The required courses in this program consist of 57 credits in chemistry 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 and MATH 315 during U1 is also strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 219	(3)	Introduction to Atmospheric Chemistry
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 332	(3)	Biological Chemistry
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry

CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
MATH 222**	(3)	Calculus 3
MATH 315	(3)	Ordinary Differential Equations

### Complementary Courses (6 credits)

3 credits, one of:

ATOC 214	(3)	Introduction: Physics of the Atmosphere
CHEM 462	(3)	Green Chemistry
CHEM 519	(3)	Advances in Chemistry of Atmosphere
CHEM 532	(3)	Structural Organic Chemistry
MATH 317	(3)	Numerical Analysis

3 credits, one of:

ATOC 315	(3)	Thermodynamics and Convection
CHEM 567	(3)	Chemometrics: Data Analysis
CHEM 575	(3)	Chemical Kinetics
CHEM 597	(3)	Analytical Spectroscopy
EPSC 542	(3)	Chemical Oceanography

### 13.7.11 Bachelor of Science (B.Sc.) - Major Chemistry - Bio-organic (63 credits)

#### Program Prerequisites

##### PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

#### Required Courses (57 credits)

The required courses in this program consist of 60 credits in chemistry, biology 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is also strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
CHEM 502	(3)	Advanced Bio-Organic Chemistry
MATH 222**	(3)	Calculus 3
PHYS 242	(2)	Electricity and Magnetism

**Complementary Course (6 credits)**

6 credits from:

BIOL 202	(3)	Basic Genetics
BIOL 301	(4)	Cell and Molecular Laboratory
CHEM 365	(2)	Statistical Thermodynamics
MATH 315	(3)	Ordinary Differential Equations
MIMM 211	(3)	Introductory Microbiology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

**13.7.12 Bachelor of Science (B.Sc.) - Major Chemistry: Biophysical Chemistry (66 credits)**

This program trains students in the fundamentals of chemistry and develops the physical science, computational, and mathematical skills needed for advanced biophysical chemistry research in the biomedical and biotechnology industries. The program features integrative, interdisciplinary courses in bio-physical sciences.

**Program Prerequisites**

Pre-Program Requirements: Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

**Required Courses (59 credits)**

The courses marked with an asterisk (\*) are omitted from the program of students who have successfully completed them at the CEGEP level. Students completing the program will not be eligible for admission to the Ordre des chimistes du Québec without additional chemistry electives. This program is not currently accredited by the Canadian Society for Chemistry.

Completion of Mathematics MATH 222 and MATH 315 during U1 is strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.



## Bio-Physical Sciences Core

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 319	(3)	Introduction to Biophysics
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
MATH 222**	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
PHYS 329	(3)	Statistical Physics with Biophysical Applications

## Chemistry

CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
PHYS 242	(2)	Electricity and Magnetism

**Complementary Courses**

(6-7 credits)

3 credits of:

CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 381	(3)	Inorganic Chemistry 2

3-4 credits of:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 316	(3)	Biomembranes and Organelles
BIOL 551	(3)	Principles of Cellular Control
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 502	(3)	Advanced Bio-Organic Chemistry
CHEM 514	(3)	Biophysical Chemistry
CHEM 520	(3)	Methods in Chemical Biology
CHEM 555	(3)	NMR Spectroscopy
CHEM 575	(3)	Chemical Kinetics

COMP 208 (3) Computers in Engineering

### 13.7.13 Bachelor of Science (B.Sc.) - Major Chemistry - Materials (62 credits)

#### Program Prerequisites

##### PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

#### Required Courses (59 credits)

The required courses in this program consist of 59 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is also strongly recommended. Physics PHYS 242 should be completed during U2.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 332	(3)	Biological Chemistry
CHEM 334	(3)	Advanced Materials
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
CHEM 574	(3)	Introductory Polymer Chemistry
MATH 222**	(3)	Calculus 3
PHYS 242	(2)	Electricity and Magnetism

#### Complementary Course (3 credits)

3 credits from the following:

CHEM 531	(3)	Chemistry of Inorganic Materials
CHEM 534	(3)	Nanoscience and Nanotechnology

CHEM 571	(3)	Polymer Synthesis
CHEM 585	(3)	Colloid Chemistry
MATH 315	(3)	Ordinary Differential Equations

### 13.7.14 Bachelor of Science (B.Sc.) - Major Chemistry - Measurement (62 credits)

The B.Sc.; Major in Chemistry; Measurement provides an emphasis on additional background and advanced courses of interest to physical and analytical chemists.

#### Program Prerequisites

##### PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

#### Required Courses (59 credits)

The required courses in this program consist of 59 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. Students completing this program will not be eligible for admission to the Ordre des chimistes du Québec without additional chemistry electives. This program is not currently accredited by the Canadian Society for Chemistry. See <http://www.chemistry.mcgill.ca/advising/inside/advisors.php>.

Completion of Mathematics MATH 222 and MATH 315 during U1 is also strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
CHEM 575	(3)	Chemical Kinetics
COMP 208	(3)	Computers in Engineering
MATH 222**	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
PHYS 241	(3)	Signal Processing
PHYS 242	(2)	Electricity and Magnetism

#### Complementary Courses (3 credits)

3 credits from:

CHEM 514	(3)	Biophysical Chemistry
CHEM 516	(3)	Nuclear and Radiochemistry
CHEM 531	(3)	Chemistry of Inorganic Materials
CHEM 533	(3)	Small Molecule Crystallography
CHEM 534	(3)	Nanoscience and Nanotechnology
CHEM 547	(3)	Laboratory Automation
CHEM 555	(3)	NMR Spectroscopy
CHEM 556	(3)	Advanced Quantum Mechanics
CHEM 567	(3)	Chemometrics: Data Analysis
CHEM 577	(3)	Electrochemistry
CHEM 585	(3)	Colloid Chemistry
CHEM 593	(3)	Statistical Mechanics
CHEM 597	(3)	Analytical Spectroscopy

### 13.7.15 Bachelor of Science (B.Sc.) - Honours Chemistry (71 credits)

Note: Attainment of the Honours degree requires a CGPA of at least 3.00.

#### Program Prerequisites

##### PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

#### Required Courses (53 credits)

The required courses in this program 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is also strongly recommended. Physics PHYS 242 should be completed during U2.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 332	(3)	Biological Chemistry
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1

CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
MATH 222**	(3)	Calculus 3
PHYS 242	(2)	Electricity and Magnetism

### Complementary Courses (18 credits)

6 credits of research\*:

\* Students may take up to 12 Research Project credits but only 6 of these may be used to fulfil the program requirement.

CHEM 470	(6)	Research Project 1
CHEM 480	(3)	Undergraduate Research Project 2

12 credits of additional Chemistry courses as follows:

6 credits of Chemistry courses at the 300 level or higher, or MATH 315 plus 3 credits of Chemistry courses at the 300 level or higher, and

6 credits of Chemistry courses at the 400 level or higher.

### 13.7.16 Bachelor of Science (B.Sc.) - Honours Chemistry - Atmosphere and Environment (75 credits)

Note: Attainment of the Honours degree requires a CGPA of at least 3.00.

#### Program Prerequisites

##### PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

#### Required Courses (63 credits)

The required courses in this program consist of 63 credits in chemistry 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their Adviser on this matter. Completion of Mathematics MATH 222 and MATH 315 during U1 is also strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 219	(3)	Introduction to Atmospheric Chemistry
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 302	(3)	Introductory Organic Chemistry 3

CHEM 332	(3)	Biological Chemistry
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 462	(3)	Green Chemistry
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
CHEM 519	(3)	Advances in Chemistry of Atmosphere
MATH 222**	(3)	Calculus 3
MATH 315	(3)	Ordinary Differential Equations

**Complementary Courses (12 credits)**

6 credits of research\*:

\* Students may take up to 12 Research Project credits but only 6 of these may be used to fulfil the program requirement.

CHEM 470	(6)	Research Project 1
CHEM 480	(3)	Undergraduate Research Project 2

3 credits, one of:

ATOC 214	(3)	Introduction: Physics of the Atmosphere
CHEM 532	(3)	Structural Organic Chemistry
MATH 317	(3)	Numerical Analysis

3 credits, one of:

ATOC 315	(3)	Thermodynamics and Convection
CHEM 567	(3)	Chemometrics: Data Analysis
CHEM 575	(3)	Chemical Kinetics
CHEM 597	(3)	Analytical Spectroscopy
EPSC 542	(3)	Chemical Oceanography

**13.7.17 Bachelor of Science (B.Sc.) - Honours Chemistry - Bio-organic (75 credits)**

Note: Attainment of the Honours degree requires a CGPA of at least 3.00.

**Program Prerequisites****PRE-PROGRAM REQUIREMENTS:**

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

**Required Courses (57 credits)**

The required courses in this program consist of 57 credits in chemistry, biology 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is also strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
CHEM 502	(3)	Advanced Bio-Organic Chemistry
MATH 222**	(3)	Calculus 3
PHYS 242	(2)	Electricity and Magnetism

### Complementary Courses (18 credits)

18 credits selected as follows:

6 credits of research\*:

\* Students may take up to 12 Research Project credits but only 6 of these may be used to fulfil the program requirement.

CHEM 470	(6)	Research Project 1
CHEM 480	(3)	Undergraduate Research Project 2

9 credits from the following:

BIOL 202	(3)	Basic Genetics
BIOL 301	(4)	Cell and Molecular Laboratory
CHEM 365	(2)	Statistical Thermodynamics
CHEM 502	(3)	Advanced Bio-Organic Chemistry
MATH 315	(3)	Ordinary Differential Equations
MIMM 211	(3)	Introductory Microbiology
MIMM 214	(3)	Introductory Immunology: Elements of Immunity

MIMM 314	(3)	Intermediate Immunology
MIMM 323	(3)	Microbial Physiology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

and 3 credits of additional Chemistry courses at the 400 level or higher.

### 13.7.18 Bachelor of Science (B.Sc.) - Honours Chemistry: Biophysical Chemistry (75 credits)

This program trains students in the fundamentals of chemistry and develops the physical science, computational, and mathematical skills needed for advanced biophysical chemistry research in the biomedical and biotechnology industries. The program features integrative, interdisciplinary courses in bio-physical sciences.

#### Program Prerequisites

Note: Attainment of the Honours degree requires a CGPA of at least 3.00.

Pre-Program Requirements: Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

#### Required Courses (65 credits)

The courses marked with an asterisk (\*) are omitted from the program of students who have successfully completed them at the CEGEP level. Students completing the program will not be eligible for admission to the Ordre des chimistes du Québec without additional chemistry electives. This program is not currently accredited by the Canadian Society for Chemistry.

Completion of Mathematics MATH 222 and MATH 315 during U1 is strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

#### Bio-Physical Sciences Core

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 319	(3)	Introduction to Biophysics
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
MATH 222**	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
PHYS 329	(3)	Statistical Physics with Biophysical Applications

#### Chemistry

CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 367	(3)	Instrumental Analysis 1



CHEM 377	(3)	Instrumental Analysis 2
CHEM 470	(6)	Research Project 1
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
PHYS 242	(2)	Electricity and Magnetism

**Complementary Courses**

(9-10 credits)

3 credits of:

CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 381	(3)	Inorganic Chemistry 2

6-7 credits of:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 316	(3)	Biomembranes and Organelles
BIOL 551	(3)	Principles of Cellular Control
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 502	(3)	Advanced Bio-Organic Chemistry
CHEM 514	(3)	Biophysical Chemistry
CHEM 520	(3)	Methods in Chemical Biology
CHEM 555	(3)	NMR Spectroscopy
CHEM 575	(3)	Chemical Kinetics
COMP 208	(3)	Computers in Engineering

**13.7.19 Bachelor of Science (B.Sc.) - Honours Chemistry - Materials (74 credits)**

Note: Attainment of the Honours degree requires a CGPA of at least 3.00.

**Program Prerequisites**

## PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

**Required Courses (65 credits)**

The required courses in this program consist of 68 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 Quebec or transfer students should consult the Academic Adviser.

See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

A computer science course, either COMP 202 or COMP 208, is strongly recommended during U1 for students who have no previous introduction to computer programming. Students should contact their adviser on this matter. Completion of Mathematics MATH 222 during U1 is also strongly recommended. Physics PHYS 242 should be completed during U2.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

\*\*\* Students may take up to 12 Research Project credits but only 6 of these may be used to fulfil the program requirement.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 332	(3)	Biological Chemistry
CHEM 334	(3)	Advanced Materials
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 392	(3)	Integrated Inorganic/Organic Laboratory
CHEM 470***	(6)	Research Project 1
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
CHEM 574	(3)	Introductory Polymer Chemistry
MATH 222**	(3)	Calculus 3
PHYS 242	(2)	Electricity and Magnetism

### Complementary Courses (9 credits)

9 credits from the following:

\* Students take either ANAT 542 or MIME 542.

ANAT 542*	(3)	Transmission Electron Microscopy
CHEM 462	(3)	Green Chemistry
CHEM 531	(3)	Chemistry of Inorganic Materials
CHEM 533	(3)	Small Molecule Crystallography
CHEM 534	(3)	Nanoscience and Nanotechnology
CHEM 571	(3)	Polymer Synthesis
CHEM 582	(3)	Supramolecular Chemistry
CHEM 585	(3)	Colloid Chemistry
MATH 315	(3)	Ordinary Differential Equations
MIME 260	(3)	Materials Science and Engineering
MIME 542*	(3)	Transmission Electron Microscopy

### 13.7.20 Bachelor of Science (B.Sc.) - Honours Chemistry - Measurement (74 credits)

The B.Sc. Honours in Chemistry; Measurement provides an emphasis on additional background and advanced courses of interest to physical and analytical chemists.

Note: Attainment of the Honours degree requires a CGPA of at least 3.00.

#### Program Prerequisites

## PRE-PROGRAM REQUIREMENTS:

Students entering from the Freshman program must have included CHEM 110 and CHEM 120 or CHEM 115, BIOL 111 or BIOL 112, MATH 133, MATH 140/MATH 141 or MATH 150/MATH 151, PHYS 131/PHYS 142, or their equivalents in their Freshman year. Quebec students must have completed the DEC with appropriate science and mathematics courses. Note that students who have successfully completed MATH 150 and MATH 151 do not have to take MATH 222.

**Required Courses (59 credits)**

The required courses in this program consist of 59 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. Students completing this program will not be eligible for admission to the Ordre des chimistes du Québec without additional chemistry electives. This program is not currently accredited by the Canadian Society for Chemistry. See <http://www.mcgill.ca/chemistry/current-undergraduate-students/advising/>.

Completion of Mathematics MATH 222 and MATH 315 during U1 is also strongly recommended.

\* Denotes courses with CEGEP equivalents.

\*\* Students who have successfully completed MATH 150 and MATH 151 are not required to take MATH 222.

CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 213	(3)	Introductory Physical Chemistry 1: Thermodynamics
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 267	(3)	Introductory Chemical Analysis
CHEM 273	(3)	Introductory Physical Chemistry 2: Kinetics and Methods
CHEM 281	(3)	Inorganic Chemistry 1
CHEM 345	(3)	Introduction to Quantum Chemistry
CHEM 355	(3)	Applications of Quantum Chemistry
CHEM 365	(2)	Statistical Thermodynamics
CHEM 367	(3)	Instrumental Analysis 1
CHEM 377	(3)	Instrumental Analysis 2
CHEM 381	(3)	Inorganic Chemistry 2
CHEM 493	(2)	Advanced Physical Chemistry Laboratory
CHEM 575	(3)	Chemical Kinetics
MATH 222**	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
PHYS 241	(3)	Signal Processing
PHYS 242	(2)	Electricity and Magnetism

**Complementary Courses (15 credits)**

6 credits from:

CHEM 514	(3)	Biophysical Chemistry
CHEM 516	(3)	Nuclear and Radiochemistry
CHEM 531	(3)	Chemistry of Inorganic Materials
CHEM 533	(3)	Small Molecule Crystallography
CHEM 534	(3)	Nanoscience and Nanotechnology
CHEM 547	(3)	Laboratory Automation
CHEM 555	(3)	NMR Spectroscopy
CHEM 556	(3)	Advanced Quantum Mechanics
CHEM 567	(3)	Chemometrics: Data Analysis
CHEM 577	(3)	Electrochemistry

CHEM 585	(3)	Colloid Chemistry
CHEM 593	(3)	Statistical Mechanics
CHEM 597	(3)	Analytical Spectroscopy

6 credits of research\*:

\* Students may take up to 9 Research Project credits but only 6 of these may be used to fulfil the program requirement.

CHEM 470	(6)	Research Project 1
CHEM 480	(3)	Undergraduate Research Project 2

Or other research-related courses at the 400 or 500 level.

3 additional credits at the 400 or 500 level.

ATOC 214	(3)	Introduction: Physics of the Atmosphere
CHEM 532	(3)	Structural Organic Chemistry
MATH 317	(3)	Numerical Analysis

### 13.7.21 Chemistry (CHEM) Related Programs

#### 13.7.21.1 Joint Honours in Physics and Chemistry

For more information, see [section 13.30: Physics \(PHYS\)](#).

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## 13.8 Cognitive Science

### 13.8.1 About Cognitive Science

Cognitive Science is the multidisciplinary study of cognition in humans, animals, and machines. The goal is to understand the principles of intelligence and thought with the hope that this will lead to a better understanding of the mind and of learning, and to the development of intelligent devices.

Students wishing to enrol in the **Minor in Cognitive Science** must meet with the Interdisciplinary Programs Adviser in the Faculty of Science. Please refer to [www.mcgill.ca/cogsci](http://www.mcgill.ca/cogsci) for advising information.

### 13.8.2 Bachelor of Science (B.Sc.) - Minor Cognitive Science (24 credits)

The Minor Cognitive Science is intended to allow students in the Faculty of Arts or the Faculty of Science to explore the interdisciplinary study of cognition. The goal is to understand the principles of intelligence with the hope that this will lead to a better understanding of the mind and learning.

Students wishing to complete this Minor must meet with the Interdisciplinary Programs Adviser in the Science Office for Undergraduate Student Advising (SOUSA).

#### Required Course (3 credits)

PSYC 433	(3)	Cognitive Science
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#### Complementary Courses (21 credits)

Note:

Students must take a minimum of 6 credits at the 400 to 500 level.

Students may not take any courses from their home department(s).

Students complete a minimum of 9 credits each in two areas.

#### Computer Science and Mathematics

COMP 206	(3)	Introduction to Software Systems
COMP 230	(3)	Logic and Computability
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 302	(3)	Programming Languages and Paradigms
COMP 330	(3)	Theory of Computation
COMP 417	(3)	Introduction Robotics and Intelligent Systems
COMP 424	(3)	Artificial Intelligence
COMP 527	(3)	Logic and Computation
COMP 531	(3)	Advanced Theory of Computation
MATH 318	(3)	Mathematical Logic

**Linguistics**

LING 201	(3)	Introduction to Linguistics
LING 330	(3)	Phonetics
LING 331	(3)	Phonology 1
LING 355	(3)	Language Acquisition 1
LING 371	(3)	Syntax 1
LING 419	(3)	Linguistic Theory and its Foundations
LING 440	(3)	Morphology
LING 455	(3)	Second Language Syntax
LING 571	(3)	Syntax 2
LING 590	(3)	Language Acquisition and Breakdown

**Philosophy**

PHIL 210	(3)	Introduction to Deductive Logic 1
PHIL 304	(3)	Chomsky
PHIL 306	(3)	Philosophy of Mind
PHIL 310	(3)	Intermediate Logic
PHIL 415	(3)	Philosophy of Language
PHIL 474	(3)	Phenomenology

**Psychology**

PSYC 213	(3)	Cognition
PSYC 301	(3)	Animal Learning and Theory
PSYC 304	(3)	Child Development
PSYC 310	(3)	Intelligence
PSYC 311	(3)	Human Cognition and the Brain
PSYC 315	(3)	Computational Psychology
PSYC 340	(3)	Psychology of Language
PSYC 410	(3)	Special Topics in Neuropsychology

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## 13.9 Computer Science (COMP)

### 13.9.1 Location

#### Main Office

McConnell Engineering Building, Room 318  
3480 University Street  
Montreal QC H3A 0E9  
Telephone: 514-398-7071  
Fax: 514-398-3883

#### Undergraduate Student Affairs Office

McConnell Engineering Building, Room 320  
3480 University Street  
Montreal QC H3A 0E9  
Telephone: 514-398-7071 ext. 00739  
Fax: 514-398-3883

Email: [ugrad-sec@cs.mcgill.ca](mailto:ugrad-sec@cs.mcgill.ca)

Website: [www.cs.mcgill.ca](http://www.cs.mcgill.ca)

### 13.9.2 About Computer Science

Computer Science covers the theory and practice behind the design and implementation of computer and information systems. Fundamental to computer science are questions about how to describe, process, manage, and analyze information and computation. A fundamental building block is the study of algorithms. An algorithm presents a detailed sequence of actions solving a particular task. A computer program is the implementation of an algorithm in a specific programming language, which enables a computer to execute the algorithm. Software generally refers to a computer program or a set of related computer programs.

Based on the building blocks of computational thinking and programming, **computer science is split into many different areas**. Examples are:

- The study of algorithms and data structures
- Programming languages and methodology
- Theory of computation
- Software engineering (the design of large software systems)
- Computer architecture (the structure of the hardware)
- Communication between computers
- Operating systems (the software that shields users from the underlying hardware)
- Database systems (software that handles large amounts of data efficiently)
- Artificial intelligence (algorithms inspired by human information processing)
- Computer vision (algorithms that let computers see and recognize their environment)
- Computer graphics
- Robotics (algorithms that control robots)
- Computational biology (algorithms and methods that address problems inspired by biology)

Computer science also plays an important role in many other fields, including Biology, Physics, Engineering, Business, Music, and Neuroscience, where it is necessary to process and reason about large amounts of data. Computer Science is strongly related to mathematics, linguistics, and engineering.

A degree in Computer Science offers excellent job prospects. As the use of computers and specialized software plays a crucial role in business, science, and our personal life, computer science graduates are in high demand. Computer scientists find jobs in software development, consulting, research, and project management. As computer scientists often develop the software for a specific application domain (e.g., business, engineering, medicine), they must be prepared and willing to get to know their application area.

The School of Computer Science offers a wide range of programs. Most programs start with the same set of basic courses allowing students to decide on their exact program once they get a basic understanding of the discipline. Within the Faculty of Science, there are:

- Major, Honours, Liberal, and Minor programs in **Computer Science**:

- Major and Liberal programs in **Software Engineering**;
- Major in **Computer Science: Computer Games Option**;
- Major and Honours in **Mathematics and Computer Science** (see [section 13.22: Mathematics and Statistics \(MATH\)](#));
- Major and Honours in **Statistics and Computer Science** (see [section 13.22: Mathematics and Statistics \(MATH\)](#));
- Major and Honours in **Physics and Computer Science** (see [section 13.30: Physics \(PHYS\)](#));
- Major and Honours in **Computer Science and Biology** (see [section 13.5: Biology \(BIOL\)](#)).

The School also offers a Major Concentration and Minor concentrations in Computer Science, and a Major Concentration in Software Engineering through the Faculty of Arts (see [Faculty of Arts > Undergraduate > Browse Academic Units & Programs > : Computer Science \(COMP\)](#)), or as part of a Bachelor of Arts and Science (see [Bachelor of Arts & Science > Undergraduate > Browse Academic Units & Programs > : Computer Science \(COMP\)](#)).

The School's courses are available as electives to Engineering students. Engineering students interested in a minor in Computer Science should consult [Faculty of Engineering > Undergraduate > Browse Academic Units & Programs > Minor Programs > : Computer Science Courses and Minor Program](#).

Most course instructors are faculty members of the School that do research in the areas they teach. The School favours interactive teaching practices where students get to know their professors and have the opportunity to do cutting-edge research. Some graduate courses in Computer Science are available to suitably qualified senior undergraduates. The School offers large computing labs in the Lorne Trotter Building, which is dedicated to undergraduate students.

*All students planning to enter Computer Science programs are strongly encouraged to make an appointment with an academic adviser through the School's Undergraduate Student Affairs Office (see [www.cs.mcgill.ca/academic/undergrad/advising](http://www.cs.mcgill.ca/academic/undergrad/advising)).*

### 13.9.3 Internship Opportunities

Students who want to get practical experience in industry before graduation are encouraged to participate in one of the following internship programs:

- The **Internship Year in Science (IYS)** is offered for a duration of 8, 12, or 16 months. It will be reflected on the student's transcript and is included in the program name (Bachelor of Science – Internship Program).
- The **Industrial Practicum (IP)** has a duration of four months and is usually carried out starting in May. It will appear as a 0-credit, Pass/Fail course on the student's transcript. If a student completes two IPs, the program name will change to include the word “internship.”

For more information on these opportunities, consult [section 12: Science Internships and Field Studies](#) or [www.mcgill.ca/science/student/internships-field](http://www.mcgill.ca/science/student/internships-field).

### 13.9.4 Research Opportunities

Computer science undergraduates have excellent opportunities to participate in research. Each summer, several awards are available, such as the NSERC Undergraduate Student Research Awards; these offer financial support for a research experience in an academic setting. Other research assistantship and volunteering opportunities in research labs are also available.

Students may also take undergraduate research project courses such as COMP 396 *Undergraduate Research Project*, COMP 400 *Project in Computer Science*, and COMP 401 *Project in Biology and Computer Science*. Students who have participated in substantial and broad undergraduate research may qualify for the Dean's Multidisciplinary Undergraduate Research List at graduation time. For more information, consult [University Regulations & Resources > Undergraduate > Graduation > Graduation Honours > : Faculty of Science Dean's Multidisciplinary Undergraduate Research List](#).

### 13.9.5 Admissions

Students intending to pursue a program in Computer Science or Software Engineering should have a reasonable mathematical background and should have completed MATH 140 (or MATH 150), MATH 141 (or MATH 151), and MATH 133, or their CEGEP equivalents. These three Mathematics courses should have been completed with at least an average of B-. A background in computer science is not necessary as students may start their studies with the introductory course COMP 202. However, taking COMP 202 in the Freshman year, or completing an equivalent course in CEGEP, would be an asset that would allow students to take more advanced courses earlier in their program.

More information about the admission process and programs is available at [www.cs.mcgill.ca](http://www.cs.mcgill.ca).

### 13.9.6 Computer Science Faculty

#### Director

B. Kemme

#### Emeritus Professors

D. Avis; B.Sc.(Wat.), Ph.D.(Stan.)

R. De Mori; Ph.D.(Politecnico Torino)

T.H. Merrett; B.Sc.(Qu.), D.Phil.(Oxf.)

M.M. Newborn; B.E.E.(Rensselaer Poly.), Ph.D.(Ohio St.), F.A.C.M.

C. Paige; B.Sc., B.Eng.(Syd.), Ph.D.(Lond.)

**Emeritus Professors**

G.F.G. Ratzer; B.Sc.(Glas.), M.Sc.(McG.)

D. Thérien; B.Sc.(Montr.), M.Sc., Ph.D.(Wat.) (*James McGill Professor*)

G.T. Toussaint; B.Sc.(Tulsa), Ph.D.(Br. Col.)

**Post-Retirement**

C. Tropper; B.Sc.(McG.), Ph.D.(Brooklyn Poly.)

**Professors**

L. Devroye; M.S.(Louvain), Ph.D.(Texas) (*James McGill Professor*)

G. Dudek; B.Sc.(Qu.), M.Sc., Ph.D.(Tor.) (*James McGill Professor*)

L. Hendren; B.Sc., M.Sc.(Qu.), Ph.D.(Cornell), F.R.S.C. (*Canada Research Chair*)

X. Liu; B.Sc., M.Sc.(Tsinghua), Ph.D.(Ill.) (*William Dawson Scholar*)

P. Panangaden; M.Sc.(IIT, Kanpur), M.S.(Chic.), Ph.D.(Wisc.)

B. Reed; B.Sc., Ph.D.(McG.) (*Canada Research Chair*)

M. Robillard; B.Eng.(École Poly., Montr.), M.Sc., Ph.D.(Br. Col.)

K. Siddiqi; B.Sc.(Lafayette), M.Sc., Ph.D.(Brown) (*William Dawson Chair*)

**Associate Professors**

M. Blanchette; B.Sc., M.Sc.(Montr.), Ph.D.(Wash.)

X.W. Chang; B.Sc., M.Sc.(Nanjing), Ph.D.(McG.)

C. Crépeau; B.Sc., M.Sc.(Montr.), Ph.D.(MIT)

N. Friedman; B.A.(W. Ont.), Ph.D.(Tor.)

H. Hatami; B.Sc.(Sharif), M.Sc., Ph.D.(Tor.)

B. Kemme; B.Sc., M.Sc.(Erlangen-Nuremberg, Germany), Ph.D.(ETH, Zurich)

J. Kienzle; Eng.Dip., Ph.D.(Swiss Fed. IT)

P. Kry; B.Sc.(Wat.), M.Sc., Ph.D.(Br. Col.)

M. Langer; B.Sc.(McG.), M.Sc.(Tor.), Ph.D.(McG.)

M. Maheswaran; B.Sc.(U. Peradeniya), M.Sc., Ph.D.(Purdue)

B. Pientka; B.Sc., M.Sc.(Tech. U. of Darmstadt, Germany), Ph.D.(Carn. Mell)

J. Pineau; B.Sc.(Wat.), M.Sc., Ph.D.(Carn. Mell) (*William Dawson Scholar*)

D. Precup; B.Sc.(Tech. U. of Cluj-Napoca), M.Sc., Ph.D.(Mass.)

D. Ruths; B.Sc., M.Sc., Ph.D.(Rice)

C. Verbrugge; B.A.(Qu.), Ph.D.(McG.)

A. Vetta; B.Sc., M.Sc.(LSE), Ph.D.(MIT)

J. Waldispuhl; B.Sc.(Nice Sophia Antipolis), M.Sc.(Paris VII), Ph.D.(École Poly., France)

**Assistant Professors**

Y. Cai; B.S.(Peking), M.S., Ph.D.(MIT) (*William Dawson Scholar*)

J. Cheung; B.Sc.(Br. Col.), M.Sc., Ph.D.(Tor.)

D. Meger; B.Sc.(Br. Col.), M.Sc.(McG.), Ph.D.(Br. Col.)

**Faculty Lecturer**

J. Vybihal; B.Sc., M.Sc.(McG.)

**Associate Members**

D. Schlimm (*Philosophy*)



**Associate Members**T.R. Shultz (*Psychology*)**Adjunct Professors**

A. Baretto, P.J. Mosterman, T. Perkins, I. Rekleitis, G.O. Sabidussi

**13.9.7 Bachelor of Science (B.Sc.) - Minor Computer Science (24 credits)**

Students must obtain approval from their main program adviser, and are also strongly encouraged to speak with a School of Computer Science adviser before choosing complementary courses. A particular course selection must be approved before the student registers for their final term of studies.

Students should note that COMP 251 is a prerequisite for many upper level COMP courses. Upper level COMP courses may have prerequisites that are not part of the Minor such as MATH 222, MATH 223, or MATH 323. Students will not get credit for these courses toward the Minor.

Students may receive up to 6 credits toward the Minor by taking certain approved courses outside the School of Computer Science. These courses must have a high computer science content and must be approved by the School of Computer Science in advance. If a student's Major program requires Computer Science courses, up to 6 credits of Computer Science courses may be used to fulfill both Major and Minor requirements.

**Required Courses (9 credits)**

\* Students who have sufficient knowledge of computer programming do not need to take COMP 202, but it must be replaced with an additional computer science complementary course.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science

**Complementary Courses (15 credits)**

15 credits selected from the courses below and computer science courses at the 300 level or above (except COMP 364 and COMP 396).

COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
MATH 240	(3)	Discrete Structures 1

**13.9.8 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Computer Science (45 credits)**

**Revision, April 2018. Start of revision.**

This program provides an introduction to the principles of computer science and offers opportunity to get insight into some of its sub-areas. Having only 45 credits, it allows students to combine it with minor or major concentrations in other disciplines.

**Required Courses (18 credits)**

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202, but it must be replaced with an additional computer science complementary course.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
MATH 240	(3)	Discrete Structures 1

**Complementary Courses (27 credits)**

3 credits from each of the groups A, B, C, and D.

Group A

MATH 222	(3)	Calculus 3
MATH 323	(3)	Probability
MATH 324	(3)	Statistics

Group B

MATH 223	(3)	Linear Algebra
MATH 318	(3)	Mathematical Logic
MATH 340	(3)	Discrete Structures 2

Group C

COMP 330	(3)	Theory of Computation
COMP 350	(3)	Numerical Computing
COMP 360	(3)	Algorithm Design

Group D

COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design

An additional 3 credits may be selected from Group A or B.

The remaining complementary credits must be selected from any COMP courses at the 300 level or above except COMP 364 and COMP 396.

**Revision, April 2018. End of revision.**

### 13.9.9 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Software Engineering (49 credits)

**Revision, April 2018. Start of revision.**

This program covers a core of programming and software engineering courses and allows students to select courses that aim at practical aspects of software development.

#### Required Courses (36 credits)

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202 and can replace it with additional computer science complementary course credits.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design
COMP 310	(3)	Operating Systems
COMP 361D1	(3)	Software Engineering Project
COMP 361D2	(3)	Software Engineering Project
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures 1

**Complementary Courses (13 credits)**

3 credits selected from:

COMP 330	(3)	Theory of Computation
COMP 360	(3)	Algorithm Design

10 credits from:

COMP 322	(1)	Introduction to C++
COMP 409	(3)	Concurrent Programming
COMP 421	(3)	Database Systems
COMP 520	(4)	Compiler Design
COMP 525	(3)	Formal Verification
COMP 529	(4)	Software Architecture
COMP 533	(3)	Model-Driven Software Development
COMP 535	(4)	Computer Networks 1
ECSE 326	(3)	Software Requirements Engineering
ECSE 437	(3)	Software Delivery
ECSE 539	(4)	Advanced Software Language Engineering

Or any COMP courses at the 300 level or above (excluding COMP 364 and COMP 396.)

**Revision, April 2018. End of revision.****13.9.10 Bachelor of Science (B.Sc.) - Major Computer Science (63 credits)**

This program is the standard Major program offered by the School of Computer Science. It provides a broad introduction to the principles of computer science and offers ample opportunity to acquire in-depth knowledge of several sub-disciplines. At the same time, its credit requirements allow students to take an additional minor.

Students may complete this program with a minimum of 60 credits or a maximum of 63 credits depending if they are exempt from taking COMP 202.

**Required Courses (33 credits)**

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design
COMP 310	(3)	Operating Systems
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures 1

**Complementary Courses (30 credits)**

Students should talk to an academic adviser before choosing their complementary courses.

At least 6 credits selected from:

COMP 330	(3)	Theory of Computation
COMP 350	(3)	Numerical Computing
COMP 360	(3)	Algorithm Design

3-9 credits selected from:

\* Must include at least one of MATH 323 and MATH 340.

MATH 318	(3)	Mathematical Logic
MATH 323*	(3)	Probability
MATH 324	(3)	Statistics
MATH 340*	(3)	Discrete Structures 2

At least 6 credits at the 400-level or above.

The remaining credits selected from computer science courses at the 300 level or above (except COMP 364 and COMP 396) and ECSE 539.

Note: Students have to make sure that they have the appropriate prerequisites when choosing upper-level courses.

### 13.9.11 Bachelor of Science (B.Sc.) - Major Computer Science and Biology (74 credits)

This program will train students in the fundamentals of biology and will give them computational and mathematical skills needed to manage, analyze, and model large biological datasets. Integrative features of the program include interdisciplinary introductory and seminar courses in bio-physical sciences, and a joint independent studies project.

Students may complete this program with a maximum of 74 credits or a minimum of 63 credits. This depends upon the student's choice of required courses and whether or not the student is exempt from taking COMP 202.

Program prerequisites: To ensure they meet the core requirements of the program it is highly recommended that the following courses be selected by U0 (Freshman) students: BIOL 111-112, CHEM 110-120, MATH 133, MATH 140-141 or MATH 150-151, PHYS 101-102 or PHYS 131-142. Note that MATH 150-151 provides equivalence for required course MATH 222. It is also advisable to take COMP 202 during U0 if possible.

#### Required Courses (46 credits)

36-46 credits:

##### Bio-Physical Sciences Core

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
COMP 202**	(3)	Foundations of Programming
MATH 222*	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 323	(3)	Probability

##### Computer Science and Mathematics

COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures

MATH 240 (3) Discrete Structures 1

### Biology

BIOL 202 (3) Basic Genetics

BIOL 215 (3) Introduction to Ecology and Evolution

### Required Joint Courses

COMP 401 (3) Project in Biology and Computer Science

\* Students with CEGEP-level credit for the equivalents of MATH 222 and/or CHEM 212 (see <http://www.mcgill.ca/students/courses/plan/transfer/> for accepted equivalents) may not take these courses at McGill and should replace them with elective courses to satisfy the total credit requirement for their degree.

\*\* Students who have sufficient knowledge in a programming language are not required to take COMP 202.

\*\*\* Students are advised to take MATH 240 before COMP 251 (MATH 240 is in the list of Complementaries below).

### Complementary Courses

27-28 credits

3-4 credits from the following:

COMP 462 (3) Computational Biology Methods

COMP 561 (4) Computational Biology Methods and Research

3-6 from the following:

MATH 315 (3) Ordinary Differential Equations

MATH 324 (3) Statistics

The remaining 18-21 credits is to be chosen from the following, with at least 9 credits at the 400 level or above.

### Computer Science Block

9-12 credits from the following, with 3-6 credits at the 400 level or above.

Note: All COMP courses at the 400 level or above (except COMP 400, 401, 499, 462, and 561).

COMP 273 (3) Introduction to Computer Systems

COMP 302 (3) Programming Languages and Paradigms

COMP 303 (3) Software Design

COMP 307 (2) Principles of Web Development

COMP 310 (3) Operating Systems

COMP 322 (1) Introduction to C++

COMP 330 (3) Theory of Computation

COMP 350 (3) Numerical Computing

COMP 360 (3) Algorithm Design

COMP 361D1\* (3) Software Engineering Project

COMP 361D2\* (3) Software Engineering Project

MATH 240 (3) Discrete Structures 1

\* Students must take both COMP 361D1 and COMP 361D2.

**Biology Block**

9-12 credits from the following, with 3-6 credits at the 400 level or above:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 304	(3)	Evolution
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 308	(3)	Ecological Dynamics
BIOL 309	(3)	Mathematical Models in Biology
BIOL 310	(3)	Biodiversity and Ecosystems
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 316	(3)	Biomembranes and Organelles
BIOL 319	(3)	Introduction to Biophysics
BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 370	(3)	Human Genetics Applied
BIOL 389	(3)	Laboratory in Neurobiology
BIOL 395	(1)	Quantitative Biology Seminar 1
BIOL 416	(3)	Genetics of Mammalian Development
BIOL 434	(3)	Theoretical Ecology
BIOL 435	(3)	Natural Selection
BIOL 495	(1)	Quantitative Biology Seminar 2
BIOL 509	(3)	Methods in Molecular Ecology
BIOL 514	(3)	Neurobiology Learning and Memory
BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 530	(3)	Advances in Neuroethology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 546	(3)	Genetics of Model Systems
BIOL 551	(3)	Principles of Cellular Control
BIOL 568	(3)	Topics on the Human Genome
BIOL 569	(3)	Developmental Evolution
BIOL 575	(3)	Human Biochemical Genetics
BIOL 580	(3)	Genetic Approaches to Neural Systems
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
NEUR 310	(3)	Cellular Neurobiology

**13.9.12 Bachelor of Science (B.Sc.) - Major Computer Science - Computer Games (67 credits)**

This program is a specialization within Computer Science. It fulfils all the basic requirements of the Major Computer Science. Complementary courses focus on topics that are important to understanding the technology behind computer games and to gaining experience in software development and design needed for computer game development.

Students may complete this program with a minimum of 62 credits or a maximum of 67 credits depending if they are exempt from taking COMP 202 and their choice of complementary courses.

**Required Courses (50 credits)**

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202 and can replace it with additional computer science complementary course credits.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design
COMP 308	(1)	Computer Systems Lab
COMP 310	(3)	Operating Systems
COMP 322	(1)	Introduction to C++
COMP 330	(3)	Theory of Computation
COMP 361D1	(3)	Software Engineering Project
COMP 361D2	(3)	Software Engineering Project
COMP 557	(3)	Fundamentals of Computer Graphics
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures 1
MATH 323	(3)	Probability

**Complementary Courses (17 credits)**

Students complete a minimum of 15 or a maximum of 17 complementary credits selected as follows:

3 credits selected from:

COMP 350	(3)	Numerical Computing
COMP 360	(3)	Algorithm Design

6-8 credits selected from:

COMP 424	(3)	Artificial Intelligence
COMP 521	(4)	Modern Computer Games
COMP 522	(4)	Modelling and Simulation
COMP 529	(4)	Software Architecture
COMP 533	(3)	Model-Driven Software Development
COMP 551	(4)	Applied Machine Learning
COMP 559	(4)	Fundamentals of Computer Animation

6 credits selected from:

COMP 409	(3)	Concurrent Programming
COMP 421	(3)	Database Systems
COMP 535	(3)	Computer Networks 1

**13.9.13 Bachelor of Science (B.Sc.) - Major Software Engineering (63 credits)**

**Revision, April 2018. Start of revision.**

This program provides a broad introduction to the principles of computer science and covers in depth the design and development of software systems. Students may complete this program with a maximum of 63 credits or a minimum of 60 credits if they are exempt from taking COMP 202.

**Required Courses**

36-39 credits

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design
COMP 310	(3)	Operating Systems
COMP 361D1	(3)	Software Engineering Project
COMP 361D2	(3)	Software Engineering Project
ECSE 429	(3)	Software Validation
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures 1

**Complementary Courses (24 credits)**

9 credits selected from Groups A and B, with at least 3 credits selected from each:

15 credits selected from Groups C and D, with at least 9 credits selected from Group C, and at least 3 credits selected from Group D.

**Group A:**

MATH 222	(3)	Calculus 3
MATH 323	(3)	Probability
MATH 324	(3)	Statistics

**Group B:**

COMP 330	(3)	Theory of Computation
COMP 360	(3)	Algorithm Design

**Group C: Software Engineering Specialization**

\* Students may select either COMP 409 or ECSE 420, but not both.

COMP 409*	(3)	Concurrent Programming
COMP 523	(3)	Language-based Security
COMP 525	(3)	Formal Verification
COMP 529	(4)	Software Architecture
COMP 533	(3)	Model-Driven Software Development
ECSE 326	(3)	Software Requirements Engineering



ECSE 420*	(3)	Parallel Computing
ECSE 424	(3)	Human-Computer Interaction
ECSE 437	(3)	Software Delivery
ECSE 539	(4)	Advanced Software Language Engineering

**Group D: Applications**

COMP 350	(3)	Numerical Computing
COMP 417	(3)	Introduction Robotics and Intelligent Systems
COMP 421	(3)	Database Systems
COMP 424	(3)	Artificial Intelligence
COMP 512	(4)	Distributed Systems
COMP 520	(4)	Compiler Design
COMP 521	(4)	Modern Computer Games
COMP 522	(4)	Modelling and Simulation
COMP 535	(4)	Computer Networks 1
COMP 551	(4)	Applied Machine Learning
COMP 557	(4)	Fundamentals of Computer Graphics
COMP 558	(3)	Fundamentals of Computer Vision

Revision, April 2018. End of revision.

**13.9.14 Bachelor of Science (B.Sc.) - Honours Computer Science (75 credits)**

Students may complete this program with a minimum of 72 credits or a maximum of 75 credits depending if they are exempt from taking COMP 202. Honours students must maintain a CGPA of at least 3.00 during their studies and at graduation.

**Required Courses (48 credits)**

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202.

\*\* Students take either MATH 340 or MATH 350.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 252	(3)	Honours Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design
COMP 310	(3)	Operating Systems
COMP 330	(3)	Theory of Computation
COMP 350	(3)	Numerical Computing
COMP 362	(3)	Honours Algorithm Design
COMP 400	(3)	Project in Computer Science
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures 1
MATH 340**	(3)	Discrete Structures 2

MATH 350\*\* (3) Graph Theory and Combinatorics

### Complementary Courses (27 credits)

6 credits selected from:

MATH 318 (3) Mathematical Logic  
MATH 323 (3) Probability  
MATH 324 (3) Statistics

The remaining credits selected from computer science courses at the 300 level or above (except COMP 364 and COMP 396) and ECSE 539. At least 12 credits must be at the 500 level.

### 13.9.15 Bachelor of Science (B.Sc.) - Honours Computer Science and Biology (77 credits)

This honours program will train students in the fundamentals of biology - with a focus on molecular biology - and will give them computational and mathematical skills needed to manage, analyze, and model large biological datasets. Integrative features of the program include interdisciplinary introductory and seminar courses in bio-physical sciences, and a joint independent studies project. Compared to its non-Honours counterpart, the Honours program requires additional research credits and a larger number of advanced courses. Students must have and maintain a minimum CPGA of 3.5. Students may complete this program with a maximum of 77 credits or a minimum of 66 credits. This depends upon the student's choice of required courses and whether or not the student is exempt from taking COMP 202.

Program prerequisites: To ensure they meet the core requirements of the program it is highly recommended that the following courses be selected by U0 (Freshman) students: BIOL 111-112, CHEM 110-120, MATH 133, MATH 140-141 or MATH 150-151, PHYS 101-102 or PHYS 131-142. Note that MATH 150-151 provides equivalence for required course MATH 222, it is also advisable to take COMP 202 during U0 if possible. It is highly recommended that Freshman BIOL, CHEM, MATH and PHYS courses be selected with an adviser to ensure they meet the core requirements of the COMP-BIO program.

#### Required Courses

39-49 credits:

#### Bio-Physical Sciences Core

BIOL 219 (4) Introduction to Physical Biology of the Cell  
BIOL 301 (4) Cell and Molecular Laboratory  
BIOL 395 (1) Quantitative Biology Seminar 1  
CHEM 212\* (4) Introductory Organic Chemistry 1  
COMP 202\*\* (3) Foundations of Programming  
MATH 222\* (3) Calculus 3  
MATH 223 (3) Linear Algebra  
MATH 323 (3) Probability

#### Computer Science and Mathematics

COMP 206 (3) Introduction to Software Systems  
COMP 250 (3) Introduction to Computer Science  
COMP 252 (3) Honours Algorithms and Data Structures  
MATH 240 (3) Discrete Structures 1

#### Biology

BIOL 202 (3) Basic Genetics  
BIOL 215 (3) Introduction to Ecology and Evolution

**Joint Courses**

COMP 402D1	(3)	Honours Project in Computer Science and Biology
COMP 402D2	(3)	Honours Project in Computer Science and Biology

\* Students with CEGEP-level credit for the equivalents of MATH 222 and/or CHEM 212 (see <http://www.mcgill.ca/students/courses/plan/transfer/> for accepted equivalents) may not take these courses at McGill and should replace them with elective courses to satisfy the total credit requirement for their degree.

\*\* Students who have sufficient knowledge in a programming language are not required to take COMP 202. \*\*\* Students take either COMP 462 or COMP 561.

**Complementary Courses**

27-28 credits

3-4 credits from the following:

COMP 462	(3)	Computational Biology Methods
COMP 561	(4)	Computational Biology Methods and Research

3-6 credits from the following:

MATH 315	(3)	Ordinary Differential Equations
MATH 324	(3)	Statistics

The remaining 18-21 credits to be chosen from the following, with at least 9 credits at the 400 level or above:

**Computer Science Block**

9-12 credits from the following, with 3-6 credits at the 400 level or above:

COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design
COMP 307	(2)	Principles of Web Development
COMP 310	(3)	Operating Systems
COMP 322	(1)	Introduction to C++
COMP 330	(3)	Theory of Computation
COMP 350	(3)	Numerical Computing
COMP 361D1***	(3)	Software Engineering Project
COMP 361D2***	(3)	Software Engineering Project
COMP 362	(3)	Honours Algorithm Design

\*\*\* Students must take both COMP 361D1 and COMP 361D2.

**Biology Block**

9-12 credits from the following, with 3-6 credits at the 400 level or above:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 304	(3)	Evolution
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 308	(3)	Ecological Dynamics

BIOL 309	(3)	Mathematical Models in Biology
BIOL 310	(3)	Biodiversity and Ecosystems
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 316	(3)	Biomembranes and Organelles
BIOL 319	(3)	Introduction to Biophysics
BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 370	(3)	Human Genetics Applied
BIOL 389	(3)	Laboratory in Neurobiology
BIOL 395	(1)	Quantitative Biology Seminar 1
BIOL 416	(3)	Genetics of Mammalian Development
BIOL 434	(3)	Theoretical Ecology
BIOL 435	(3)	Natural Selection
BIOL 495	(1)	Quantitative Biology Seminar 2
BIOL 509	(3)	Methods in Molecular Ecology
BIOL 514	(3)	Neurobiology Learning and Memory
BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 530	(3)	Advances in Neuroethology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 546	(3)	Genetics of Model Systems
BIOL 551	(3)	Principles of Cellular Control
BIOL 568	(3)	Topics on the Human Genome
BIOL 569	(3)	Developmental Evolution
BIOL 575	(3)	Human Biochemical Genetics
BIOL 580	(3)	Genetic Approaches to Neural Systems
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
NEUR 310	(3)	Cellular Neurobiology

### 13.9.16 Bachelor of Science (B.Sc.) - Honours Software Engineering (75 credits)

#### Revision, April 2018. Start of revision.

This program provides a more challenging and research-oriented version of the Major Software Engineering program.

Students may complete this program with a maximum of 75 credits or a minimum of 72 credits if they are exempt from taking COMP 202.

Honours students must maintain a CGPA of at least 3.00 during their studies and at graduation.

#### Required Courses

39-42 credits

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures

COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 303	(3)	Software Design
COMP 310	(3)	Operating Systems
COMP 361D1	(3)	Software Engineering Project
COMP 361D2	(3)	Software Engineering Project
COMP 400	(4)	Project in Computer Science
ECSE 429	(3)	Software Validation
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures 1

**Complementary Courses (33 credits)**

At least 9 credits must be from Groups A and B, with at least 3 credits from each:

At least 18 credits must be from Groups C and D, with at least 9 credits from Group C and at least 6 credits from Group D.

At least 12 credits must be from COMP courses at the 500 level or above.

**Group A:**

MATH 222	(3)	Calculus 3
MATH 323	(3)	Probability
MATH 324	(3)	Statistics

**Group B:**

COMP 330	(3)	Theory of Computation
COMP 360	(3)	Algorithm Design

**Group C: Software Engineering Specialization**

\* Students may select either COMP 409 or ECSE 420, but not both.

COMP 409*	(3)	Concurrent Programming
COMP 523	(3)	Language-based Security
COMP 525	(3)	Formal Verification
COMP 529	(4)	Software Architecture
COMP 533	(3)	Model-Driven Software Development
ECSE 326	(3)	Software Requirements Engineering
ECSE 420*	(3)	Parallel Computing
ECSE 424	(3)	Human-Computer Interaction
ECSE 437	(3)	Software Delivery
ECSE 539	(4)	Advanced Software Language Engineering

**Group D: Applications**

COMP 350	(3)	Numerical Computing
COMP 417	(3)	Introduction Robotics and Intelligent Systems
COMP 421	(3)	Database Systems
COMP 424	(3)	Artificial Intelligence

COMP 512	(4)	Distributed Systems
COMP 520	(4)	Compiler Design
COMP 521	(4)	Modern Computer Games
COMP 522	(4)	Modelling and Simulation
COMP 535	(4)	Computer Networks 1
COMP 551	(4)	Applied Machine Learning
COMP 557	(4)	Fundamentals of Computer Graphics
COMP 558	(3)	Fundamentals of Computer Vision

Revision, April 2018. End of revision.

### 13.9.17 Computer Science (COMP) Related Programs

#### 13.9.17.1 Major and Honours in Mathematics and Computer Science

For more information, see [section 13.22: Mathematics and Statistics \(MATH\)](#). Honours students must consult an Honours adviser in both departments.

#### 13.9.17.2 Major and Honours in Statistics and Computer Science

For more information, see [section 13.22: Mathematics and Statistics \(MATH\)](#). Honours students must consult an Honours adviser in both departments.

#### 13.9.17.3 Major and Honours in Physics and Computer Science

For more information, see [section 13.30: Physics \(PHYS\)](#). Honours students must consult an Honours adviser in both departments.

#### 13.9.17.4 Minor in Cognitive Science

Students following Major or Honours programs in Computer Science may want to consider the Minor in Cognitive Science. For more information, see [section 13.8: Cognitive Science](#).

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## 13.10 Earth and Planetary Sciences (EPSC)

### 13.10.1 Location

Frank Dawson Adams Building, Room 238  
3450 University Street  
Montreal QC H3A 0E8  
Telephone: 514-398-6767  
Fax: 514-398-4680  
Email: [kristy.thornton@mcgill.ca](mailto:kristy.thornton@mcgill.ca)  
Website: [www.mcgill.ca/eps](http://www.mcgill.ca/eps)

### 13.10.2 About Earth and Planetary Sciences

Earth and Planetary Sciences is a multidisciplinary field that includes the solid Earth and its hydrosphere and extends to the neighbouring terrestrial planets. Principles of chemistry, physics, and mathematics are applied to elucidate the complex and diverse planetary processes at play as we seek to understand how planets like the Earth changed over time and continue to evolve.

**Career opportunities** are many and diverse in the Earth and Planetary Sciences. Graduates of the Major and Honours in Geology are often recruited by resource (fossil fuel and mineral) exploration companies, as well as the mining and environmental sectors. Industry or government agencies may hire undergraduate students during the summer months, providing them with both financial benefits and first-hand geoscientific experience. Career opportunities in planetary science can also be found in universities and research organizations.

**The Department** has a full-time staff of 17 professors and one faculty lecturer. There are approximately 55 graduate and 30 undergraduate students registered in the various programs offered. 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 explore and learn.

### 13.10.3 Undergraduate Studies

The undergraduate curriculum is designed to provide both a strong 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 is one of the three departments that actively contribute to the Earth System Science Interdepartmental program, and also offers a **Joint Major in Physics and Geophysics**, which combines a rigorous mathematics and physics curriculum with exposure to the geosciences.

The **Minor in Geology** offers students from other departments the opportunity to discover the earth sciences in the classroom and in the field, while the **Minor in Geochemistry** is designed for Chemistry Major students who want to apply chemical principles to the study of planetary processes.

Students interested in any of the programs should inquire at:

Frank Dawson Adams Building, Room 238  
Telephone: 514-398-6767  
Website: [www.mcgill.ca/eps/studies/undergraduate](http://www.mcgill.ca/eps/studies/undergraduate)

or should consult the Undergraduate Director:

Professor Jeanne Paquette  
Frank Dawson Adams Building, Room 214  
Telephone: 514-398-4402  
Email: [jeanne.paquette@mcgill.ca](mailto:jeanne.paquette@mcgill.ca)

### 13.10.4 Earth and Planetary Sciences Faculty

#### Chair

Jeffrey McKenzie

#### Emeritus Professors

Jafar Arkani-Hamed; B.Eng.(Tehran), Ph.D.(MIT)  
Donald Francis; B.Sc.(McG.), M.Sc.(Br. Col.), Ph.D.(MIT)  
Andrew J. Hynes; B.Sc.(Tor.), Ph.D.(Cant.)  
Robert F. Martin; B.Sc.(Ott.), M.S.(Penn. St.), Ph.D.(Stan.)  
Colin W. Stearn; B.Sc.(McM.), M.S., Ph.D.(Yale), F.R.S.C.

#### Professors

Don Baker; A.B.(Chic.), Ph.D.(Penn. St.)  
Olivia G. Jensen; B.Sc., M.Sc., Ph.D.(Br. Col.)  
Alfonso Mucci; B.Sc., M.Sc.(Montr.), Ph.D.(Miami)  
John Stix; A.B.(Dart.), M.Sc., Ph.D.(Tor.)  
A.E. (Willy) Williams-Jones; B.Sc., M.Sc.(Natal), Ph.D.(Qu.) (*William E. Logan Professor of Geology*)

#### Associate Professors

Galen Halverson; B.A.(Mont.), M.A., Ph.D.(Harv.) (*T.H. Clark Chair in Sedimentary and Petroleum Geology*)  
Yajing Liu; B.Sc.(Peking), Ph.D.(Harv.)  
Jeffrey McKenzie; B.Sc.(McG.), M.Sc., Ph.D.(Syrac.)  
Jeanne Paquette; B.Sc., M.Sc.(McG.), Ph.D.(Stonybrook)  
Christie Rowe; A.B.(Smith), Ph.D.(Calif.-Santa Cruz) (*Robert Wares Faculty Scholar*)

#### Assistant Professors

Kim Berlo; Propadeuse, Doctorandus(Utrecht), Ph.D.(Brist.)  
Nicolas Cowan; B.Sc.(McG.), Ph.D.(Wash.) (*joint appt. with Physics*)  
Peter Douglas; B.Sc., Ph.D.(Yale)  
Natalya Gomez; B.Sc., M.Sc.(Tor.), Ph.D.(Harv.)

**Assistant Professors**

James Kirkpatrick; B.Sc., M.Sc.(Leeds), Ph.D.(Glas.)

Nagissa Mahmoudi; B.Sc.(Tor.), Ph.D.(McM.)

Vincent van Hinsberg; Propadeuse, Doctorandus(Utrecht), Ph.D.(Brist.) (*Osisko Faculty Scholar*)

**Faculty Lecturer**

W. Minarik; B.A.(St. Olaf), M.Sc.(Wash.), Ph.D.(Rensselaer Poly.)

**Adjunct Professors**

R. Léveillé, B. Sundby

**Retired Professor**

R. Hesse

**13.10.5 Bachelor of Science (B.Sc.) - Minor Geology (18 credits)**

The Minor Geology offers students from other departments the opportunity to obtain exposure to the Earth Sciences.

**Required Courses (6 credits)**

EPSC 210	(3)	Introductory Mineralogy
EPSC 212	(3)	Introductory Petrology

**Complementary Courses (12 credits)**

3 credits, one of:

EPSC 201	(3)	Understanding Planet Earth
EPSC 233	(3)	Earth and Life History

9 credits selected from the list below and other 300-level and higher courses in Earth and Planetary Sciences may be substituted with permission.

EPSC 203	(3)	Structural Geology
EPSC 231	(3)	Field School 1
EPSC 334	(3)	Invertebrate Paleontology
EPSC 350	(3)	Tectonics
EPSC 452	(3)	Mineral Deposits
EPSC 542	(3)	Chemical Oceanography
EPSC 561	(3)	Ore-forming Processes

**13.10.6 Bachelor of Science (B.Sc.) - Minor Geochemistry (18 credits)****Required Courses (9 credits)**

EPSC 201	(3)	Understanding Planet Earth
EPSC 210	(3)	Introductory Mineralogy
EPSC 212	(3)	Introductory Petrology

**Complementary Courses (9 credits)**

9 credits selected from:



EPSC 220	(3)	Principles of Geochemistry
EPSC 501	(3)	Crystal Chemistry
EPSC 519	(3)	Isotope Geology
EPSC 542	(3)	Chemical Oceanography
EPSC 561	(3)	Ore-forming Processes
EPSC 570	(3)	Cosmochemistry
EPSC 590	(3)	Applied Geochemistry Seminar

### 13.10.7 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Earth and Planetary Sciences (45 credits)

The B.Sc. (Liberal) program in Earth and Planetary Sciences provides the graduate with a solid core of knowledge of Geology, Geophysics, Earth Systems Science, and Planetary Science while allowing for a broadening of the student's educational experience with courses from the other sciences or the arts. The program is flexible, allowing students to assemble a truly interdisciplinary degree.

#### Required Courses (21 credits)

EPSC 203	(3)	Structural Geology
EPSC 210	(3)	Introductory Mineralogy
EPSC 212	(3)	Introductory Petrology
EPSC 220	(3)	Principles of Geochemistry
EPSC 231	(3)	Field School 1
EPSC 233	(3)	Earth and Life History
EPSC 320	(3)	Elementary Earth Physics

#### Complementary Courses (24 credits)

3 credits, one of:

EPSC 331	(3)	Field School 2
EPSC 341	(3)	Field School 3

plus 21 credits chosen from the following:

Note: Courses at the 300 or higher level in other departments in the Faculties of Science and Engineering may also be used as complementary credits, with the permission of the Director of undergraduate studies.

EPSC 330	(3)	Earthquakes and Earth Structure
EPSC 334	(3)	Invertebrate Paleontology
EPSC 340	(3)	Earth and Planetary Inference
EPSC 350	(3)	Tectonics
EPSC 355	(3)	Sedimentary Geology
EPSC 423	(3)	Igneous Petrology
EPSC 425	(3)	Sediments to Sequences
EPSC 435	(3)	Applied Geophysics
EPSC 445	(3)	Metamorphic Petrology
EPSC 452	(3)	Mineral Deposits
EPSC 501	(3)	Crystal Chemistry
EPSC 519	(3)	Isotope Geology
EPSC 530	(3)	Volcanology

EPSC 542	(3)	Chemical Oceanography
EPSC 547	(3)	Modelling Geochemical Processes
EPSC 548	(3)	Processes of Igneous Petrology
EPSC 549	(3)	Hydrogeology
EPSC 550	(3)	Selected Topics 1
EPSC 551	(3)	Selected Topics 2
EPSC 552	(3)	Selected Topics 3
EPSC 561	(3)	Ore-forming Processes
EPSC 567	(3)	Advanced Volcanology
EPSC 570	(3)	Cosmochemistry
EPSC 580	(3)	Aqueous Geochemistry
EPSC 590	(3)	Applied Geochemistry Seminar
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
ESYS 500	(3)	Earth System Applications

### 13.10.8 Bachelor of Science (B.Sc.) - Major Geology (66 credits)

The program curriculum provides a rigorous foundation in the fundamental earth science subjects and in the advanced subjects relevant to exploration for energy resources, industrial and ore minerals, and to environmental geosciences. The program meets the academic requirements shared by the professional orders for geologists and environmental geoscientists in most Canadian provinces. It also offers students the opportunity to take courses or acquire experience in areas of current research. It is a path to a wide range of careers in industry, teaching and research in earth sciences.

#### Required Courses (30 credits)

EPSC 203	(3)	Structural Geology
EPSC 210	(3)	Introductory Mineralogy
EPSC 212	(3)	Introductory Petrology
EPSC 220	(3)	Principles of Geochemistry
EPSC 231	(3)	Field School 1
EPSC 233	(3)	Earth and Life History
EPSC 240	(3)	Geology in the Field
EPSC 320	(3)	Elementary Earth Physics
EPSC 340	(3)	Earth and Planetary Inference
MATH 222	(3)	Calculus 3

#### Complementary Courses (36 credits)

15 credits of advanced earth science

EPSC 334	(3)	Invertebrate Paleontology
EPSC 355	(3)	Sedimentary Geology
EPSC 423	(3)	Igneous Petrology
EPSC 425	(3)	Sediments to Sequences
EPSC 445	(3)	Metamorphic Petrology
EPSC 452	(3)	Mineral Deposits

## 3 credits of field school

EPSC 331	(3)	Field School 2
EPSC 341	(3)	Field School 3

## 3 credits of environmental and ore-forming processes

EPSC 513	(3)	Climate and the Carbon Cycle
EPSC 519	(3)	Isotope Geology
EPSC 542	(3)	Chemical Oceanography
EPSC 549	(3)	Hydrogeology
EPSC 561	(3)	Ore-forming Processes
EPSC 580	(3)	Aqueous Geochemistry
EPSC 590	(3)	Applied Geochemistry Seminar

## 15 credits of other specializations can be drawn from the categories above or from:

EPSC 350	(3)	Tectonics
EPSC 435	(3)	Applied Geophysics
EPSC 470D1	(3)	Undergraduate Thesis Research
EPSC 470D2	(3)	Undergraduate Thesis Research
EPSC 482	(3)	Research in Earth and Planetary Sciences
EPSC 501	(3)	Crystal Chemistry
EPSC 520	(3)	Earthquake Physics and Geology
EPSC 530	(3)	Volcanology
EPSC 547	(3)	Modelling Geochemical Processes
EPSC 548	(3)	Processes of Igneous Petrology
EPSC 550	(3)	Selected Topics 1
EPSC 551	(3)	Selected Topics 2
EPSC 552	(3)	Selected Topics 3
EPSC 567	(3)	Advanced Volcanology

Other ATOC, EPSC, ESYS, GEOG, MATH and MIME courses may also be used, with the permission of the Director of undergraduate studies, if they meet the academic requirements of professional orders in most Canadian provinces.

**13.10.9 Bachelor of Science (B.Sc.) - Honours Geology (75 credits)**

The program curriculum is designed to provide a rigorous foundation in the fundamental earth science disciplines and in the advanced subjects relevant to fundamental and applied research in exploration for energy resources or industrial and ore minerals, and in environmental geosciences. The program meets the academic requirements shared by the professional orders for geologists and environmental geoscientists in most Canadian provinces. It is intended to provide an excellent preparation for graduate work in the earth sciences but offers enough flexibility to prepare for a wide range of careers in industry and teaching.

**Required Courses (42 credits)**

EPSC 203	(3)	Structural Geology
EPSC 210	(3)	Introductory Mineralogy
EPSC 212	(3)	Introductory Petrology

EPSC 220	(3)	Principles of Geochemistry
EPSC 231	(3)	Field School 1
EPSC 233	(3)	Earth and Life History
EPSC 240	(3)	Geology in the Field
EPSC 320	(3)	Elementary Earth Physics
EPSC 340	(3)	Earth and Planetary Inference
EPSC 480D1	(3)	Honours Research Thesis
EPSC 480D2	(3)	Honours Research Thesis
MATH 222	(3)	Calculus 3
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations

**Complementary Courses (33 credits)**

15 credits of advanced earth science

EPSC 334	(3)	Invertebrate Paleontology
EPSC 355	(3)	Sedimentary Geology
EPSC 423	(3)	Igneous Petrology
EPSC 425	(3)	Sediments to Sequences
EPSC 445	(3)	Metamorphic Petrology
EPSC 452	(3)	Mineral Deposits

3 credits of field school

EPSC 331	(3)	Field School 2
EPSC 341	(3)	Field School 3

3 credits of environmental and ore-forming processes

EPSC 513	(3)	Climate and the Carbon Cycle
EPSC 519	(3)	Isotope Geology
EPSC 542	(3)	Chemical Oceanography
EPSC 549	(3)	Hydrogeology
EPSC 561	(3)	Ore-forming Processes
EPSC 580	(3)	Aqueous Geochemistry
EPSC 590	(3)	Applied Geochemistry Seminar

12 credits of other specializations can be drawn from the categories above or from:

EPSC 350	(3)	Tectonics
EPSC 435	(3)	Applied Geophysics
EPSC 501	(3)	Crystal Chemistry
EPSC 510	(3)	Geodynamics
EPSC 520	(3)	Earthquake Physics and Geology
EPSC 530	(3)	Volcanology

EPSC 547	(3)	Modelling Geochemical Processes
EPSC 548	(3)	Processes of Igneous Petrology
EPSC 550	(3)	Selected Topics 1
EPSC 551	(3)	Selected Topics 2
EPSC 552	(3)	Selected Topics 3
EPSC 567	(3)	Advanced Volcanology

Courses from other departments may also be used, with the permission of the Director of undergraduate studies, when they meet the academic requirements of professional orders in most Canadian provinces.

### 13.10.10 Bachelor of Science (B.Sc.) - Honours Planetary Sciences (78 credits)

The program curriculum is designed to provide a rigorous foundation in physical sciences and the flexibility to create an individualized program in preparation for careers in industry, teaching, and research. It is intended to provide an excellent preparation for graduate work in the earth and planetary sciences.

Note: Honours students must maintain a CGPA equal to or greater than 3.20.

#### Required Courses (66 credits)

EPSC 203	(3)	Structural Geology
EPSC 210	(3)	Introductory Mineralogy
EPSC 212	(3)	Introductory Petrology
EPSC 220	(3)	Principles of Geochemistry
EPSC 231	(3)	Field School 1
EPSC 233	(3)	Earth and Life History
EPSC 320	(3)	Elementary Earth Physics
EPSC 330	(3)	Earthquakes and Earth Structure
EPSC 340	(3)	Earth and Planetary Inference
EPSC 350	(3)	Tectonics
EPSC 423	(3)	Igneous Petrology
EPSC 480D1	(3)	Honours Research Thesis
EPSC 480D2	(3)	Honours Research Thesis
EPSC 510	(3)	Geodynamics
EPSC 570	(3)	Cosmochemistry
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
MATH 317	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
PHYS 340	(3)	Majors Electricity and Magnetism

#### Complementary Courses (12 credits)

3 credits from:

PHYS 230	(3)	Dynamics of Simple Systems
PHYS 251	(3)	Honours Classical Mechanics 1

plus 9 credits (three courses) chosen from the following:

Note: Courses at the 300 level or higher in other departments in the Faculties of Science and Engineering may also be used as complementary credits, with the permission of the Director of undergraduate studies.

EPSC 334	(3)	Invertebrate Paleontology
EPSC 425	(3)	Sediments to Sequences
EPSC 435	(3)	Applied Geophysics
EPSC 501	(3)	Crystal Chemistry
EPSC 519	(3)	Isotope Geology
EPSC 520	(3)	Earthquake Physics and Geology
EPSC 530	(3)	Volcanology
EPSC 542	(3)	Chemical Oceanography
EPSC 547	(3)	Modelling Geochemical Processes
EPSC 548	(3)	Processes of Igneous Petrology
EPSC 549	(3)	Hydrogeology
EPSC 550	(3)	Selected Topics 1
EPSC 551	(3)	Selected Topics 2
EPSC 552	(3)	Selected Topics 3
EPSC 561	(3)	Ore-forming Processes
EPSC 567	(3)	Advanced Volcanology
EPSC 580	(3)	Aqueous Geochemistry
EPSC 590	(3)	Applied Geochemistry Seminar

### 13.10.11 Earth and Planetary Sciences (EPSC) Related Programs

#### 13.10.11.1 Joint Major in Physics and Geophysics

For more information, see [section 13.30: Physics \(PHYS\)](#).

#### 13.10.11.2 Earth System Science Interdepartmental Major

This program is offered by the Departments of Atmospheric and Oceanic Sciences; Earth and Planetary Sciences; and Geography. Students in the Department of Earth and Planetary Sciences who are interested in this program should contact Professor William Minarik ([william.minarik@mcgill.ca](mailto:william.minarik@mcgill.ca)).

For more information, see [section 13.11: Earth System Science \(ESYS\)](#).

#### 13.10.11.3 Earth System Science Interdepartmental Honours

This program is offered by the Departments of Atmospheric and Oceanic Sciences; Earth and Planetary Sciences; and Geography. Students in the Department of Earth and Planetary Sciences who are interested in this program should contact Professor William Minarik ([william.minarik@mcgill.ca](mailto:william.minarik@mcgill.ca)).

For more information, see [section 13.11: Earth System Science \(ESYS\)](#).

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## 13.11 Earth System Science (ESYS)

### 13.11.1 Location

Program Adviser  
Dr. William Minarik  
Frank Dawson Adams, Room 215  
Telephone: 514-398-2596  
Email: [william.minarik@mcgill.ca](mailto:william.minarik@mcgill.ca)

Website: [www.ess.mcgill.ca](http://www.ess.mcgill.ca)

### 13.11.2 About Earth System Science

The McGill interdepartmental **Major** program in Earth System Science (ESYS) is designed to equip students with the skills and knowledge to address six “Grand Challenges” that are fundamental to our understanding of the way in which the Earth operates. These Grand Challenges are being tackled with scientific and technological innovation and interdisciplinary research, creating bountiful employment opportunities for ESYS graduates in industry, research institutions, and government. They are:

- Global biogeochemical cycles;
- Climate variability and change;
- Land use and land cover change;
- Energy and resources;
- Earth hazards: volcanoes, earthquakes, and hurricanes; and
- Earth-atmosphere observation, analysis, and prediction.

Many of our graduates go on to M.Sc. or Ph.D. programs in a variety of scientific fields that address these grand challenges, including those arising from the interaction of human activities and natural systems.

**Career opportunities** after a B.Sc. are diverse and increasing. Our graduates work for environmental consulting firms (assessing suitable sites for new industrial facilities and predicting their environmental impact, and cleaning contaminated sites), research groups in re-insurance firms (evaluating risks of natural disasters), in product's life cycle management (studying energy and resources use, and the effect of recycling or waste disposal), and software companies that develop algorithms to assist farmers on choices of crops and soil management practices, and business owners with inventory management.

The **Honours** program in Earth System Science (ESYS) prepares students for graduate studies in a wide range of transdisciplinary programs that address these challenges.

The ESS programs are offered jointly by the Department of [section 13.3: Atmospheric and Oceanic Sciences \(ATOC\)](#), the Department of [section 13.10: Earth and Planetary Sciences \(EPSC\)](#), and the Department of [section 13.17: Geography \(GEOG\)](#).

The individual departments, their disciplines, and specific courses offered by them are described in their respective entries in this publication.

### 13.11.3 Bachelor of Science - Minor Earth System Science (18 credits)

The Minor in Earth System Science (ESYS) is offered jointly by the following departments:

Atmospheric and Oceanic Sciences (ATOC)

Earth and Planetary Sciences (EPSC)

Geography (GEOG)

#### Required Courses (12 credits)

ESYS 200	(3)	Earth System Processes
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
ESYS 500	(3)	Earth System Applications

#### Complementary Courses (6 credits)

Two courses from 2 of 3 ESYS Departments (EPSC, ATOC, or GEOG), 300 level or higher, in consultation with the ESS student adviser.

### 13.11.4 Bachelor of Science (B.Sc.) - Major Earth System Science (57 credits)

The Major in Earth System Science (ESYS) is offered jointly by the following departments:

Atmospheric and Oceanic Sciences (ATOC)

Earth and Planetary Sciences (EPSC)

Geography (GEOG)

Earth System Science (ESYS) views Earth as a single integrated system that provides a unifying context to examine the interrelationships between all components of the Earth system. The approach concentrates on the nature of linkages among the biological, chemical, human, and physical subsystems of the Earth. Earth System Science primarily involves studying the cycling of matter and energy through the atmosphere, biosphere, cryosphere, exosphere, and hydrosphere. It examines the dynamics and interrelationships among these processes at time scales that range from billions of years to days, and seeks to understand how these interrelationships have changed over time.

**Required Courses (24 credits)**

COMP 202	(3)	Foundations of Programming
ENVR 201	(3)	Society, Environment and Sustainability
ESYS 200	(3)	Earth System Processes
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
ESYS 500	(3)	Earth System Applications
MATH 203	(3)	Principles of Statistics 1
MATH 222	(3)	Calculus 3

**Complementary Courses (33 credits)**

One of the following two courses:

ATOC 214	(3)	Introduction: Physics of the Atmosphere
ATOC 219	(3)	Introduction to Atmospheric Chemistry

One of the following two courses:

EPSC 210	(3)	Introductory Mineralogy
EPSC 220	(3)	Principles of Geochemistry

One of the following two courses:

GEOG 306	(3)	Raster Geo-Information Science
GEOG 308	(3)	Principles of Remote Sensing

One of the following two courses:

ENVR 200	(3)	The Global Environment
GEOG 203	(3)	Environmental Systems

One of the following two courses:

BIOL 215	(3)	Introduction to Ecology and Evolution
ENVR 202	(3)	The Evolving Earth

One of the following courses:

ANTH 339	(3)	Ecological Anthropology
GEOG 217	(3)	Cities in the Modern World
GEOG 221	(3)	Environment and Health
GEOG 300	(3)	Human Ecology in Geography
GEOG 310	(3)	Development and Livelihoods
GEOG 382	(3)	Principles Earth Citizenship
GEOG 406	(3)	Human Dimensions of Climate Change



15 credits from the following course list, with at least 3 credits from each of subject codes ATOC, EPSC, and GEOG. At least 9 of the 15 credits must be at the 400 level or higher.

Note: Courses at the 300 level or higher in other departments in the Faculties of Science and Engineering may also be used as complementary credits, with the permission of an academic adviser. Please see the list posted on the Departmental web page.

ATOC 215	(3)	Oceans, Weather and Climate
ATOC 309	(3)	Weather Radars and Satellites
ATOC 315	(3)	Thermodynamics and Convection
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
BIOL 308	(3)	Ecological Dynamics
BIOL 309	(3)	Mathematical Models in Biology
BIOL 310	(3)	Biodiversity and Ecosystems
BIOL 432	(3)	Limnology
BIOL 434	(3)	Theoretical Ecology
BIOL 441	(3)	Biological Oceanography
BIOL 465	(3)	Conservation Biology
BIOL 540	(3)	Ecology of Species Invasions
BIOL 573	(3)	Vertebrate Palaeontology Field Course
BREE 217	(3)	Hydrology and Water Resources
BREE 319	(3)	Engineering Mathematics
BREE 509	(3)	Hydrologic Systems and Modelling
BREE 510	(3)	Watershed Systems Management
BREE 515	(3)	Soil Hydrologic Modelling
BREE 533	(3)	Water Quality Management
ECON 347	(3)	Economics of Climate Change
ECON 405	(3)	Natural Resource Economics
EPSC 212	(3)	Introductory Petrology
EPSC 320	(3)	Elementary Earth Physics
EPSC 330	(3)	Earthquakes and Earth Structure
EPSC 331	(3)	Field School 2
EPSC 334	(3)	Invertebrate Paleontology
EPSC 340	(3)	Earth and Planetary Inference
EPSC 341	(3)	Field School 3
EPSC 350	(3)	Tectonics
EPSC 355	(3)	Sedimentary Geology

EPSC 423	(3)	Igneous Petrology
EPSC 425	(3)	Sediments to Sequences
EPSC 445	(3)	Metamorphic Petrology
EPSC 452	(3)	Mineral Deposits
EPSC 519	(3)	Isotope Geology
EPSC 530	(3)	Volcanology
EPSC 542	(3)	Chemical Oceanography
EPSC 549	(3)	Hydrogeology
EPSC 561	(3)	Ore-forming Processes
EPSC 567	(3)	Advanced Volcanology
EPSC 580	(3)	Aqueous Geochemistry
EPSC 590	(3)	Applied Geochemistry Seminar
GEOG 272	(3)	Earth's Changing Surface
GEOG 305	(3)	Soils and Environment
GEOG 307	(3)	Socioeconomic Applications of GIS
GEOG 321	(3)	Climatic Environments
GEOG 322	(3)	Environmental Hydrology
GEOG 350	(3)	Ecological Biogeography
GEOG 351	(3)	Quantitative Methods
GEOG 372	(3)	Running Water Environments
GEOG 470	(3)	Wetlands
GEOG 495	(3)	Field Studies - Physical Geography
GEOG 499	(3)	Subarctic Field Studies
GEOG 501	(3)	Modelling Environmental Systems
GEOG 505	(3)	Global Biogeochemistry
GEOG 506	(3)	Advanced Geographic Information Science
GEOG 523	(3)	Global Ecosystems and Climate
GEOG 530	(3)	Global Land and Water Resources
GEOG 535	(3)	Remote Sensing and Interpretation
GEOG 536	(3)	Geocryology
GEOG 537	(3)	Advanced Fluvial Geomorphology
GEOG 550	(3)	Historical Ecology Techniques
MATH 314	(3)	Advanced Calculus
MATH 315*	(3)	Ordinary Differential Equations
MATH 317	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 323	(3)	Probability
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 423	(3)	Regression and Analysis of Variance
MATH 437	(3)	Mathematical Methods in Biology
MATH 447	(3)	Introduction to Stochastic Processes
MATH 525	(4)	Sampling Theory and Applications
NRSC 540	(3)	Socio-Cultural Issues in Water

PHYS 331	(3)	Topics in Classical Mechanics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 432	(3)	Physics of Fluids

\* MATH 315 is a required course for the B.Sc. Honours Earth System Science.

### 13.11.5 Bachelor of Science (B.Sc.) - Honours Earth System Science (66 credits)

The Honours in Earth System Science (ESYS) is offered jointly by the following departments:

Atmospheric and Oceanic Sciences (ATOC)

Earth and Planetary Sciences (EPSC)

Geography (GEOG)

A rigorous foundation in earth system science and the flexibility to create an individualized program in preparation for careers in industry, teaching, and research. It is also intended to provide an excellent preparation for graduate work in earth system science. A CGPA of 3.20 or higher is required for registration in and graduation from this program.

"First Class Honours" is awarded to students who obtain a minimum cumulative grade point average of 3.70, a minimum program GPA of 3.20, and a minimum grade of B+ in ESYS 300, ESYS 301, and ESYS 500.

#### Required Courses (33 credits)

COMP 202	(3)	Foundations of Programming
ENVR 201	(3)	Society, Environment and Sustainability
ESYS 200	(3)	Earth System Processes
ESYS 300	(3)	Investigating the Earth System
ESYS 301	(3)	Earth System Modelling
ESYS 480D1	(3)	Honours Research Project
ESYS 480D2	(3)	Honours Research Project
ESYS 500	(3)	Earth System Applications
MATH 203	(3)	Principles of Statistics 1
MATH 222	(3)	Calculus 3
MATH 315	(3)	Ordinary Differential Equations

#### Complementary Courses (33 credits)

One of the following two courses:

ATOC 214	(3)	Introduction: Physics of the Atmosphere
ATOC 219	(3)	Introduction to Atmospheric Chemistry

One of the following two courses:

EPSC 210	(3)	Introductory Mineralogy
EPSC 220	(3)	Principles of Geochemistry

One of the following two courses:

GEOG 306	(3)	Raster Geo-Information Science
GEOG 308	(3)	Principles of Remote Sensing

One of the following two courses:

ENVR 200	(3)	The Global Environment
GEOG 203	(3)	Environmental Systems

One of the following two courses:

BIOL 215	(3)	Introduction to Ecology and Evolution
ENVR 202	(3)	The Evolving Earth

One of the following courses:

ANTH 339	(3)	Ecological Anthropology
GEOG 217	(3)	Cities in the Modern World
GEOG 221	(3)	Environment and Health
GEOG 300	(3)	Human Ecology in Geography
GEOG 310	(3)	Development and Livelihoods
GEOG 382	(3)	Principles Earth Citizenship
GEOG 406	(3)	Human Dimensions of Climate Change

15 credits from the following course list, with at least 3 credits from each of subject codes ATOC, EPSC, and GEOG. At least 9 of the 15 credits must be at the 400 level or higher.

Note: Courses at the 300 level or higher in other departments in the Faculties of Science and Engineering may also be used as complementary credits, with the permission of an academic adviser. Please see the list posted on the Departmental web page.

ATOC 215	(3)	Oceans, Weather and Climate
ATOC 309	(3)	Weather Radars and Satellites
ATOC 315	(3)	Thermodynamics and Convection
ATOC 512	(3)	Atmospheric and Oceanic Dynamics
ATOC 513	(3)	Waves and Stability
ATOC 515	(3)	Turbulence in Atmosphere and Oceans
ATOC 519	(3)	Advances in Chemistry of Atmosphere
ATOC 521	(3)	Cloud Physics
ATOC 525	(3)	Atmospheric Radiation
ATOC 530	(3)	Paleoclimate Dynamics
ATOC 531	(3)	Dynamics of Current Climates
ATOC 540	(3)	Synoptic Meteorology 1
ATOC 541	(3)	Synoptic Meteorology 2
BIOL 308	(3)	Ecological Dynamics
BIOL 309	(3)	Mathematical Models in Biology
BIOL 310	(3)	Biodiversity and Ecosystems
BIOL 432	(3)	Limnology
BIOL 434	(3)	Theoretical Ecology
BIOL 441	(3)	Biological Oceanography
BIOL 465	(3)	Conservation Biology

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BIOL 540	(3)	Ecology of Species Invasions
BIOL 573	(3)	Vertebrate Palaeontology Field Course
BREE 217	(3)	Hydrology and Water Resources
BREE 319	(3)	Engineering Mathematics
BREE 509	(3)	Hydrologic Systems and Modelling
BREE 510	(3)	Watershed Systems Management
BREE 515	(3)	Soil Hydrologic Modelling
BREE 533	(3)	Water Quality Management
ECON 347	(3)	Economics of Climate Change
ECON 405	(3)	Natural Resource Economics
EPSC 212	(3)	Introductory Petrology
EPSC 320	(3)	Elementary Earth Physics
EPSC 330	(3)	Earthquakes and Earth Structure
EPSC 331	(3)	Field School 2
EPSC 334	(3)	Invertebrate Paleontology
EPSC 340	(3)	Earth and Planetary Inference
EPSC 341	(3)	Field School 3
EPSC 350	(3)	Tectonics
EPSC 355	(3)	Sedimentary Geology
EPSC 423	(3)	Igneous Petrology
EPSC 425	(3)	Sediments to Sequences
EPSC 445	(3)	Metamorphic Petrology
EPSC 452	(3)	Mineral Deposits
EPSC 519	(3)	Isotope Geology
EPSC 530	(3)	Volcanology
EPSC 542	(3)	Chemical Oceanography
EPSC 549	(3)	Hydrogeology
EPSC 561	(3)	Ore-forming Processes
EPSC 567	(3)	Advanced Volcanology
EPSC 580	(3)	Aqueous Geochemistry
EPSC 590	(3)	Applied Geochemistry Seminar
GEOG 272	(3)	Earth's Changing Surface
GEOG 305	(3)	Soils and Environment
GEOG 307	(3)	Socioeconomic Applications of GIS
GEOG 321	(3)	Climatic Environments
GEOG 322	(3)	Environmental Hydrology
GEOG 350	(3)	Ecological Biogeography
GEOG 351	(3)	Quantitative Methods
GEOG 372	(3)	Running Water Environments
GEOG 470	(3)	Wetlands
GEOG 495	(3)	Field Studies - Physical Geography
GEOG 499	(3)	Subarctic Field Studies
GEOG 501	(3)	Modelling Environmental Systems

GEOG 505	(3)	Global Biogeochemistry
GEOG 506	(3)	Advanced Geographic Information Science
GEOG 523	(3)	Global Ecosystems and Climate
GEOG 530	(3)	Global Land and Water Resources
GEOG 535	(3)	Remote Sensing and Interpretation
GEOG 536	(3)	Geocryology
GEOG 537	(3)	Advanced Fluvial Geomorphology
GEOG 550	(3)	Historical Ecology Techniques
MATH 314	(3)	Advanced Calculus
MATH 315*	(3)	Ordinary Differential Equations
MATH 317	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 323	(3)	Probability
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 423	(3)	Regression and Analysis of Variance
MATH 437	(3)	Mathematical Methods in Biology
MATH 447	(3)	Introduction to Stochastic Processes
MATH 525	(4)	Sampling Theory and Applications
NRSC 540	(3)	Socio-Cultural Issues in Water
PHYS 331	(3)	Topics in Classical Mechanics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 432	(3)	Physics of Fluids

\* MATH 315 is a required course for the B.Sc. Honours Earth System Science.

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## 13.12 Entrepreneurship for Science Students

### 13.12.1 About Entrepreneurship for Science Students

This Minor is geared toward Science students with an interest in entrepreneurship and key business topics. The set of six courses will introduce them to concepts and skills needed to effectively complement the technical expertise obtained. These concepts and skills form the basis of successful companies in the high technology sector, be they start-ups, small-, or medium-sized.

### 13.12.2 Bachelor of Science (B.Sc.) - Minor Entrepreneurship for Science Students (18 credits)

This Minor is a collaboration of the Faculty of Science and Desautels Faculty of Management and is designed to provide Science (B.Sc.) students with an understanding of how to conceptualize, develop, and manage successful new ventures - including for-profit private companies, social enterprises, and cooperatives as well as intrapreneurship initiatives. The program covers the essentials of management and is interdisciplinary and integrative. Many courses in the Minor will address a mix of students from across multiple McGill faculties.

Students in this Minor are not permitted to take the Desautels Minors in Management, Marketing, Finance or Operations Management (for Non-Management students).

To obtain the Minor, all courses must be completed with a grade of C or better.

Advising note: Desautels Faculty of Management courses in this Minor have limited enrolment and include INTG 201, INTG 202, MGPO 362, MGPO 364, MGPO 438, and BUSA 465. For advising regarding Management courses, students should contact the Desautels Faculty of Management, B.Com. Office (see coordinates in the calendar notes). For advising regarding MIMM 387, see your adviser in the Science Office for Undergraduate Student Advising (SOUSA) in Dawson Hall.

**Required Courses (12 credits)**

INTG 201	(3)	Integrated Management Essentials 1
INTG 202	(3)	Integrated Management Essentials 2
MGPO 362	(3)	Fundamentals of Entrepreneurship
MGPO 364	(3)	Entrepreneurship in Practice

**Complementary Courses (6 credits)**

Choose 6 credits from the following:

BUSA 465	(3)	Technological Entrepreneurship
MGPO 438	(3)	Social Entrepreneurship and Innovation
MIMM 387	(3)	The Business of Science

**13.13 Environment**

Science students who are interested in studying the environment should refer to [McGill School of Environment > Undergraduate](#).

- Minor: : [Minor in Environment](#)
- Major: : [Major in Environment – B.Sc.\(Ag.Env.Sc.\) and B.Sc.](#) or : [Major in Environment – B.Sc.](#)
- Honours: : [Honours Program in Environment](#)
- Diploma: : [Diploma in Environment](#)

**13.14 Experimental Medicine (EXMD)****13.14.1 Location**

Division of Experimental Medicine  
 Department of Medicine  
 1001 Decarie Boulevard  
 Montreal QC H4A 3J1  
 Canada  
 Telephone: 514-934-1934, ext. 34699 or 34700  
 Email: [experimental.medicine@mcgill.ca](mailto:experimental.medicine@mcgill.ca)  
 Website: [www.mcgill.ca/expmed](http://www.mcgill.ca/expmed)

**13.14.2 About Experimental Medicine**

Experimental Medicine is a Division of the Department of Medicine. There are no B.Sc. programs in Experimental Medicine, but the EXMD courses listed below are considered as courses taught by the Faculty of Science.

**Experimental Medicine Courses**

EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
EXMD 502	(3)	Advanced Endocrinology 01
EXMD 503	(3)	Advanced Endocrinology 02
EXMD 504	(3)	Biology of Cancer
EXMD 506	(3)	Advanced Applied Cardiovascular Physiology
EXMD 507	(3)	Advanced Applied Respiratory Physiology
EXMD 508	(3)	Advanced Topics in Respiration

**Experimental Medicine Courses**

EXMD 509	(3)	Gastrointestinal Physiology and Pathology
EXMD 510	(3)	Bioanalytical Separation Methods
EXMD 511	(3)	Joint Venturing with Industry

**13.15 Field Study**

For details about the available Field Study Semesters, see [Study Abroad & Field Studies](#).

**13.15.1 Field Studies - Minor Field Studies (18 credits)**

Students participating in any one of the field study semesters, i.e., the Africa Field Study Semester, the Barbados Field Study Semester, the Barbados Interdisciplinary Tropical Studies (BITS) Field Study Semester, McGill Arctic Field Study Semester, or the Panama Field Study Semester may complete the 18-credit Minor in Field Studies.

The Minor consists of the 15 credits of a field study semester plus three additional complementary credits chosen by the student in consultation with their departmental adviser and/or the Field Study Minor adviser.

For students in the B.Sc. Liberal Program, the Field Studies Minor can serve as the breadth component.

Program descriptions for each of the field study semesters are provided below.

Note: The field study semesters are not degree programs. Credits may be counted toward McGill degrees with the permission of program advisers. Students who complete a field study semester may consult the Field Study Minor adviser about completing the Minor program as part of their McGill degree.

**Africa Field Study Semester (15 credits)**

The Africa Field Study Semester (AFSS) is run through McGill's Canadian Field Study in Africa Program (CFSIA).

The AFSS provides one term of integrated field study in East Africa, with emphasis on environmental conservation, culture change, and sustainable development. Students investigate challenges of sustaining biological diversity and social justice in African environments subject to cultural change, economic development, and environmental stress. Cultural and ecological variation is examined in highland, montane, rangeland, desert, riverine, salt- and fresh-water lake, coastal, and urban settings.

**Africa Field Study Semester - Required Courses**

6 credits

Students select one course titled "Research in Society and Development in Africa" and one course titled "Research in Ecology and Development in Africa" from the courses below.

ANTH 451	(3)	Research in Society and Development in Africa
BIOL 451	(3)	Research in Ecology and Development in Africa
GEOG 451	(3)	Research in Society and Development in Africa
NRSC 451	(3)	Research in Ecology and Development in Africa

**Africa Field Study Semester - Complementary Courses**

9 credits from:

\* Note: Courses marked with an asterisk ("\*") are offered on a rotational basis, at least 3 credits annually.

ANTH 411	(3)	Primate Studies & Conservation
ANTH 416	(3)	Environment/Development: Africa
BIOL 428	(3)	Biological Diversity in Africa
BIOL 429	(3)	East African Ecology
GEOG 404*	(3)	Environmental Management 2
GEOG 408	(3)	Geography of Development
GEOG 423	(3)	Dilemmas of Development
HIST 413	(3)	Independent Research



NRSC 405	(3)	Natural History of East Africa
NUTR 404	(3)	Nutrition Field Studies in East Africa
REDM 405	(3)	Natural History of East Africa
WILD 420*	(3)	Ornithology

### Barbados Field Study Semester (15 credits)

The Barbados Field Study Semester (BFSS) provides one term of integrated field study for students with an interest in global issues related to natural resource use as affected by socio-economic, management, urban, and physical constraints. Offered at the Bellairs Research Institute in Barbados, this program challenges students to be more effective environmental decision makers, policy makers, and managers. There is a growing need for professionals with such skills at all levels of government, within NGOs, and in the private sector. The overall goal of the BFSS is to equip future leaders to address the complexity of issues associated with the formulation and implementation of organizational strategies compatible with the societal goal of sustainable use and development of our natural resources.

The BFSS is intended for senior undergraduate students from across the University. Students must apply to participate in the program. Selection will be based on the student's Academic Standing and demonstrated interests and involvement in international issues related to natural resource use.

### Barbados Field Study Semester - Required Courses

6 credits

URBP 507	(3)	Planning and Infrastructure
URBP 520	(3)	Globalization: Planning and Change

### Barbados Field Study Semester - Complementary Courses

9 credits

Students select one 3-credit course titled "Water Resources in Barbados" and one 6-credit course titled "Sustainable Development Plans" from the list below.

AGRI 452	(3)	Water Resources in Barbados
AGRI 519	(6)	Sustainable Development Plans
CIVE 452	(3)	Water Resources in Barbados
CIVE 519	(6)	Sustainable Development Plans
URBP 519	(6)	Sustainable Development Plans

### Barbados Interdisciplinary Tropical Studies Field Semester (15 credits)

The Barbados Interdisciplinary Tropical Studies (BITS) Field Semester is an activity-filled, hands-on experience for students with an interest in international studies with a Caribbean flavour. The focus is on sustainable agri-food, nutrition, and energy production on a tropical island with a tourist-based economy. It is offered annually (in the Summer). It consists of two 2-hour orientation sessions conducted on the Macdonald campus and at the Bellairs Research Institute in Barbados, followed by three 3-credit and one 6-credit project courses at Bellairs Research Institute. This program integrates intensive course work with group project work and contributes to the formation of professionals with planning, managing, decision-making, and communication skills. The program addresses a global need for experienced professionals capable of interacting with various levels of government, non-governmental organizations, and the private sector. BITS welcomes applications from senior undergraduate students from across the University.

### Barbados Interdisciplinary Tropical Studies Field Semester - Required Courses

15 credits

AEBI 421	(3)	Tropical Horticultural Ecology
AEBI 423	(3)	Sustainable Land Use
AEBI 425	(3)	Tropical Energy and Food
AEBI 427	(6)	Barbados Interdisciplinary Project

### Panama Field Study Semester (15 credits)

This program is offered in Panama with the support of the Smithsonian Tropical Research Institute (STRI).

Hands-on experience is gained through research projects organized around multidisciplinary environmental issues. The nature of these projects will centre on practical environmental problems/questions important for Panama. Students will form teams that will work with Panamanian institutions (NGO, governmental, or research).

There is a one- or two-day period of transition and 13 weeks of course attendance in Panama. Field trips will be integrated into each of the courses offered.

### **Panama Field Study Semester - Required Courses**

9 credits

BIOL 553	(3)	Neotropical Environments
ENVR 451	(6)	Research in Panama

### **Panama Field Study Semester - Complementary Courses**

6 credits

Complementary courses change from year to year. Students will register for the 6 credits offered the Winter of their participation in the field study semester.

First Winter semester complementary courses:

AGRI 550	(3)	Sustained Tropical Agriculture
GEOG 498	(3)	Humans in Tropical Environments

Second Winter semester complementary courses:

GEOG 404	(3)	Environmental Management 2
HIST 510	(3)	Environmental History of Latin America (Field)

### **McGill Arctic Field Study Semester**

#### **Required Courses (15 credits)**

9 credits

ATOC 373	(3)	Arctic Climate and Climate Change
EPSC 373	(3)	Arctic Geology
GEOG 373	(3)	Arctic Geomorphology

and 6 credits from

ATOC 473	(6)	Arctic Field Research
EPSC 473	(6)	Arctic Field Research
GEOG 473	(6)	Arctic Field Research

#### **Minor Field Studies - Complementary Course**

In consultation with their departmental adviser and/or the Field Study Minor adviser, students who have completed one of the field study semesters described above may select a 3-credit complementary course to complete the requirements for the Minor and ask for it to be added to their academic records.

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## **13.16 General Science**

### **13.16.1 Location**

Interdisciplinary Programs Adviser

Ryan Bouma  
 Telephone: 514-398-7330  
 Email: [ryan.bouma@mcgill.ca](mailto:ryan.bouma@mcgill.ca)

### 13.16.2 About the General Science Minor

The Minor in General Science is only open to students in a B.Sc. Liberal program. Students interested in completing this Minor must consult with the Adviser for this program. See the program description in [section 13.16.3: Bachelor of Science \(B.Sc.\) - Minor General Science \(18 credits\)](#) for more information.

### 13.16.3 Bachelor of Science (B.Sc.) - Minor General Science (18 credits)

The Minor General Science is restricted to students in the B.Sc. Liberal program and may be used for the breadth component in this option. Students should consult their program adviser for their core science component and the Interdisciplinary Programs Adviser when selecting courses for this Minor.

#### Complementary Courses (18 credits)

Courses are to be chosen according to the following guidelines:

All courses must be offered by the Faculty of Science and must be at or above the 200 level\*.

All courses must be different from the student's core science component courses.

Two options:

9 credits at the 300 level or above and at least 9 credits outside the student's core science component subject.

or

12 credits at the 300 level or above and at least 6 credits outside the student's core science component subject.

\* Note: All Undergraduate research project courses with the 396 or 397 course number cannot be used toward the Minor General Science.

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## 13.17 Geography (GEOG)

### 13.17.1 Location

Burnside Hall, Room 705  
 805 Sherbrooke Street West  
 Montreal QC H3A 0B9  
 Telephone: 514-398-4951 or 514-398-4111  
 Fax: 514-398-7437  
 Website: [www.mcgill.ca/geography](http://www.mcgill.ca/geography)

### 13.17.2 About Geography

**The Department of Geography offers programs in both Arts and Science. All Bachelor of Arts (B.A.) programs in Geography (including Urban Systems) can be found in [Faculty of Arts > Undergraduate > Browse Academic Units & Programs > : Geography \(GEOG\)](#).**

Geography is a broad, holistic discipline; both a natural and a social science because it examines people and their environment and serves as a bridge between physical and cultural processes.

**Human Geography** (B.A. programs) is concerned especially with the political, economic, social, and cultural processes and resource practices that create spatial patterns and define particular places.

**Physical Geography** (B.Sc. programs) integrates disciplines such as climatology, geomorphology, geology, biology, hydrology, ecology, soil science, and even marine science.

Whether considering greenhouse gas emissions, the spread of disease, or threats to biodiversity, geographers are interested in where things happen, why, and with what consequences. Our graduates go on to careers in environmental consulting, social agencies, or non-governmental organizations. Skills in Geographic Information Science (GIS) are very marketable. Students are well prepared for graduate work in social sciences, urban planning, and environmental studies at leading schools.

### 13.17.3 Prerequisites

There are no departmental prerequisites for entrance to the B.Sc. Geography programs. Students who have completed college or pre-university geography courses fully equivalent to those in the first year of university may, with an adviser's approval, substitute other courses as part of their program.

A Science Major Concentration in Geography – Physical Geography option is available to students pursuing the B.A. & Sc. degree. This Major concentration is described in [Bachelor of Arts & Science](#) > [Undergraduate](#) > [Browse Academic Units & Programs](#) > : [Geography \(GEOG\)](#).

### 13.17.4 Geography Faculty

#### Chair

N.T. Roulet

#### Graduate Program Director

O.T. Coomes

#### Post-Retirement

S.H. Olson; M.A., Ph.D.(Johns Hop.)

#### Professors

P.G. Brown; M.A., Ph.D.(Col.) (*cross appt. with McGill School of Environment*)

O.T. Coomes; M.A.(Tor.), Ph.D.(Wisc. Mad.)

T.R. Moore; Ph.D.(Aberd.), F.R.S.C.

W.H. Pollard; M.A.(Guelph), Ph.D.(Ott.)

N.A. Ross; M.A.(Qu.), Ph.D.(McM.)

N.T. Roulet; M.Sc.(Trent), Ph.D.(McM.) (*James McGill Professor*)

S. Turner; M.Soc.Sc.(Waikato, N.Z.), Ph.D.(Hull)

G.W. Wenzel; M.A.(Manit.), Ph.D.(McG.)

#### Associate Professors

S. Breau; M.A.(Laval), Ph.D.(Calif.-LA)

G.L. Chmura; M.Sc.(Rhode Is.), Ph.D.(Louis. St.)

B. Forest; A.B.(Chic.), Ph.D.(Calif.-LA)

M. Kalacska; Ph.D.(Alta.)

M.F. Lapointe; M.Sc.(McG.), Ph.D.(Br. Col.)

B. Lehner; Ph.D.(Frankfurt)

T.C. Meredith; M.Sc., Dip.Cons.(Lond.), Ph.D.(Cant.)

N. Oswin; M.A.(Dal.), Ph.D.(Br. Col.)

R. Sengupta; M.Sc., Ph.D.(Ill.) (*joint appt. with McGill School of Environment*)

R. Sieber; M.P.A.(W. Mich.), Ph.D.(Rutg.) (*joint appt. with McGill School of Environment*)

I.B. Strachan; B.Sc.(Tor.), M.Sc., Ph.D.(Qu.) (*cross appt. with Natural Resource Sciences*)

J. Unruh; M.S.(Wisc.), Ph.D.(Ariz.)

#### Assistant Professors

Y. le Polain de Waroux; Ph.D.(Louvain)

G. MacDonald; M.Sc., Ph.D.(McG.)

K. Manaugh; Ph.D.(McG.)

S. Moser; Ph.D.(Sing.)

M. Riva; M.Sc., Ph.D.(Montr.) (*joint appt. with the Institute for Health and Social Policy*)

B. Robinson; Ph.D.(Wisc. Mad.)

#### Adjunct Professor

J. Wu

**13.17.5 Bachelor of Science (B.Sc.) - Minor Geography (18 credits)**

The Minor Geography is expandable into the B.Sc. Major Geography.

The Minor Geography is designed to provide students in the Faculty of Science with an overview of basic elements of geography at the introductory and advanced level.

This Minor permits no overlap with any other programs.

**Required Courses (6 credits)**

GEOG 203	(3)	Environmental Systems
GEOG 216	(3)	Geography of the World Economy

**Complementary Courses (12 credits)**

3 credits of Geography courses at the 200 level below.

GEOG 201	(3)	Introductory Geo-Information Science
GEOG 205	(3)	Global Change: Past, Present and Future
GEOG 210	(3)	Global Places and Peoples
GEOG 217	(3)	Cities in the Modern World
GEOG 221	(3)	Environment and Health
GEOG 272	(3)	Earth's Changing Surface

9 credits at a 300 and 400 level from any Geography course.

**13.17.6 Bachelor of Science (B.Sc.) - Minor Geographic Information Systems and Remote Sensing (18 credits)**

The Geographic Information Systems (GIS) and Remote Sensing Minor program provides B.Sc. students with the fundamentals of geospatial tools and technologies.

**Required Courses (6 credits)**

COMP 202	(3)	Foundations of Programming
GEOG 201	(3)	Introductory Geo-Information Science

**Complementary Courses (12 credits)**

3 credits selected from:

GEOG 306	(3)	Raster Geo-Information Science
GEOG 307	(3)	Socioeconomic Applications of GIS

6 credits selected from:

GEOG 308	(3)	Principles of Remote Sensing
GEOG 384*	(3)	Principles of Geospatial Web
GEOG 506	(3)	Advanced Geographic Information Science
GEOG 535	(3)	Remote Sensing and Interpretation

3 credits selected from:

ANTH 511	(3)	Computational Approaches to Prehistory
ATOC 309	(3)	Weather Radars and Satellites

COMP 208	(3)	Computers in Engineering
COMP 250	(3)	Introduction to Computer Science
ESYS 300	(3)	Investigating the Earth System
GEOG 306*	(3)	Raster Geo-Information Science
GEOG 307*	(3)	Socioeconomic Applications of GIS
GEOG 308*	(3)	Principles of Remote Sensing
GEOG 384*	(3)	Principles of Geospatial Web
GEOG 506*	(3)	Advanced Geographic Information Science
GEOG 535*	(3)	Remote Sensing and Interpretation

\* may be taken in either list of complementary courses, but credits from one group may not be doubled-counted in the other.

### 13.17.7 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Geography (49 credits)

This is the Core Science Component in Geography for the B.Sc. Liberal. Required courses provide a foundation in Geography (which takes a holistic approach to environmental sciences, distinguished by its incorporation of human and climatic elements). By completing these courses, students will be armed with the prerequisites for 300-level courses in Geography. Our set of complementary courses provides students with necessary analytical skills and a broad background in physical geography. The 300-level courses in the complementary set prepare students for advanced study at the 400 and 500 level.

#### Required Courses (13 credits)

GEOG 201	(3)	Introductory Geo-Information Science
GEOG 203	(3)	Environmental Systems
GEOG 272	(3)	Earth's Changing Surface
GEOG 290	(1)	Local Geographical Excursion
GEOG 351	(3)	Quantitative Methods

#### Complementary Courses (36 credits)

3 credits of statistics\*

\* Note: Credit given for statistics courses is subject to certain restrictions. Students in Science should consult the "Course Overlap" information in the "Course Requirements" section for the Faculty of Science.

BIOL 373	(3)	Biometry
GEOG 202	(3)	Statistics and Spatial Analysis
MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics
SOCI 350	(3)	Statistics in Social Research

9 credits of systematic physical geography

GEOG 305	(3)	Soils and Environment
GEOG 321	(3)	Climatic Environments
GEOG 322	(3)	Environmental Hydrology
GEOG 372	(3)	Running Water Environments
GEOG 373	(3)	Arctic Geomorphology
GEOG 470	(3)	Wetlands

Students must take a total of 9 credits from the next 2 blocks; they will choose 6 credits from one block and 3 credits from the other, depending on their training focus.

3 to 6 credits of 300 level environmental analysis/techniques

GEOG 306	(3)	Raster Geo-Information Science
GEOG 307	(3)	Socioeconomic Applications of GIS
GEOG 308	(3)	Principles of Remote Sensing
GEOG 384	(3)	Principles of Geospatial Web

3 or 6 credits (In Environment, Earth System and Sustainability Sciences)

ENVR 200	(3)	The Global Environment
ENVR 201	(3)	Society, Environment and Sustainability
ENVR 202	(3)	The Evolving Earth
ESYS 200	(3)	Earth System Processes
ESYS 300	(3)	Investigating the Earth System
GEOG 302	(3)	Environmental Management 1
GEOG 360	(3)	Analyzing Sustainability
GEOG 460	(3)	Research in Sustainability

9 credits on human-environment linkages

GEOG 210	(3)	Global Places and Peoples
GEOG 216	(3)	Geography of the World Economy
GEOG 217	(3)	Cities in the Modern World
GEOG 221	(3)	Environment and Health
GEOG 303	(3)	Health Geography
GEOG 310	(3)	Development and Livelihoods
GEOG 311	(3)	Economic Geography
GEOG 315	(3)	Urban Transportation Geography

3 credits of field courses:

GEOG 495	(3)	Field Studies - Physical Geography
GEOG 496	(3)	Geographical Excursion
GEOG 499	(3)	Subarctic Field Studies

3 credits of approved advanced courses in Geography, or elsewhere in the Faculty of Science that have been approved by the Program Adviser, including any geography courses from the above complementary lists.

Geography Approved Course List - Major, Honours and Liberal Programs

GEOG 404	(3)	Environmental Management 2
GEOG 501	(3)	Modelling Environmental Systems
GEOG 505	(3)	Global Biogeochemistry
GEOG 506	(3)	Advanced Geographic Information Science
GEOG 523	(3)	Global Ecosystems and Climate

GEOG 530	(3)	Global Land and Water Resources
GEOG 535	(3)	Remote Sensing and Interpretation
GEOG 536	(3)	Geocryology
GEOG 537	(3)	Advanced Fluvial Geomorphology
GEOG 550	(3)	Historical Ecology Techniques
GEOG 555	(3)	Ecological Restoration

### 13.17.8 Bachelor of Science (B.Sc.) - Major Geography (58 credits)

The BSc Major in Geography provides students with strong training in the theory and tools of physical geography. Students will explore the science of how physical, chemical, and biological processes interact at various spatial and temporal scales to produce distinct environments over the planet, and study different suites of ecosystem services while investigating sustainability challenges for human communities that depend on them. The program includes core training in systematic areas of physical geography (geomorphology, hydrology, soil biogeochemistry, biogeography and climatology), field courses providing hands on exposure to environmental data collection, and courses in quantitative techniques and in GIS and Remote Sensing..

#### Required Courses (13 credits)

GEOG 201	(3)	Introductory Geo-Information Science
GEOG 203	(3)	Environmental Systems
GEOG 272	(3)	Earth's Changing Surface
GEOG 290	(1)	Local Geographical Excursion
GEOG 351	(3)	Quantitative Methods

#### Complementary Courses (45 credits)

3 credits of statistics:

Note: Credit given for statistics courses is subject to certain restrictions. Students in Science should consult the "Course Overlap" information in the "Course Requirements" section for the Faculty of Science.

BIOL 373	(3)	Biometry
GEOG 202	(3)	Statistics and Spatial Analysis
MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics
SOCI 350	(3)	Statistics in Social Research

9 credits of systematic physical geography:

GEOG 305	(3)	Soils and Environment
GEOG 321	(3)	Climatic Environments
GEOG 322	(3)	Environmental Hydrology
GEOG 372	(3)	Running Water Environments
GEOG 373	(3)	Arctic Geomorphology
GEOG 470	(3)	Wetlands

3 credits of field courses:

(Field course availability is determined each year in February.)

GEOG 495	(3)	Field Studies - Physical Geography
GEOG 496	(3)	Geographical Excursion



GEOG 499 (3) Subarctic Field Studies

Students must take a total of 15 credits from the next 2 blocks; they will choose 9 credits from one block and 6 credits from the other block, depending on their training focus.

6 or 9 credits of 300 level environmental analysis/techniques

GEOG 306 (3) Raster Geo-Information Science  
 GEOG 307 (3) Socioeconomic Applications of GIS  
 GEOG 308 (3) Principles of Remote Sensing  
 GEOG 384 (3) Principles of Geospatial Web

6 or 9 credits in (Environment, Earth System and Sustainability sciences)

ENVR 200 (3) The Global Environment  
 ENVR 201 (3) Society, Environment and Sustainability  
 ENVR 202 (3) The Evolving Earth  
 ESYS 200 (3) Earth System Processes  
 ESYS 300 (3) Investigating the Earth System  
 GEOG 302 (3) Environmental Management 1  
 GEOG 360 (3) Analyzing Sustainability  
 GEOG 460 (3) Research in Sustainability

9 credits on human-environment linkages

GEOG 210 (3) Global Places and Peoples  
 GEOG 216 (3) Geography of the World Economy  
 GEOG 217 (3) Cities in the Modern World  
 GEOG 221 (3) Environment and Health  
 GEOG 303 (3) Health Geography  
 GEOG 310 (3) Development and Livelihoods  
 GEOG 311 (3) Economic Geography  
 GEOG 315 (3) Urban Transportation Geography

6 credits of approved advanced courses in Geography, or elsewhere in the Faculty of Science that have been approved by the Program Adviser, including any geography courses from the above complementary lists.

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 term.

#### **Geography Approved Course List - Major, Honours and Liberal Programs**

GEOG 404 (3) Environmental Management 2  
 GEOG 501 (3) Modelling Environmental Systems  
 GEOG 505 (3) Global Biogeochemistry  
 GEOG 506 (3) Advanced Geographic Information Science  
 GEOG 523 (3) Global Ecosystems and Climate  
 GEOG 530 (3) Global Land and Water Resources

GEOG 535	(3)	Remote Sensing and Interpretation
GEOG 536	(3)	Geocryology
GEOG 537	(3)	Advanced Fluvial Geomorphology
GEOG 550	(3)	Historical Ecology Techniques
GEOG 555	(3)	Ecological Restoration

### 13.17.9 Bachelor of Science (B.Sc.) - Honours Geography (66 credits)

The Honours program provides specialized systematic training in physical geography. In addition to the Faculty of Science 3.00 CGPA requirement, students in a Geography Honours program must maintain a program GPA of 3.30 and complete a 6-credit Honours thesis.

#### Required Courses (21 credits)

GEOG 201	(3)	Introductory Geo-Information Science
GEOG 203	(3)	Environmental Systems
GEOG 272	(3)	Earth's Changing Surface
GEOG 351	(3)	Quantitative Methods
GEOG 381	(3)	Geographic Thought and Practice
GEOG 491D1	(3)	Honours Research
GEOG 491D2	(3)	Honours Research

#### Complementary Courses (45 credits)

9 credits on human-environment linkages

GEOG 210	(3)	Global Places and Peoples
GEOG 216	(3)	Geography of the World Economy
GEOG 217	(3)	Cities in the Modern World
GEOG 221	(3)	Environment and Health
GEOG 303	(3)	Health Geography
GEOG 310	(3)	Development and Livelihoods
GEOG 311	(3)	Economic Geography
GEOG 315	(3)	Urban Transportation Geography

3 credits of statistics\*, one of:

\* Note: Credit given for statistics courses is subject to certain restrictions. Students in Science should consult the "Course Overlap" information in the "Course Requirements" section for the Faculty of Science.

BIOL 373	(3)	Biometry
GEOG 202	(3)	Statistics and Spatial Analysis
MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics
SOCI 350	(3)	Statistics in Social Research

9 credits of systematic physical geography:

GEOG 305	(3)	Soils and Environment
GEOG 321	(3)	Climatic Environments

GEOG 322	(3)	Environmental Hydrology
GEOG 372	(3)	Running Water Environments
GEOG 470	(3)	Wetlands

3 credits of field courses:

GEOG 495	(3)	Field Studies - Physical Geography
GEOG 496	(3)	Geographical Excursion
GEOG 499	(3)	Subarctic Field Studies

Students must take a total of 15 credits from the next 2 blocks; they will choose 9 credits from one block and 6 credits from the other block, depending on their training focus

6 or 9 credits of 300 level environmental analysis/techniques

GEOG 306	(3)	Raster Geo-Information Science
GEOG 307	(3)	Socioeconomic Applications of GIS
GEOG 308	(3)	Principles of Remote Sensing
GEOG 384	(3)	Principles of Geospatial Web

6 or 9 credits (In Environment, Earth Science and Sustainability sciences)

ENVR 200	(3)	The Global Environment
ENVR 201	(3)	Society, Environment and Sustainability
ENVR 202	(3)	The Evolving Earth
ESYS 200	(3)	Earth System Processes
ESYS 300	(3)	Investigating the Earth System
GEOG 302	(3)	Environmental Management 1
GEOG 360	(3)	Analyzing Sustainability
GEOG 460	(3)	Research in Sustainability

6 credits of approved advanced courses in Geography, or elsewhere in the Faculty of Science that have been approved by the Program Adviser, including any geography courses from the above complementary lists.

Geography Approved Course List - Major, Honours and Liberal Programs

GEOG 404	(3)	Environmental Management 2
GEOG 501	(3)	Modelling Environmental Systems
GEOG 505	(3)	Global Biogeochemistry
GEOG 506	(3)	Advanced Geographic Information Science
GEOG 523	(3)	Global Ecosystems and Climate
GEOG 530	(3)	Global Land and Water Resources
GEOG 535	(3)	Remote Sensing and Interpretation
GEOG 536	(3)	Geocryology
GEOG 537	(3)	Advanced Fluvial Geomorphology
GEOG 550	(3)	Historical Ecology Techniques
GEOG 555	(3)	Ecological Restoration

### 13.17.10 Geography (GEOG) Related Programs and Study Semesters

The following programs, as well as several other opportunities for field study, are offered by the Faculty of Science. For further information, refer to the [Study Abroad & Field Studies Undergraduate section](#) or the [Science Internship & Field Studies Office website](#).

#### 13.17.10.1 Africa Field Study Semester

The Africa program introduces students to East Africa specifically with a view to increasing their understanding of the goals, circumstances, challenges, and opportunities of people living in the areas visited. For more information, see [www.mcgill.ca/africa](http://www.mcgill.ca/africa).

#### 13.17.10.2 Panama Field Study Semester

The Panama program is a joint venture between McGill University and the Smithsonian Tropical Research Institute (STRI) and addresses Latin America's social and tropical environmental issues. For more information, see [www.mcgill.ca/pfss](http://www.mcgill.ca/pfss).

#### 13.17.10.3 Arctic Field Study Semester

The primary mission of the McGill Arctic Field Studies is to train a future generation of northern specialists and leaders who are able to understand and address the rapidly changing polar environment in a scientifically and culturally responsible manner. For more information, see [www.mcgill.ca/arctic](http://www.mcgill.ca/arctic).

#### 13.17.10.4 Earth System Science Interdepartmental Major

This program is offered by the Department of Atmospheric and Oceanic Sciences; Earth and Planetary Sciences; and Geography.

Students in the Department of Geography interested in this program should contact:

William (Bill) Minarik  
Telephone: 514-398-2596  
Email: [william.minarik@mcgill.ca](mailto:william.minarik@mcgill.ca)

For more information, see [section 13.11: Earth System Science \(ESYS\)](#).

#### 13.17.10.5 Sustainability, Science and Society – Bachelor of Arts and Science (B.A. & Sc.)

The Interfaculty Program in Sustainability, Science and Society as well as the Honours in Sustainability, Science and Society is open only to students in the B.A. & Sc. degree.

Adviser: Brian Robinson, Dr.  
Telephone: 514-398-3453  
Email: [brian.e.robinson@mcgill.ca](mailto:brian.e.robinson@mcgill.ca)

For more information about these programs, see [Bachelor of Arts & Science > Undergraduate > Browse Academic Units & Programs > : Sustainability, Science and Society](#).

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## 13.18 Immunology

### 13.18.1 Location

McGill University Health Centre – Glen Site  
1001 Decarie Boulevard, Bloc E, Office EM23248  
Montreal QC H3G 1A4

or

McIntyre Medical Sciences Building, Room 1136  
3655 Promenade Sir-William-Osler  
Montreal QC H3G 1Y6

### 13.18.2 About Immunology

Three departments offer the **Honours** program in Immunology, combining elements of each:

- [section 13.4: Biochemistry \(BIOC\)](#)

- [section 13.23: Microbiology and Immunology \(MIMM\)](#)
- [section 13.31: Physiology \(PHGY\)](#)

The program is a demanding one which will prepare students for graduate work in immunology.

Students who do not maintain Honours standing must transfer their registration to a program in one of the three participating departments.

Apply to:

Dr. Monroe Cohen  
Physiology  
McIntyre Medical Sciences Building, Room 1136  
3655 Promenade Sir-William-Osler, Montreal QC H3G 1Y6  
Telephone: 514-398-4342  
Email: [monroe.cohen@mcgill.ca](mailto:monroe.cohen@mcgill.ca)

or

Dr. C. Piccirillo  
Microbiology and Immunology  
McGill University Health Centre – Glen Site  
1001 Decarie Boulevard, Bloc E, Office EM23248  
Montreal QC H3G 1A4  
Telephone: 514-934-1934, ext. 76143  
Email: [ciro.piccirillo@mcgill.ca](mailto:ciro.piccirillo@mcgill.ca)

### 13.18.3 Bachelor of Science (B.Sc.) - Honours Immunology (Interdepartmental) (75 credits)

**Revision, April 2018. Start of revision.**

IHI is a 75-credit program involving the Departments of Biochemistry; Microbiology and Immunology; and Physiology, and incorporates elements from each of these disciplines. Immunology is a key area of biomedical research and is critical to our understanding of the patho-physiology of many immune-mediated diseases. This program provides an excellent foundation for students interested in pursuing a career in biomedical research and/or medicine.

The program consists of 48 required credits of basic science courses, covering cell and molecular biology; microbiology and immunology; biochemistry; and physiology. There are also 27 complementary credits which allow for specialization in immunology and related disciplines. To graduate from IHI, students must have a minimum CGPA of 3.30 and pass five immunology courses (MIMM 214, MIMM 314, MIMM 414, PHGY 419D1 and D2, PHGY 513, and one of BIOC 503, MIMM 509, PHGY 531) with a minimum grade of B.

#### Required Courses (48 credits)

##### U1 Required Courses

20 credits selected as follows:

\* Students select either BIOC 212 or BIOL 201.

\*\* Students select either PHGY 209 or MIMM 211.

BIOC 212*	(3)	Molecular Mechanisms of Cell Function
BIOL 200	(3)	Molecular Biology
BIOL 201*	(3)	Cell Biology and Metabolism
CHEM 212	(4)	Introductory Organic Chemistry 1
CHEM 222	(4)	Introductory Organic Chemistry 2
MIMM 211**	(3)	Introductory Microbiology
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
PHGY 209**	(3)	Mammalian Physiology 1

##### U2 Required Courses

13 credits from the following:

ANAT 261	(4)	Introduction to Dynamic Histology
BIOC 311	(3)	Metabolic Biochemistry

BIOC 312	(3)	Biochemistry of Macromolecules
MIMM 314	(3)	Intermediate Immunology

**U3 Required Courses**

15 credits from the following:

MIMM 414	(3)	Advanced Immunology
PHGY 419D1	(4.5)	Immunology Research Project
PHGY 419D2	(4.5)	Immunology Research Project
PHGY 513	(3)	Cellular Immunology

**Complementary Courses (27 credits)****U1 Complementary Courses**

6 credits chosen in the following manner.

3 credits selected from:

BIOL 373	(3)	Biometry
MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

plus 3 credits selected from the following:

\* Students take either PHGY 209 or MIMM 211.

\*\* Students take either CHEM 203 or CHEM 204.

ANAT 214	(3)	Systemic Human Anatomy
ANAT 262	(3)	Introductory Molecular and Cell Biology
BIOL 202	(3)	Basic Genetics
BIOL 205	(3)	Biology of Organisms
BIOL 304	(3)	Evolution
CHEM 203**	(3)	Survey of Physical Chemistry
CHEM 204**	(3)	Physical Chemistry/Biological Sciences 1
COMP 204	(3)	Computer Programming for Life Sciences
COMP 250	(3)	Introduction to Computer Science
MATH 204	(3)	Principles of Statistics 2
MIMM 211**	(3)	Introductory Microbiology
MIMM 212	(3)	Laboratory in Microbiology
PHGY 209**	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

**U2 Complementary Courses**

12 credits chosen as follows:

6 credits selected from:

Students may take

\* BIOC 220 and BIOC 320, or

\*\* MIMM 384 and MIMM 385, or

\*\*\* PHGY 212 and PHGY 213 and BIOL 301

BIOC 220*	(3)	Laboratory Methods in Biochemistry and Molecular Biology 1
BIOC 320*	(3)	Laboratory Methods in Biochemistry and Molecular Biology 2
BIOL 301***	(4)	Cell and Molecular Laboratory
MIMM 384**	(3)	Molecular Microbiology Laboratory
MIMM 385**	(3)	Laboratory in Immunology
PHGY 212***	(1)	Introductory Physiology Laboratory 1
PHGY 213***	(1)	Introductory Physiology Laboratory 2

plus 6 credits, selected from:

\* Students take either BIOL 309 or MATH 315, but not both.

ANAT 365	(3)	Cellular Trafficking
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 309*	(3)	Mathematical Models in Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
CHEM 302	(3)	Introductory Organic Chemistry 3
MATH 222	(3)	Calculus 3
MATH 315*	(3)	Ordinary Differential Equations
MIMM 323	(3)	Microbial Physiology
MIMM 324	(3)	Fundamental Virology
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHAR 303	(3)	Principles of Toxicology
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience

### U3 Complementary Courses

9 credits of U3 complementary courses chosen in the following manner:

3 credits selected from:

BIOC 503	(3)	Immunochemistry
MIMM 509	(3)	Inflammatory Processes
PHGY 531	(3)	Topics in Applied Immunology

plus 6 credits selected from:

\* Students take either ANAT 458 or BIOC 458, but not both.

ANAT 458*	(3)	Membranes and Cellular Signaling
BIOC 404	(3)	Biophysical Methods in Biochemistry
BIOC 450	(3)	Protein Structure and Function

BIOC 454	(3)	Nucleic Acids
BIOC 458*	(3)	Membranes and Cellular Signaling
BIOC 503	(3)	Immunochemistry
BIOL 520	(3)	Gene Activity in Development
EXMD 504	(3)	Biology of Cancer
MIMM 413	(3)	Parasitology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis
MIMM 509	(3)	Inflammatory Processes
NEUR 502	(3)	Basic and Clinical Aspects of Neuroimmunology
PHAR 503	(3)	Drug Discovery and Development 1
PHAR 504	(3)	Drug Discovery and Development 2
PHGY 488	(3)	Stem Cell Biology
PHGY 531	(3)	Topics in Applied Immunology
PHGY 552	(3)	Cellular and Molecular Physiology

Revision, April 2018. End of revision.

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## 13.19 Interdisciplinary Life Sciences

### 13.19.1 Location

Interdisciplinary Programs Adviser  
Ryan Bouma  
Telephone: 514-398-7330  
Email: [ryan.bouma@mcgill.ca](mailto:ryan.bouma@mcgill.ca)

### 13.19.2 About the Interdisciplinary Life Sciences Minor

The Interdisciplinary Life Sciences Minor allows students to obtain exposure to Life Sciences and life science related areas. Students must consult with the Adviser to review course selection.



**Please note:** Students studying in Anatomy and Cell Biology; Biochemistry; Honours Immunology; Microbiology and Immunology; Neuroscience; Pharmacology; and Physiology are not permitted to complete this Minor.

### 13.19.3 Bachelor of Science (B.Sc.) - Minor Interdisciplinary Life Sciences (24 credits)

The Interdisciplinary Life Sciences Minor will allow students from the earth, physical, math, and computational science areas to broaden their studies with some basic life sciences, health social science, and empirical technological science. The Minor is 24 credits and allows students flexibility in their course selections. Students must take 9 credits from an extensive list of basic life science courses, 3 credits from an extensive list of health and social science courses, and 3 credits from an empirical and technological science list. The remaining 9 credits may be taken from courses listed in any of the three categories.

Please note: Students studying in Anatomy and Cell Biology; Biochemistry; Honours Immunology; Microbiology and Immunology; Neuroscience; Pharmacology; and Physiology are not permitted to complete this Minor.

Interested students should contact the Interdisciplinary Programs Adviser.

#### Complementary Courses (24 credits)

The 24 credits required for this program must satisfy the following criteria:

At least 18 credits must be outside the student's main discipline.

Depth requirement:

at least 6 credits must be at the 300 level or above.



## Breadth requirement:

at least 9 credits must be taken from the Basic Life Sciences List,

at least 3 credits from the Health Social Sciences List,

at least 3 credits from the Empirical Science and Technology List.

The remaining 9 credits may be selected from any of the lists.

**Basic Life Sciences**

At least 9 credits from:

\* Students take either ANAT 212 or BIOC 212, but not both.

ANAT 212*	(3)	Molecular Mechanisms of Cell Function
ANAT 214	(3)	Systemic Human Anatomy
ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Introductory Molecular and Cell Biology
ANAT 321	(3)	Circuitry of the Human Brain
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
BIOC 212*	(3)	Molecular Mechanisms of Cell Function
BIOC 311	(3)	Metabolic Biochemistry
BIOC 450	(3)	Protein Structure and Function
BIOC 458	(3)	Membranes and Cellular Signaling
BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 370	(3)	Human Genetics Applied
CHEM 212	(4)	Introductory Organic Chemistry 1
CHEM 222	(4)	Introductory Organic Chemistry 2
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 502	(3)	Advanced Bio-Organic Chemistry
CHEM 503	(3)	Drug Discovery
CHEM 504	(3)	Drug Design
EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
MIMM 211	(3)	Introductory Microbiology
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
MIMM 314	(3)	Intermediate Immunology
MIMM 323	(3)	Microbial Physiology
MIMM 324	(3)	Fundamental Virology
MIMM 387	(3)	The Business of Science
MIMM 465	(3)	Bacterial Pathogenesis

MIMM 466	(3)	Viral Pathogenesis
NSCI 201	(3)	Introduction to Neuroscience 2
NUTR 307	(3)	Metabolism and Human Nutrition
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHAR 303	(3)	Principles of Toxicology
PHAR 503	(3)	Drug Discovery and Development 1
PHAR 504	(3)	Drug Discovery and Development 2
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience
PSYC 211	(3)	Introductory Behavioural Neuroscience
PSYC 311	(3)	Human Cognition and the Brain
PSYC 317	(3)	Genes and Behaviour
PSYC 318	(3)	Behavioural Neuroscience 2
PSYC 342	(3)	Hormones and Behaviour

**Health Social Science**

At least 3 credits from:

ANTH 204	(3)	Anthropology of Meaning
ANTH 227	(3)	Medical Anthropology
ANTH 302	(3)	New Horizons in Medical Anthropology
ANTH 314	(3)	Psychological Anthropology 01
ECON 440	(3)	Health Economics
GEOG 221	(3)	Environment and Health
GEOG 303	(3)	Health Geography
HIST 249	(3)	Health and the Healer in Western History
HIST 335	(3)	Science and Medicine in Canada
HIST 350	(3)	Science and the Enlightenment
HIST 381	(3)	Colonial Africa
HIST 424	(3)	Gender, Sexuality & Medicine
HSEL 308	(3)	Issues in Women's Health
HSEL 309	(3)	Women's Reproductive Health
PHIL 237	(3)	Contemporary Moral Issues
PHIL 343	(3)	Biomedical Ethics
POLI 417	(3)	Health Care in Canada
PSYC 215	(3)	Social Psychology
PSYC 304	(3)	Child Development
PSYC 333	(3)	Personality and Social Psychology

PSYC 412	(3)	Developmental Psychopathology
PSYC 413	(3)	Cognitive Development
PSYC 414	(3)	Social Development
SOCI 225	(3)	Medicine and Health in Modern Society
SOCI 309	(3)	Health and Illness
SOCI 310	(3)	Sociology of Mental Disorder
SOCI 338	(3)	Introduction to Biomedical Knowledge
SOCI 365	(3)	Health and Development
SOCI 390	(3)	Gender and Health
SOCI 515	(3)	Medicine and Society
SOCI 525	(3)	Health Care Systems in Comparative Perspective
SOCI 538	(3)	Selected Topics in Sociology of Biomedical Knowledge

### Empirical Science and Technology

At least 3 credits from:

\* Students who have already received credit for MATH 324 will NOT receive credit for GEOG 202, MATH 203, PSYC 204, BIOL 373, MATH 204, or PSYC 305.

Credit given for statistics courses is subject to certain restrictions. Students should consult the "Course Overlap" information in the "Course Requirements" section for the Faculty of Science.

BIOL 309	(3)	Mathematical Models in Biology
BIOL 373	(3)	Biometry
COMP 202	(3)	Foundations of Programming
COMP 364	(3)	Computer Tools for Life Sciences
COMP 462	(3)	Computational Biology Methods
GEOG 202	(3)	Statistics and Spatial Analysis
MATH 203	(3)	Principles of Statistics 1
MATH 204	(3)	Principles of Statistics 2
MATH 323	(3)	Probability
MATH 324*	(3)	Statistics
PSYC 204	(3)	Introduction to Psychological Statistics
PSYC 305	(3)	Statistics for Experimental Design

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## 13.20 Kinesiology for Science Students

### 13.20.1 Location

Department of Kinesiology and Physical Education  
 Currie Gymnasium  
 475 Pine Avenue West, 2nd Floor  
 Montreal QC H2W 1S4  
 Telephone: 514-398-4184, ext. 09689  
 Fax: 514-398-4186  
 Email: [ugrad.kpe@mcgill.ca](mailto:ugrad.kpe@mcgill.ca)  
 Website: [www.mcgill.ca/edu-kpe](http://www.mcgill.ca/edu-kpe)

Program Adviser: Nada Abu-Merhy; [ugrad.kpe@mcgill.ca](mailto:ugrad.kpe@mcgill.ca)

### 13.20.2 About Kinesiology for Science Students

Students planning a career in the health sciences, whether as a health professional or a biomedical researcher, will find courses in Kinesiology to be of interest from both theoretical and applied perspectives. There is a focus on the benefits of physical activity for health and well-being, as well as appropriate prescription of exercise in the treatment of various diseases, injuries, and disabilities. Courses deal with both prevention and rehabilitation.

Students are not permitted to enrol in more than the 18 credits of EDKP courses required for the Minor in Kinesiology for Science Students.

### 13.20.3 Bachelor of Science (B.Sc.) - Minor Kinesiology (24 credits)

The Minor Kinesiology is designed to provide students in B.Sc. programs with basic but comprehensive knowledge of scientific bases of human physical activity and its relationship with health and well-being.

Students registered in the Minor Kinesiology may not take additional courses outside the Faculties of Arts and of Science.

This minor program requires an application due to limited enrolment space. Please see <http://www.mcgill.ca/isa/faculty-advising/minor-programs> for procedures and deadlines.

#### Required Courses (15 credits)

EDKP 206	(3)	Biomechanics of Human Movement
EDKP 261	(3)	Motor Development
EDKP 395	(3)	Exercise Physiology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

#### Complementary Courses (9 credits)

9 credits, three of the following courses:

EDKP 330	(3)	Physical Activity and Health
EDKP 394	(3)	Historical Perspectives
EDKP 396	(3)	Adapted Physical Activity
EDKP 405	(3)	Sport in Society
EDKP 444	(3)	Ergonomics
EDKP 445	(3)	Exercise Metabolism
EDKP 446	(3)	Physical Activity and Ageing
EDKP 447	(3)	Motor Control
EDKP 448	(3)	Exercise and Health Psychology
EDKP 449	(3)	Exercise Pathophysiology 2
EDKP 485	(3)	Exercise Pathophysiology 1
EDKP 495	(3)	Scientific Principles of Training
EDKP 498	(3)	Sport Psychology
EDKP 542	(3)	Environmental Exercise Physiology
EDKP 566	(3)	Advanced Biomechanics Theory

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### 13.21 Management for Science Students

The Desautels Faculty of Management offers four minor programs for non-Management students open for application to students in the Faculty of Science. Please refer to [Desautels Faculty of Management > Undergraduate > Overview of Programs Offered by the Desautels Faculty of Management > : Minors for Non-Management Students](#) for detailed information about program requirements and applying.

Also available to Science students is the Minor in Entrepreneurship for Science students; see [section 13.12: Entrepreneurship for Science Students](#). Students in this Minor are not permitted to take the Desautels Minors in Finance, Management, Marketing, or Operations Management (for Non-Management students).

**13.21.1 Bachelor of Commerce (B.Com.) - Minor Finance (For Non-Management Students) (18 credits)**

The Minor Finance consists of 18 credits of Management courses and is offered to non-Management students in the Faculties of Arts, Engineering, and Science.

The Minor has been designed to provide students with an understanding of the key concepts in corporate finance as well as investment banking.

**Required Courses (9 credits)**

FINE 342	(3)	Corporate Finance
FINE 441	(3)	Investment Management
MGCR 341*	(3)	Introduction to Finance

**Complementary Courses (9 credits)**

9 credits selected from:

FINE 434	(3)	Topics in Finance 1
FINE 435	(3)	Advanced Topics in Finance
FINE 442	(3)	Capital Markets and Institutions
FINE 443	(3)	Applied Corporate Finance
FINE 444	(3)	Principles and Strategies of Securities Trading
FINE 445	(3)	Real Estate Finance
FINE 446	(3)	Behavioural Finance
FINE 447	(3)	Venture Capital and Entrepreneurial Finance
FINE 448	(3)	Financial Derivatives
FINE 449	(3)	Market Risk Models
FINE 451	(3)	Fixed Income Analysis
FINE 452	(3)	Applied Quantitative Finance
FINE 480	(3)	Global Investments
FINE 482	(3)	International Finance 1
FINE 492	(3)	International Corporate Finance

or other appropriate 300- or 400-level FINE courses with the approval of the Program Adviser.

\* Prerequisite: MGCR 271, Business Statistics, or another equivalent Statistics course approved by the Program Adviser.

Note: Students should select their Statistics course only after consulting the "Course Overlap" section in the Faculty of Arts, the "Course Overlap" section in the Faculty of Science, and the "Course Overlap" section in the Desautels Faculty of Management to avoid overlapping Statistics courses.

**13.21.2 Bachelor of Commerce (B.Com.) - Minor Management (For Non-Management Students) (18 credits)**

The Minor Management consists of 18 credits of Management courses and is currently offered to non-Management students in the following Faculties: Arts, Engineering, Science, Agricultural & Environmental Sciences, Music, Religious Studies, and Kinesiology.

This Minor is designed to provide non-management students with the opportunity to obtain basic knowledge in various aspects of management.

**Complementary Courses (18 credits)**

Selected from categories A, B, and C:

**Category A**

3 credits selected from:

MGCR 211	(3)	Introduction to Financial Accounting
MGCR 341*	(3)	Introduction to Finance

**Category B**

9 credits selected from:

MGCR 222	(3)	Introduction to Organizational Behaviour
MGCR 271**	(3)	Business Statistics
MGCR 293***	(3)	Managerial Economics
MGCR 331	(3)	Information Systems
MGCR 352	(3)	Principles of Marketing
MGCR 382	(3)	International Business
MGCR 472*	(3)	Operations Management

**Category C**

6 credits selected from:

3-6 credits from any 300- or 400-level Management courses for which prerequisites have been met.

0-3 credits may be from a specifically designated course by the student's home faculty.

\* Prerequisite: MGCR 271, Business Statistics, or another equivalent Statistics course approved by the Program Adviser.

\*\* 3 credits of statistics: Students who have taken an equivalent Statistics course in another faculty may not count those credits towards the Minor; an additional 3-credit complementary course must be chosen from the course list above.

\*\*\* Students who have taken an equivalent Economics course in another faculty may not count those credits toward the Minor; an additional 3-credit complementary course must be chosen from the course list above.

Note: Students should select their Statistics course only after consulting the "Course Overlap" section in the Faculty of Arts, the "Course Overlap" section in the Faculty of Science, and the "Course Overlap" section in the Desautels Faculty of Management to avoid overlapping Statistics courses.

**13.21.3 Bachelor of Commerce (B.Com.) - Minor Marketing (For Non-Management Students) (18 credits)**

The Minor Marketing consists of 18 credits of Management courses and is currently offered to non-Management students in the Faculties of Arts, Engineering, Science, and the Schulich School of Music.

This Minor is designed to provide students with an understanding of the fundamental concepts in marketing and a framework for applying marketing in a decision-making context. Students will be introduced to the basic concepts in marketing. The use of marketing theory and concepts for decision making will be covered. Marketing research methods for marketing decisions is introduced. Subsequently, students will be able to specialize by choosing from the list of complementary courses.

**Required Courses (9 credits)**

MGCR 352	(3)	Principles of Marketing
MRKT 354	(3)	Marketing Strategy
MRKT 451	(3)	Marketing Research

**Complementary Courses (9 credits)**

3 credits:

MGCR 271*	(3)	Business Statistics
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6 credits selected from:

MRKT 357	(3)	Marketing Planning I
MRKT 365	(3)	New Products
MRKT 438	(3)	Brand Management
MRKT 452	(3)	Consumer Behaviour
MRKT 453	(3)	Integrated Mktg Communications

MRKT 455	(3)	Sales Management
MRKT 459	(3)	Retail Management
MRKT 483	(3)	International Marketing Management

or other appropriate 300- or 400-level MRKT courses with the approval of the Program Adviser.

\* Students who have taken an equivalent Statistics course in another faculty may not count those credits toward the Minor; an additional 3-credit complementary course must be chosen from the course list above.

Note: Students should select their Statistics course only after consulting the "Course Overlap" section in the Faculty of Arts, the "Course Overlap" section in the Faculty of Science, and the "Course Overlap" section in the Desautels Faculty of Management to avoid overlapping Statistics courses.

### 13.21.4 Bachelor of Commerce (B.Com.) - Minor Operations Management (For Non-Management Students) (18 credits)

The Minor Operations Management consists of 18 credits of Management courses and is currently offered to non-Management students in the Faculties of Arts, Engineering, Science, and Agricultural & Environmental Sciences.

It provides non-Management students with the opportunity to pursue a career that involves decision making at the operational level. Graduates will be able to find employment in consulting, manufacturing, supply chain, distribution, retail operations, healthcare management and environmental management for profit and non-profit corporations. This Minor has been designed to provide students with an understanding of the key concepts in operations management theory and practice.

#### Required Courses (6 credits)

MGCR 472	(3)	Operations Management
MGSC 373	(3)	Operations Research 1

#### Complementary Courses (12 credits)

3 credits

MGCR 271*	(3)	Business Statistics
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9 credits selected from:

MGSC 372	(3)	Advanced Business Statistics
MGSC 402	(3)	Operations Strategy
MGSC 403	(3)	Introduction to Logistics Management
MGSC 405	(3)	Quality Management
MGSC 415	(3)	Supplier Management
MGSC 431	(3)	Operations and Supply Chain Analysis
MGSC 479	(3)	Applied Optimization
MGSC 575	(3)	Applied Time Series Analysis Managerial Forecasting
MGSC 578	(3)	Simulation of Management Systems

or other appropriate 300- or 400-level MGSC courses with the approval of the Program Adviser.

\* 3 credits of Statistics: Students who have taken an equivalent Statistics course in another faculty may not count those credits toward the Minor; an additional 3-credit complementary course must be chosen from the course list above.

Note: Students should select their Statistics course only after consulting the "Course Overlap" section in the Faculty of Arts, the "Course Overlap" section in the Faculty of Science, and the "Course Overlap" section in the Desautels Faculty of Management to avoid overlapping Statistics courses.

## 13.22 Mathematics and Statistics (MATH)

### 13.22.1 Location

Burnside Hall, Room 1005  
805 Sherbrooke Street West  
Montreal QC H3A 0B9  
Telephone: 514-398-3800  
Website: [www.mcgill.ca/mathstat](http://www.mcgill.ca/mathstat)

### 13.22.2 About Mathematics and Statistics

Mathematics and statistics are omnipresent in today's world of information and technology. Their theories, models, and methods are integral to the way we analyze, understand, and build the world around us. They play a key role in nearly every effort to push the boundaries of science, engineering, medicine, and social sciences and contribute, in a major way, to solving some of the most pressing human, environmental, and economic problems of our time.

The Department of Mathematics and Statistics is one of the oldest and most distinguished of its kind in Canada. It is home to active, internationally acclaimed, and award-winning researchers in the three principal subdisciplines in the mathematical sciences.

**Pure mathematics** is concerned with abstract structures and concepts mainly with respect to their intrinsic and technical nature, although many areas in pure mathematics have developed from questions in science and technology. Core areas of expertise in pure mathematics include algebra, analysis, geometry, number theory, and topology.

**Applied mathematics** develops and utilizes advanced mathematical methods to solve problems in a broad range of applications in science, technology, engineering, computer science, and business. Core areas of expertise in applied mathematics include discrete mathematics, game theory, graph theory, mathematical physics, numerical analysis, optimization, and probability.

**Statistics** is motivated by the need to extract information from data, to quantify uncertainty, and to make predictions about random phenomena. To do this effectively, sophisticated mathematical and probabilistic techniques and computational tools are needed. Core areas of expertise include Bayesian inference, biostatistics, computational statistics, high-dimensional data modeling, multivariate analysis, and survival analysis.

### 13.22.3 Undergraduate Program Options

Our programs provide a broad and solid mathematical and statistical education that paves the way to many interesting career options in academia, government, and industry. Top students typically get admitted to prestigious graduate schools around the world and often become leaders in their areas of research in academic or industrial settings. Our graduates at all levels are in high demand in government departments, health research centers, banks, insurance and pharmaceutical companies, statistical agencies, and multinational high-technology industries.

There are two popular undergraduate streams. The **Honours** programs in mathematics, applied mathematics and probability/statistics (including **Joint Honours** with Physics or Computer Science) are at an advanced level for students who wish to specialize their studies in the mathematical sciences. The Honours stream is well suited for students who intend to move on to graduate school and essential for those who are envisaging research careers in the mathematical sciences. The **Major** versions are less intense and leave room for a **Minor** or a second Major concentration in another discipline. The Major stream is particularly suited for students whose future creative activity will involve mathematics or statistics and its applications in another area. Several **Joint Major** programs and a **Liberal** program are also available.

Furthermore, the Desautels Faculty of Management offers the B.Com. degree with a Major in Mathematics.

Students considering programs in Mathematics and Statistics are encouraged to [contact the Department of Mathematics and Statistics](#) to arrange for academic advising.

### 13.22.4 Research Opportunities

During their undergraduate degree, students in the Department of Mathematics and Statistics are encouraged to engage in research. The two main opportunities are:

- Funded summer research projects allowing students to engage in state-of-the art research with faculty members
- Opportunities for hands-on experience with data analysis offered through the [Statistical Consulting Service](#)

### 13.22.5 Internship Opportunities

Students who want to get practical experience in industry before graduation are encouraged to participate in one of the following internship programs:

- The **Internship Year in Science (IYS)** is an option offered for a duration of 8, 12, or 16 months. It is reflected on the transcript and included in the program name (Bachelor of Science – Internship Program). Eligible students usually take this program between their U2 and U3 years.
- The **Industrial Practicum (IP)** has a duration of four months and is usually carried out starting in May. It will appear as a 0-credit, Pass/Fail course on your transcript.



For more information on these opportunities, consult [section 12: Science Internships and Field Studies](#).



**Note:** Students entering a program listed below that has MATH 222 (Calculus 3) as a required course and who have successfully completed a course equivalent to MATH 222 with a grade of C or better may omit MATH 222 (Calculus 3) from the program, but must replace it with 3 credits of mathematics complementary courses chosen after consultation with a Mathematics adviser.

### 13.22.6 Mathematics and Statistics Faculty

#### Chair

David A. Stephens

#### Graduate Program Director

Dmitry Jakobson

#### Emeritus Professors

William J. Anderson; B.Eng., Ph.D.(McG.)

Michael Barr; A.B., Ph.D.(Penn.) (*Peter Redpath Emeritus Professor of Pure Mathematics*)

William G. Brown; B.A.(Tor.), M.A.(Col.), Ph.D.(Tor.)

Marta Bunge; M.A., Ph.D.(Penn.)

Ian Connell; B.Sc., M.Sc.(Manit.), Ph.D.(McG.)

Kohur N. GowriSankaran; B.A., M.A.(Madr.), Ph.D.(Bom.)

Paul Koosis; B.A., Ph.D.(Calif., Berk.)

Michael Makkai; M.A., Ph.D.(Bud.) (*Peter Redpath Professor of Pure Mathematics*)

Sherwin Maslowe; B.Sc.(Wayne St.), M.Sc., Ph.D.(Calif.)

Arak M. Mathai; M.Sc.(Kerala), M.A., Ph.D.(Tor.)

Karl Peter Russell; Vor.Dip.(Hamburg), Ph.D.(Calif.)

Georg Schmidt; B.Sc.(Natal), M.Sc.(S. Af.), Ph.D.(Stan.)

Vanamamalai Seshadri; B.Sc, M.Sc.(Madr.), Ph.D.(Okl.)

George P.H. Styan; M.A., Ph.D.(Col.)

Kwok Kuen Tam; M.A., Ph.D.(Tor.)

John C. Taylor; B.Sc.(Acad.), M.A.(Qu.), Ph.D.(McM.)

Jian-Jun Xu; B.Sc., M.Sc.(Beijing), M.Sc., Ph.D.(Rensselaer Poly.)

Sanjo Zlobec; M.Sc.(Zagreb), Ph.D.(N'western)

#### Professors

Masoud Asgharian; B.Sc.(Shahid Beheshti), M.Sc., Ph.D.(McG.)

Peter Bartello; B.Sc.(Tor.), M.Sc., Ph.D.(McG.) (*joint appt. with Atmospheric and Oceanic Sciences*)

Rustum Choksi; B.Sc.(Tor.), M.Sc., Ph.D.(Brown)

Henri Darmon; B.Sc.(McG.), Ph.D.(Harv.), F.R.S.C. (*James McGill Professor*)

Stephen W. Drury; M.A., Ph.D.(Cant.)

Christian Genest; B.Sp.Sc.(UQAC), M.Sc.(UQAM), Ph.D.(Br. Col.) (*Canada Research Chair*)

Eyal Z. Goren; B.A., M.S., Ph.D.(Hebrew)

Pengfei Guan; B.Sc.(Zhejiang), M.Sc., Ph.D.(Princ.) (*Canada Research Chair*)

Jacques C. Hurtubise; B.Sc.(Montr.), D.Phil.(Oxf.) F.R.S.C.

Dmitry Jakobson; B.Sc.(MIT), Ph.D.(Princ.) (*Peter Redpath Professor*)

Vojkan Jaksic; B.S.(Belgrade), Ph.D.(Calif. Tech.)

Niky Kamran; B.Sc., M.Sc.(Bruxelles), Ph.D.(Wat.), F.R.S.C. (*James McGill Professor*)

**Professors**

Adam Oberman; B.S.(Tor.), M.S., Ph.D.(Chic.)  
 Charles Roth; M.Sc.(McG.), Ph.D.(Hebrew)  
 David A. Stephens; B.Sc., Ph.D.(Nott.) (*James McGill Professor*)  
 John A. Toth; B.Sc., M.Sc.(McM.), Ph.D.(MIT) (*William Dawson Scholar*)  
 Adrian Vetta; B.Sc., M.Sc.(LSE), Ph.D.(MIT) (*joint appt. with Computer Science*)  
 Daniel T. Wise; B.A.(Yeshiva), Ph.D.(Princ.) (*James McGill Professor*)  
 David Wolfson; B.Sc., M.Sc.(Natal), Ph.D.(Purd.)

**Associate Professors**

Louigi Addario-Berry; B.Sc., M.Sc., Ph.D.(McG.)  
 Antony R. Humphries; B.A., M.A.(Camb.), Ph.D.(Bath)  
 Abbas Khalili; B.S., M.S.(Isfahan Univ. of Tech), Ph.D.(Wat.)  
 Jean-Philippe Lessard; B.Sc.(Sher.), M.Sc.(Montr.), Ph.D.(Georgia Tech.)  
 Jean-Christophe Nave; B.Sc., Ph.D.(Calif., Santa Barbara)  
 Johanna Neslehova; B.Sc., M.Sc.(Hamburg), Ph.D.(Oldenburg)  
 Sergey Norin; M.S.(Saint Petersburg St.), Ph.D.(Georgia Tech.)  
 Mikael Pichot; B.Sc.(Lyon), M.S., Ph.D.(ENS Lyon)  
 Russell Steele; B.S., M.S.(Carn. Mell), Ph.D.(Wash.)  
 Gantumur Tsogtgerel; B.Sc.(Nat. Univ. Mongolia), M.Sc., Ph.D.(Utrecht)

**Assistant Professors**

Linan Chen; B.S.(Tsinghua), Ph.D.(MIT)  
 Sarah Harrison; B.Sc.(MIT), Ph.D.(Stan.)  
 Tim Hoheisel; Dipl., Ph.D.(Wurzburg)  
 Jessica Lin; B.A.(NYU), Ph.D.(Chic.)  
 Piotr Przytycki; M.Sc., Ph.D.(Warsaw)  
 Maksym Radziwill; B.Sc.(McG.), Ph.D.(Stan.) (*Canada Research Chair*)  
 Marcin Sabok; M.Sc., Ph.D.(Warsaw)  
 Jérôme Vétois; Ph.D.(Cergy-Pontoise)  
 Yi Yang; B.S.(Sichuan), M.S., Ph.D.(Minn.)

**Associate Members**

Xiao-Wen Chang (*Computer Science*)  
 Luc P. Devroye (*Computer Science*)  
 Pierre R.L. Dutilleul (*Plant Science*)  
 Leon Glass (*Physiology*)  
 James A. Hanley (*Epidemiology and Biostatistics*)  
 Hamed Hatami (*Computer Science*)  
 Lawrence Joseph (*Epidemiology and Biostatistics*)  
 Anmar Khadra (*Physiology*)  
 Michael Mackey (*Physiology*)  
 Erica E.M. Moodie (*Epidemiology and Biostatistics*)  
 Prakash Panangaden (*Computer Science*)  
 Robert W. Platt (*Epidemiology and Biostatistics*)

**Associate Members**

James O. Ramsay (*Psychology*)

Alexandra Schmidt (*Epidemiology and Biostatistics*)

Kaleem Siddiqi (*Computer Science*)

Christina Wolfson (*Epidemiology and Biostatistics*)

**Adjunct Professors**

Renato C. Calleja; B.S.(Tec. Autonomo de Mexico), Ph.D.(Texas-Austin)

Vasek Chvatal; Ph.D.(Wat.)

Eliot Freid; B.S.(Calif. Poly. St.), M.S., Ph.D.(Calif. Tech.)

Andrew Granville; B.A., CASM(Camb.), Ph.D.(Qu.)

Adrian Iovita; B.S.(Bucharest), Ph.D.(Boston)

Payman L. Kassaei; B.Sc.(Sharif Tech.), Ph.D.(MIT)

Dimitris Koukouloupoulos; M.Sc., Ph.D.(Ill.-Chic.)

Etienne Marceau; B.Sc., M.Sc.(Laval); Ph.D.(Louvain)

Ming Mei; B.Sc., M.Sc.(Jiangxi Normal Uni.), Ph.D.(Kanazawa)

Claude-Alain Pillet; M.Sc., Ph.D.(ETH Zurich)

Iosif Polterovich; M.Sc.(Moscow St.), Ph.D.(Weizmann Inst.)

M. Ram Murty; B.Sc.(Car.), Ph.D.(MIT), F.R.S.C.

Robert A. Seely; B.Sc.(McG.), Ph.D.(Cant.)

F. Bruce Shepherd; B.Sc.(Vic., Tor.), M.Sc., Ph.D.(Wat.)

Armen Shirikyan; M.Sc., Ph.D.(Moscow St.); Habilitation(Paris-Sud XI)

Johannes Walcher; Dip., Ph.D.(ETH Zurich) (*joint appt. with Physics*)

**Senior Faculty Lecturer**

Axel Hundemer; M.Sc., Ph.D.(Munich)

**Faculty Lecturers**

José A. Correa; M.Sc.(Wat.), Ph.D.(Car.)

Armel Djivede Kelome; M.Sc.(Benin), M.Sc.(McG.), Ph.D.(Georgia Tech.)

Sidney Trudeau; Ph.D.(McG.)

**13.22.7 Bachelor of Science (B.Sc.) - Minor 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 Mathematics at the beginning of the penultimate year and should obtain approval for the selection of courses to fulfil the requirements for the Minor from the Departmental Chief Adviser (or delegate).

It is strongly recommended that students in the Minor program take MATH 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 6 credits may be allowed for appropriate courses from other departments.

Generally, no more than 6 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 9 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)**

\* MATH 223 may be replaced by MATH 235 and MATH 236. In this case, the complementary credit requirement is reduced by 3 credits.

MATH 222	(3)	Calculus 3
MATH 223*	(3)	Linear Algebra

MATH 315 (3) Ordinary Differential Equations

### Complementary Courses (15 credits)

15 credits selected from the required and complementary courses for majors and honours students in Mathematics, with MATH 323 strongly recommended; alternatively, up to 6 credits may be allowed for appropriate courses from other departments.

### 13.22.8 Bachelor of Science (B.Sc.) - Minor 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 Statistics at the beginning of the penultimate year and must obtain approval for the selection of courses to fulfil 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 6 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 9 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)

\* MATH 223 may be replaced by MATH 235 and MATH 236. In this case the complementary credit requirement is reduced by 3 credits.

MATH 222	(3)	Calculus 3
MATH 223*	(3)	Linear Algebra
MATH 323	(3)	Probability
MATH 324	(3)	Statistics
MATH 423	(3)	Regression and Analysis of Variance

### Complementary Courses (9 credits)

9 credits selected from:

CHEM 593	(3)	Statistical Mechanics
GEOG 351	(3)	Quantitative Methods
MATH 427	(3)	Statistical Quality Control
MATH 447	(3)	Introduction to Stochastic Processes
MATH 523	(4)	Generalized Linear Models
MATH 525	(4)	Sampling Theory and Applications
MATH 545	(4)	Introduction to Time Series Analysis
MATH 556	(4)	Mathematical Statistics 1
MATH 557	(4)	Mathematical Statistics 2
PHYS 362	(3)	Statistical Mechanics
PHYS 559	(3)	Advanced Statistical Mechanics
SOCI 504	(3)	Quantitative Methods 1

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.

### 13.22.9 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Mathematics (45 credits)

#### Program Prerequisites

Students entering the Core Science Component in Mathematics are normally expected to have completed the courses below or their equivalents. Otherwise, they will be required to make up any deficiencies in these courses over and above the 45 credits required for the program.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

### Guidelines for Selection of Courses

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: MATH 317, MATH 318, MATH 327, MATH 328, MATH 335, MATH 340, MATH 407, MATH 417 and to complete the Computer Science Minor.

Students interested in probability and statistics are advised to take MATH 204, MATH 324, MATH 407, MATH 423, MATH 447, MATH 523, MATH 525.

Students interested in applied mathematics should take MATH 317, MATH 319, MATH 324, MATH 326, MATH 327, MATH 407, MATH 417.

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

Students interested in careers in business, industry or government are advised to select courses from the following list:

MATH 317, MATH 319, MATH 327, MATH 329, MATH 407, MATH 417, MATH 423, MATH 430, MATH 447, MATH 523, MATH 525.

### Required Courses (27 credits)

\* Students may select either MATH 249 or MATH 316 but not both.

\*\* Students who have successfully completed a course equivalent to MATH 222 with a grade of C or better may omit MATH 222, but must replace it with 3 credits of elective courses.

MATH 222**	(3)	Calculus 3
MATH 235	(3)	Algebra 1
MATH 236	(3)	Algebra 2
MATH 242	(3)	Analysis 1
MATH 243	(3)	Analysis 2
MATH 249*	(3)	Honours Complex Variables
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
MATH 316*	(3)	Complex Variables
MATH 323	(3)	Probability

### Complementary Courses (18 credits)

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

MATH 317	(3)	Numerical Analysis
MATH 324	(3)	Statistics
MATH 335	(3)	Computational Algebra
MATH 340	(3)	Discrete Structures 2

the remainder of the 18 credits to be selected from:

MATH 204	(3)	Principles of Statistics 2
MATH 318	(3)	Mathematical Logic
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 320	(3)	Differential Geometry
MATH 326	(3)	Nonlinear Dynamics and Chaos

MATH 327	(3)	Matrix Numerical Analysis
MATH 329	(3)	Theory of Interest
MATH 338	(3)	History and Philosophy of Mathematics
MATH 346	(3)	Number Theory
MATH 348	(3)	Euclidean Geometry
MATH 352	(1)	Problem Seminar
MATH 407	(3)	Dynamic Programming
MATH 410	(3)	Majors Project
MATH 417	(3)	Linear Optimization
MATH 423	(3)	Regression and Analysis of Variance
MATH 430	(3)	Mathematical Finance
MATH 447	(3)	Introduction to Stochastic Processes
MATH 523	(4)	Generalized Linear Models
MATH 524	(4)	Nonparametric Statistics
MATH 525	(4)	Sampling Theory and Applications
MATH 545	(4)	Introduction to Time Series Analysis

### 13.22.10 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Statistics (48 credits)

**Revision, April 2018. Start of revision.**

(45 or 48 credits)

This program provides training in statistics, with a solid mathematical core, and basic training in computing. With strong performance in an appropriate selection of courses, this program can lead to "A.Stat." professional accreditation from the Statistical Society of Canada, which is regarded as the entry level requirement for Statisticians practising in Canada.

Students may complete this program with a minimum of 45 credits or a maximum of 48 credits depending on whether or not they are required to take MATH 203.

#### Program Prerequisites

Students entering the Core Science Component in Statistics are normally expected to have completed the courses below or their equivalents. Otherwise they will be required to make up any deficiencies in these courses over and above the 45 credits required for the program.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

In addition, a student who has not completed the equivalent of MATH 203 on entering the program must consult an academic adviser and take MATH 203 in the first semester, increasing the total number of program credits from 45 to 48.

#### Required Courses (27 credits)

\* Students who have successfully completed a course equivalent to MATH 222 with a grade of C or better may omit MATH 222, but must replace it with 3 credits of complementary courses.

\*\* Students who have sufficient knowledge in a programming language do not need to take COMP 202, but must replace it by either COMP 250 or COMP 350.

\*\*\*MATH 236 is an equivalent prerequisite to MATH 223 for required and complementary Computer Science courses listed below.

+ Students have to take MATH 204 prior to MATH 324.

COMP 202**	(3)	Foundations of Programming
MATH 204+	(3)	Principles of Statistics 2
MATH 222*	(3)	Calculus 3
MATH 235	(3)	Algebra 1

MATH 236***	(3)	Algebra 2
MATH 242	(3)	Analysis 1
MATH 323	(3)	Probability
MATH 324+	(3)	Statistics
MATH 423	(3)	Regression and Analysis of Variance

### Complementary Courses

18 or 21 credits

0-3 credits from:

MATH 203	(3)	Principles of Statistics 1
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At least 6 credits selected from:

\* Students can take either MATH 317 or COMP 350, but not both.

COMP 250	(3)	Introduction to Computer Science
COMP 350*	(3)	Numerical Computing
MATH 243	(3)	Analysis 2
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
MATH 316	(3)	Complex Variables
MATH 317*	(3)	Numerical Analysis
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 327	(3)	Matrix Numerical Analysis
MATH 329	(3)	Theory of Interest
MATH 340	(3)	Discrete Structures 2
MATH 350	(3)	Graph Theory and Combinatorics
MATH 417	(3)	Linear Optimization
MATH 430	(3)	Mathematical Finance

At least 9 credits selected from:

\*Students can take either MATH 410 or MATH 420, but not both.

CCOM 314	(3)	Communicating Science
COMP 551	(4)	Applied Machine Learning
MATH 410*	(3)	Majors Project
MATH 420*	(3)	Independent Study
MATH 427	(3)	Statistical Quality Control
MATH 447	(3)	Introduction to Stochastic Processes
MATH 523	(4)	Generalized Linear Models
MATH 524	(4)	Nonparametric Statistics
MATH 525	(4)	Sampling Theory and Applications
MATH 540	(4)	Life Actuarial Mathematics
MATH 541	(4)	Nonlife Actuarial Models
MATH 545	(4)	Introduction to Time Series Analysis

MATH 556	(4)	Mathematical Statistics 1
MATH 557	(4)	Mathematical Statistics 2
MATH 598	(4)	Topics in Probability and Statistics

Revision, April 2018. End of revision.

### 13.22.11 Bachelor of Science (B.Sc.) - Major Mathematics (54 credits)

Revision, May 2018. Start of revision.

#### Program Prerequisites

Students entering the Major program are normally expected to have completed the courses below 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.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

#### 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: MATH 317, MATH 318, MATH 327, MATH 335, MATH 340, MATH 407, MATH 417 and to complete the Computer Science Minor.

Students interested in probability and statistics are advised to take MATH 204, MATH 324, MATH 407, MATH 423, MATH 447, MATH 523, MATH 525.

Students interested in applied mathematics should take MATH 317, MATH 319, MATH 324, MATH 326, MATH 327, MATH 407, MATH 417.

Students considering a career in secondary school teaching are advised to take MATH 318, MATH 338, MATH 346, MATH 348.

Students interested in careers in business, industry or government are advised to select courses from the following list:

MATH 317, MATH 319, MATH 327, MATH 329, MATH 407, MATH 417, MATH 423, MATH 430, MATH 447, MATH 523, MATH 525.

#### Required Courses (27 credits)

Note: Students who have done well in MATH 235 and MATH 242 should consider entering the Honours stream by registering in MATH 251 and MATH 255 instead of MATH 236 and MATH 243.

\* Students may select either MATH 249 or MATH 316 but not both.

\*\* Students who have successfully completed a course equivalent to MATH 222 with a grade of C or better may omit MATH 222, but must replace it with 3 credits of elective courses.

MATH 222**	(3)	Calculus 3
MATH 235	(3)	Algebra 1
MATH 236	(3)	Algebra 2
MATH 242	(3)	Analysis 1
MATH 243	(3)	Analysis 2
MATH 249*	(3)	Honours Complex Variables
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
MATH 316*	(3)	Complex Variables
MATH 323	(3)	Probability

#### Complementary Courses (27 credits)

27 credits selected as follows:



6-12 credits selected from the following:

MATH 317	(3)	Numerical Analysis
MATH 324	(3)	Statistics
MATH 335	(3)	Computational Algebra
MATH 340	(3)	Discrete Structures 2

15-21 credits selected from the following: at least 6 credits must be at the 400 or 500 level.

MATH 204	(3)	Principles of Statistics 2
MATH 318	(3)	Mathematical Logic
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 320	(3)	Differential Geometry
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 327	(3)	Matrix Numerical Analysis
MATH 329	(3)	Theory of Interest
MATH 338	(3)	History and Philosophy of Mathematics
MATH 346	(3)	Number Theory
MATH 348	(3)	Euclidean Geometry
MATH 352	(1)	Problem Seminar
MATH 407	(3)	Dynamic Programming
MATH 410	(3)	Majors Project
MATH 417	(3)	Linear Optimization
MATH 423	(3)	Regression and Analysis of Variance
MATH 427	(3)	Statistical Quality Control
MATH 430	(3)	Mathematical Finance
MATH 447	(3)	Introduction to Stochastic Processes
MATH 478	(3)	Computational Methods in Applied Mathematics
MATH 523	(4)	Generalized Linear Models
MATH 525	(4)	Sampling Theory and Applications
MATH 545	(4)	Introduction to Time Series Analysis

If necessary, 6 additional credits in Mathematics or related disciplines selected in consultation with the Adviser.

**Revision, May 2018. End of revision.**

### 13.22.12 Bachelor of Science (B.Sc.) - Major Mathematics and Computer Science (72 credits)

#### Program Prerequisites

Students entering the Joint Major in Mathematics and Computer Science are normally expected to have completed the courses below or their equivalents. Otherwise, they will be required to make up any deficiencies in these courses over and above the 72 credits of courses in the program specification.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

**Required Courses (54 credits)**

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202 but can replace it with an additional Computer Science complementary course.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 310	(3)	Operating Systems
COMP 330	(3)	Theory of Computation
COMP 360	(3)	Algorithm Design
MATH 222	(3)	Calculus 3
MATH 235	(3)	Algebra 1
MATH 236	(3)	Algebra 2
MATH 242	(3)	Analysis 1
MATH 315	(3)	Ordinary Differential Equations
MATH 317	(3)	Numerical Analysis
MATH 318	(3)	Mathematical Logic
MATH 323	(3)	Probability
MATH 340	(3)	Discrete Structures 2

**Complementary Courses (18 credits)**

9 credits from the set of courses recommended for a major or honours program in Mathematics.

9 credits selected from Computer Science courses at the 300 level or above (except COMP 364 and COMP 396) and ECSE 508.

**13.22.13 Bachelor of Science (B.Sc.) - Major Statistics and Computer Science (72 credits)**

This program provides students with a solid training in both computer science and statistics together with the necessary mathematical background. As statistical endeavours involve ever increasing amounts of data, some students may want training in both disciplines.

**Program Prerequisites**

Students entering the Joint Major in Statistics and Computer Science are normally expected to have completed the courses below or their equivalents. Otherwise they will be required to make up any deficiencies in these courses over and above the 72 credits of required courses.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

**Required Courses (51 credits)**

\* Students who have sufficient knowledge in a programming language do not need to take COMP 202 but can replace it with an additional Computer Science complementary course.

\*\* Students take either COMP 350 or MATH 317, but not both.

\*\*\* Students take either MATH 223 or MATH 236, but not both.

Both courses are equivalent as prerequisites for required and complementary Computer Science courses listed below.

COMP 202*	(3)	Foundations of Programming
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COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 251	(3)	Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 330	(3)	Theory of Computation
COMP 350**	(3)	Numerical Computing
COMP 360	(3)	Algorithm Design
MATH 222	(3)	Calculus 3
MATH 223***	(3)	Linear Algebra
MATH 235	(3)	Algebra 1
MATH 236***	(3)	Algebra 2
MATH 242	(3)	Analysis 1
MATH 314	(3)	Advanced Calculus
MATH 317**	(3)	Numerical Analysis
MATH 323	(3)	Probability
MATH 324	(3)	Statistics
MATH 423	(3)	Regression and Analysis of Variance

### Complementary Courses (21 credits)

#### Revision, April 2018. Start of revision.

12 credits in Mathematics selected from:

\* Students take either MATH 340 or MATH 350, but not both.

\*\* MATH 578 and COMP 540 cannot both be taken for program credit.

MATH 327	(3)	Matrix Numerical Analysis
MATH 340*	(3)	Discrete Structures 2
MATH 350*	(3)	Graph Theory and Combinatorics
MATH 352	(1)	Problem Seminar
MATH 410	(3)	Majors Project
MATH 427	(3)	Statistical Quality Control
MATH 447	(3)	Introduction to Stochastic Processes
MATH 523	(4)	Generalized Linear Models
MATH 524	(4)	Nonparametric Statistics
MATH 525	(4)	Sampling Theory and Applications
MATH 545	(4)	Introduction to Time Series Analysis
MATH 578**	(4)	Numerical Analysis 1
MATH 594	(4)	Topics in Mathematics and Statistics

#### Revision, April 2018. End of revision.

9 credits in Computer Science selected as follows:

At least 6 credits selected from:

COMP 424	(3)	Artificial Intelligence
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COMP 462	(3)	Computational Biology Methods
COMP 526	(3)	Probabilistic Reasoning and AI
COMP 540**	(4)	Matrix Computations
COMP 547	(4)	Cryptography and Data Security
COMP 551	(4)	Applied Machine Learning
COMP 564	(3)	Advanced Computational Biology Methods and Research
COMP 566	(3)	Discrete Optimization 1
COMP 567	(3)	Discrete Optimization 2

The remaining Computer Science credits are selected from COMP courses at the 300 level or above (except COMP 396) and ECSE 508.

### 13.22.14 Bachelor of Science (B.Sc.) - Honours Applied Mathematics (60 credits)

**Revision, April 2018. Start of revision.**

Applied Mathematics is a very broad field and students are encouraged to choose a coherent program of complementary courses. Most students specialize in "continuous" or "discrete" applied mathematics, but there are many sensible combinations of courses, and the following informal guidelines should be discussed with the student's adviser. Also, 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. To develop an appreciation of the diversity of Applied Mathematics, students are advised to develop some depth (e.g., by completing a minor) in a field related to Applied Mathematics such as Atmospheric and Oceanic Sciences, Biology, Biochemistry, Chemistry, Computer Science, Earth and Planetary Sciences, Economics, Engineering, Management, Physics, Physiology, and Psychology.

#### Required Courses (39 credits)

\* COMP 250 may be preceded by COMP 202.

\*\* Students select either MATH 251 or MATH 247, but not both.

COMP 250*	(3)	Introduction to Computer Science
COMP 252	(3)	Honours Algorithms and Data Structures
MATH 235	(3)	Algebra 1
MATH 247**	(3)	Honours Applied Linear Algebra
MATH 248	(3)	Honours Advanced Calculus
MATH 251**	(3)	Honours Algebra 2
MATH 255	(3)	Honours Analysis 2
MATH 325	(3)	Honours Ordinary Differential Equations
MATH 350	(3)	Graph Theory and Combinatorics
MATH 356	(3)	Honours Probability
MATH 357	(3)	Honours Statistics
MATH 376	(3)	Honours Nonlinear Dynamics
MATH 470	(3)	Honours Research Project
MATH 475	(3)	Honours Partial Differential Equations

#### Complementary Courses (21 credits)

3 credits selected from:

MATH 242	(3)	Analysis 1
MATH 254	(3)	Honours Analysis 1

\*\*\* It is strongly recommended that students take MATH 254.

Advising Notes:

Students interested in continuous applied mathematics are urged to choose these as part of their Complementary Courses: MATH 454 and MATH 455, and are advised to choose additional courses from MATH 387, MATH 397, MATH 555, MATH 560, MATH 574, MATH 578, MATH 579, MATH 580, MATH 581.

Students interested in discrete applied mathematics are advised to choose from these as part of their Complementary Courses: COMP 362, COMP 490, MATH 456, MATH 457, MATH 407, MATH 547, MATH 550, MATH 552, MATH 560.

3 credits selected from:

MATH 249	(3)	Honours Complex Variables
MATH 366	(3)	Honours Complex Analysis

at least 3 credits selected from:

MATH 387	(3)	Honours Numerical Analysis
MATH 397	(3)	Honours Matrix Numerical Analysis

and the remainder of credits selected from:

COMP 362	(3)	Honours Algorithm Design
MATH 352	(1)	Problem Seminar
MATH 377	(3)	Honours Number Theory
MATH 398	(3)	Honours Euclidean Geometry
MATH 454*	(3)	Honours Analysis 3
MATH 455**	(3)	Honours Analysis 4
MATH 456***	(3)	Honours Algebra 3
MATH 457+	(3)	Honours Algebra 4
MATH 458++	(3)	Honours Differential Geometry
MATH 478	(3)	Computational Methods in Applied Mathematics
MATH 480	(3)	Honours Independent Study
MATH 488	(3)	Honours Set Theory
MATH 490	(3)	Honours Mathematics of Finance
MATH 517	(4)	Honours Linear Optimization

\* Not open to students who have taken MATH 354.

\*\* Not open to students who have taken MATH 355.

\*\*\* Not open to students who have taken MATH 370.

+ Not open to students who have taken MATH 371.

++ Not open to students who have taken MATH 380.

All MATH 500-level courses.

No more than 6 credits from the following courses for which no Honours equivalent exists:

MATH 204	(3)	Principles of Statistics 2
MATH 329	(3)	Theory of Interest
MATH 338	(3)	History and Philosophy of Mathematics
MATH 407	(3)	Dynamic Programming

Other courses with the permission of the Department.

**Revision, April 2018. End of revision.**

### 13.22.15 Bachelor of Science (B.Sc.) - Honours Mathematics (60 credits)

**Revision, April 2018. Start of revision.**

#### Program Prerequisites

The minimum requirement for entry into the Honours program is that the student has completed with high standing the following courses below or their equivalents. In addition, a student who has not completed the equivalent of MATH 222 must take it in the first term without receiving credits toward 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.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

#### Required Courses (45 credits)

\* MATH 314 may be substituted for MATH 248 if MATH 222 had to be taken in the Fall.

\*\* Not open to students who have taken MATH 354.

\*\*\* Not open to students who have taken MATH 355.

^ Not open to students who have taken MATH 380.

+ Not open to students who have taken MATH 370.

++ Not open to students who have taken MATH 371.

+++ Not open to students who have taken MATH 375.

MATH 235	(3)	Algebra 1
MATH 248*	(3)	Honours Advanced Calculus
MATH 251	(3)	Honours Algebra 2
MATH 255	(3)	Honours Analysis 2
MATH 325	(3)	Honours Ordinary Differential Equations
MATH 356	(3)	Honours Probability
MATH 357	(3)	Honours Statistics
MATH 366	(3)	Honours Complex Analysis
MATH 454**	(3)	Honours Analysis 3
MATH 455***	(3)	Honours Analysis 4
MATH 456+	(3)	Honours Algebra 3
MATH 457++	(3)	Honours Algebra 4
MATH 458^	(3)	Honours Differential Geometry
MATH 470	(3)	Honours Research Project
MATH 475+++	(3)	Honours Partial Differential Equations

#### Complementary Courses (15 credits)

3 credits selected from;

MATH 242	(3)	Analysis 1
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MATH 254\*\* (3) Honours Analysis 1

\*\* It is strongly recommended that students take MATH 254.

12 credits selected from:

MATH 350	(3)	Graph Theory and Combinatorics
MATH 352	(1)	Problem Seminar
MATH 376	(3)	Honours Nonlinear Dynamics
MATH 377	(3)	Honours Number Theory
MATH 387	(3)	Honours Numerical Analysis
MATH 397	(3)	Honours Matrix Numerical Analysis
MATH 398	(3)	Honours Euclidean Geometry
MATH 480	(3)	Honours Independent Study
MATH 488	(3)	Honours Set Theory
MATH 517	(4)	Honours Linear Optimization

all MATH 500-level courses.

Honours-level courses from related disciplines:

\* COMP 250 may be preceded by COMP 202.

COMP 250*	(3)	Introduction to Computer Science
COMP 252	(3)	Honours Algorithms and Data Structures

no more than 6 credits from the following courses for which no Honours equivalent exists:

MATH 204	(3)	Principles of Statistics 2
MATH 329	(3)	Theory of Interest
MATH 338	(3)	History and Philosophy of Mathematics
MATH 407	(3)	Dynamic Programming

Students may select other courses with the permission of the Department.

**Revision, April 2018. End of revision.**

### 13.22.16 Bachelor of Science (B.Sc.) - Honours Probability and Statistics (65 credits)

#### Required Courses (47 credits)

\* COMP 250 may be preceded by COMP 202.

\*\* Students select either MATH 251 or MATH 247, but not both.

COMP 250*	(3)	Introduction to Computer Science
MATH 235	(3)	Algebra 1
MATH 247**	(3)	Honours Applied Linear Algebra
MATH 248	(3)	Honours Advanced Calculus
MATH 251**	(3)	Honours Algebra 2
MATH 255	(3)	Honours Analysis 2
MATH 356	(3)	Honours Probability
MATH 357	(3)	Honours Statistics

MATH 454	(3)	Honours Analysis 3
MATH 470	(3)	Honours Research Project
MATH 523	(4)	Generalized Linear Models
MATH 533	(4)	Honours Regression and Analysis of Variance
MATH 556	(4)	Mathematical Statistics 1
MATH 557	(4)	Mathematical Statistics 2
MATH 587	(4)	Advanced Probability Theory 1

**Complementary Courses (18 credits)**

3 credits selected from:

\* It is strongly recommended that students take MATH 254.

MATH 242	(3)	Analysis 1
MATH 254*	(3)	Honours Analysis 1

**Revision, April 2018. Start of revision.**

12-15 credits selected from:

\* MATH 455 cannot be taken as a substitute for MATH 587. Students may obtain credit for both MATH 587 and MATH 455.

MATH 325	(3)	Honours Ordinary Differential Equations
MATH 350	(3)	Graph Theory and Combinatorics
MATH 352	(1)	Problem Seminar
MATH 366	(3)	Honours Complex Analysis
MATH 387	(3)	Honours Numerical Analysis
MATH 397	(3)	Honours Matrix Numerical Analysis
MATH 455*	(3)	Honours Analysis 4
MATH 458	(3)	Honours Differential Geometry
MATH 475	(3)	Honours Partial Differential Equations
MATH 480	(3)	Honours Independent Study
MATH 490	(3)	Honours Mathematics of Finance
MATH 524	(4)	Nonparametric Statistics
MATH 525	(4)	Sampling Theory and Applications
MATH 545	(4)	Introduction to Time Series Analysis
MATH 547	(4)	Stochastic Processes
MATH 550	(4)	Combinatorics
MATH 589	(4)	Advanced Probability Theory 2
MATH 594	(4)	Topics in Mathematics and Statistics
MATH 598	(4)	Topics in Probability and Statistics

**Revision, April 2018. End of revision.**

0-3 credits from the following courses for which no Honours equivalent exists:

MATH 204	(3)	Principles of Statistics 2
MATH 407	(3)	Dynamic Programming
MATH 427	(3)	Statistical Quality Control



**13.22.17 Bachelor of Science (B.Sc.) - Honours Statistics and Computer Science (79 credits)**

This is a challenging program providing students with a solid training in both computer science and statistics suitable for entry into graduate school in either discipline.

Students may complete this program with a minimum of 76 credits or a maximum of 79 credits depending on whether or not they are exempt from taking COMP 202.

**Program Prerequisites**

Students entering the Joint Honours in Statistics and Computer Science are normally expected to have completed the courses below or their equivalents. Otherwise, they will be required to make up any deficiencies in these courses over and above the 76-79 credits of courses in the program.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

**Required Courses (46 credits)**

\* Students who have sufficient knowledge in a programming language are not required to take COMP 202.

\*\* Students take either MATH 251 or MATH 247, but not both.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 252	(3)	Honours Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 330	(3)	Theory of Computation
COMP 362	(3)	Honours Algorithm Design
MATH 235	(3)	Algebra 1
MATH 247**	(3)	Honours Applied Linear Algebra
MATH 248	(3)	Honours Advanced Calculus
MATH 251**	(3)	Honours Algebra 2
MATH 255	(3)	Honours Analysis 2
MATH 356	(3)	Honours Probability
MATH 357	(3)	Honours Statistics
MATH 533	(4)	Honours Regression and Analysis of Variance

**Complementary Courses (33 credits)**

18 credits in Mathematics selected as follows:

3 credits selected from:

MATH 242	(3)	Analysis 1
MATH 254*	(3)	Honours Analysis 1

\* It is strongly recommended that students take MATH 254.

3 credits selected from:

MATH 387	(3)	Honours Numerical Analysis
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MATH 397 (3) Honours Matrix Numerical Analysis

At least 8 credits selected from:

MATH 523 (4) Generalized Linear Models  
MATH 524 (4) Nonparametric Statistics  
MATH 525 (4) Sampling Theory and Applications  
MATH 556 (4) Mathematical Statistics 1  
MATH 557 (4) Mathematical Statistics 2

The remaining Mathematics credits selected from:

\*\* MATH 578 and COMP 540 cannot both be taken for program credit.

MATH 350 (3) Graph Theory and Combinatorics  
MATH 352 (1) Problem Seminar  
MATH 454 (3) Honours Analysis 3  
MATH 545 (4) Introduction to Time Series Analysis  
MATH 578\*\* (4) Numerical Analysis 1  
MATH 587 (4) Advanced Probability Theory 1  
MATH 594 (0) Topics in Mathematics and Statistics

15 credits in Computer Science selected as follows:

At least 6 credits selected from:

COMP 424 (3) Artificial Intelligence  
COMP 462 (3) Computational Biology Methods  
COMP 526 (3) Probabilistic Reasoning and AI  
COMP 540\*\* (3) Matrix Computations  
COMP 547 (4) Cryptography and Data Security  
COMP 551 (4) Applied Machine Learning  
COMP 552 (4) Combinatorial Optimization  
COMP 564 (3) Advanced Computational Biology Methods and Research  
COMP 566 (3) Discrete Optimization 1  
COMP 567 (3) Discrete Optimization 2

The remaining Computer Science credits are selected from COMP courses at the 300 level or above excluding COMP 396.

### 13.22.18 Bachelor of Science (B.Sc.) - Honours Mathematics and Computer Science (75 credits)

Students may complete this program with a minimum of 72 credits or a maximum of 75 credits depending on whether or not they are exempt from taking COMP 202.

#### Program Prerequisites

Students must consult an Honours adviser in both departments. Students entering the Joint Honours in Mathematics and Computer Science are normally expected to have completed the courses below or their equivalents. Otherwise, they will be required to make up any deficiencies in these courses over and above the 72-75 credits of courses in the program.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2

**Required Courses (42 credits)**

\* Students who have sufficient knowledge in a programming language are not required to take COMP 202.

COMP 202*	(3)	Foundations of Programming
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 252	(3)	Honours Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 310	(3)	Operating Systems
COMP 330	(3)	Theory of Computation
COMP 362	(3)	Honours Algorithm Design
MATH 235	(3)	Algebra 1
MATH 248	(3)	Honours Advanced Calculus
MATH 251	(3)	Honours Algebra 2
MATH 255	(3)	Honours Analysis 2
MATH 350	(3)	Graph Theory and Combinatorics

**Complementary Courses (33 credits)**

3 credits selected from:

MATH 242	(3)	Analysis 1
MATH 254*	(3)	Honours Analysis 1

\* It is strongly recommended that students take MATH 254.

18 credits in Mathematics, at least 12 credits selected from:

\*\* Not open to students who have taken MATH 354.

\*\*\* Not open to students who have taken MATH 355.

+ Not open to students who have taken MATH 370.

++ Not open to students who have taken MATH 371.

MATH 356*	(3)	Honours Probability
MATH 387	(3)	Honours Numerical Analysis
MATH 454**	(3)	Honours Analysis 3
MATH 455***	(3)	Honours Analysis 4
MATH 456+	(3)	Honours Algebra 3
MATH 457++	(3)	Honours Algebra 4

The remaining credits should be selected from honours courses given by the Department of Mathematics and Statistics.

12 credits in Computer Science, selected from Computer Science courses at the 300 level or above excluding COMP 364 and COMP 396. ECSE 508 may also be taken.

### 13.22.19 Mathematics and Statistics (MATH) Related Programs

#### 13.22.19.1 Major in Biology and Mathematics

For more information, see [section 13.5: Biology \(BIOL\)](#) > [section 13.5.10: Bachelor of Science \(B.Sc.\) - Major Biology and Mathematics \(76 credits\)](#).

#### 13.22.19.2 Major in Physiology and Mathematics

For more information, see [section 13.31: Physiology \(PHGY\)](#) > [section 13.31.6: Bachelor of Science \(B.Sc.\) - Major Physiology and Mathematics \(79 credits\)](#).

#### 13.22.19.3 Honours Program in Mathematics and Physics

For more information, see [section 13.30: Physics \(PHYS\)](#) > [section 13.30.15: Bachelor of Science \(B.Sc.\) - Honours Mathematics and Physics \(81 credits\)](#).

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### 13.23 Microbiology and Immunology (MIMM)

#### 13.23.1 Location

Lyman Duff Medical Sciences Building, Room 511  
3775 University Street  
Montreal QC H3A 2B4  
Telephone: 514-398-3915  
Fax: 514-398-7052  
Email: [undergrad.microimm@mcgill.ca](mailto:undergrad.microimm@mcgill.ca)  
Website: [www.mcgill.ca/microimm](http://www.mcgill.ca/microimm)

#### 13.23.2 About Microbiology and Immunology

**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; and 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 sequesters 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:

- microbial physiology and genetics;
- microbial pathogenesis;
- molecular virology;
- cellular and molecular immunology;
- parasitology.

Students registered in the Department are therefore 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.

An online undergraduate handbook, containing course and program information and information on careers in microbiology and immunology is available on our [website](#).

All new students should attend a departmental **orientation/advising session** in August. Please check [www.mcgill.ca/microimm/student-affairs/advising](http://www.mcgill.ca/microimm/student-affairs/advising) for dates.

**13.23.3 Microbiology and Immunology Faculty****Interim Chair**

G. Matlashewski

**Emeritus Professors**

N. Acheson, M. Baines, J.W. Coulton

**Professors**

J. Archambault; Ph.D.(Tor.)

A. Berghuis; M.Sc.(Rijks Univ. Groningen), Ph.D.(Br. Col.)

G.J. Matlashewski; B.Sc.(C'dia), Ph.D.(Ohio)

R.A. Murgita; B.Sc.(Maine), M.S.(Vermont), Ph.D.(McG.)

M. Olivier; B.Sc.(Montr.), Ph.D.(McG.)

C. Piccirillo; B.Sc., Ph.D.(McG.)

D. Sheppard; M.D.(Tor.)

M. Stevenson; M.Sc., Ph.D.(Catholic Univ. of Amer.)

**Associate Professors**

D.J. Briedis; B.A., M.D.(Johns Hop.)

B. Cousineau; B.Sc., M.Sc., Ph.D.(Montr.)

S. Fournier; Ph.D.(Montr.)

J. Fritz; Ph.D.(Vienna)

S. Gruenheid; B.Sc.(Br. Col.), Ph.D.(McG.)

G. T. Marczynski; B.Sc., Ph.D.(Ill.)

**Assistant Professors**

I. King; B.Sc.(Ohio St.), M.Sc.(Pitt. St.), Ph.D.(Roch.)

C. Krawczyk; Ph.D.(Tor.)

C. Maurice; M.S., Ph.D.(Montpellier II)

M. Richer; B.Sc.(McG.), M.Sc.(Montr.), Ph.D.(Br. Col.)

S. Sagan; B.Sc.(McG.), Ph.D.(Ott.)

**Associate Members**

*Epidemiology and Infectious Diseases:* M. Behr, A. Dascal, V. Loo

*Immunology, Autoimmunity, Host Defense:* J. Antel, M. Burnier, I. Colmegna, P. Gros, A. Kristof, J. Mandl, A. Orthwein, J. Rauch, M. Saleh, J. Spicer, C. Tsoukas, S. Vidal

*Immunology and Parasitology:* B. Brenner, M. Ndao, P. Rohrbach, B. Ward, J. Zhang

*Microbiology:* D. Cuong Vinh, M. Divangahi, C. Liang, D. Nguyen, M. Reed

*Molecular Biology:* N. Cermakian, S. Hussain, A. Jardim, A. Moulard, K. Pantopoulos, M. Tremblay, B. Turcotte, J. Xia

*Virology:* A. Gatignol, A.E. Koromilas, R. Lin, T. Mesplede, J. Teodoro

**Adjunct Professors**

A. Bar-Or

E. Cohen

A. Descoteaux

J.M. Di Noia

**Adjunct Professors**

E. Emani

A. Finzi

N. Grandvaux

G. Kukulj

P. Lau

S. Lesage

S.L. Liu

J. Madrenas

R. Moutih

C. Paradis-Bleau

A. Petronela

K. Pike

W-K. Suh

S. Tran

**13.23.4 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Microbiology and Immunology (50 credits)****U1 Required Courses (19 credits)**

\* Students who have taken CHEM 212 in CEGEP are exempt and must replace these credits with an elective course(s).

BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 212*	(4)	Introductory Organic Chemistry 1
MIMM 211	(3)	Introductory Microbiology
MIMM 212	(3)	Laboratory in Microbiology
MIMM 214	(3)	Introductory Immunology: Elements of Immunity

**U1 Complementary Course (3 credits)**

3 credits, select one from:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

**U1, U2, or U3 Required Course (3 credits)**

3 credits, select one from:

BIOL 373	(3)	Biometry
MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

**U2 Required Courses (16 credits)**

MIMM 301	(1)	Scientific Writing Skills in MIMM
MIMM 314	(3)	Intermediate Immunology
MIMM 323	(3)	Microbial Physiology

MIMM 324	(3)	Fundamental Virology
MIMM 384	(3)	Molecular Microbiology Laboratory
MIMM 385	(3)	Laboratory in Immunology

**U3 Complementary Courses (6 credits)**

6 credits selected from:

MIMM 387	(3)	The Business of Science
MIMM 413	(3)	Parasitology
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis
MIMM 509	(3)	Inflammatory Processes

**U1, U2 or U3 Complementary Courses (3 credits)**

3 credits selected from:

\* Students who have taken CHEM 212 or CHEM 222 in CEGEP must replace it with another complementary course.

ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Introductory Molecular and Cell Biology
ANAT 365	(3)	Cellular Trafficking
ANAT 458	(3)	Membranes and Cellular Signaling
BIOC 311	(3)	Metabolic Biochemistry
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
BIOC 458	(3)	Membranes and Cellular Signaling
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 309	(3)	Mathematical Models in Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOT 505	(3)	Selected Topics in Biotechnology
CHEM 203	(3)	Survey of Physical Chemistry
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1
CHEM 222*	(4)	Introductory Organic Chemistry 2
CHEM 302	(3)	Introductory Organic Chemistry 3
COMP 204	(3)	Computer Programming for Life Sciences
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
EXMD 504	(3)	Biology of Cancer
MIMM 387	(3)	The Business of Science
MIMM 413	(3)	Parasitology
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis

MIMM 496D1	(3)	Microbiology Advanced Research Project
MIMM 496D2	(3)	Microbiology Advanced Research Project
MIMM 497D1	(3)	Immunology Advanced Research Project
MIMM 497D2	(3)	Immunology Advanced Research Project
MIMM 509	(3)	Inflammatory Processes
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

### 13.23.5 Bachelor of Science (B.Sc.) - Major Microbiology and Immunology (66 credits)

Revision, April 2018. Start of revision.

The Major program is designed for students who want to acquire a substantial background in microbiology and immunology and related disciplines (chemistry, biology, biochemistry) which will prepare them for professional schools, graduate education, or entry into jobs in industry or research institutes.

#### U1 Required Courses (26 credits)

\* Students who have taken CHEM 212 in CEGEP are exempt and must replace these credits with an elective course(s).

\*\* Students who have taken CHEM 222 in CEGEP are exempt and must replace these credits with an elective course(s).

BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222**	(4)	Introductory Organic Chemistry 2
MIMM 211	(3)	Introductory Microbiology
MIMM 212	(3)	Laboratory in Microbiology
MIMM 214	(3)	Introductory Immunology: Elements of Immunity

One of:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

#### U1, U2, or U3 Required Course (3 credits)

One of:

BIOL 373	(3)	Biometry
MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

#### U2 Required Courses (19 credits)

BIOC 311	(3)	Metabolic Biochemistry
MIMM 301	(1)	Scientific Writing Skills in MIMM
MIMM 314	(3)	Intermediate Immunology
MIMM 323	(3)	Microbial Physiology



MIMM 324	(3)	Fundamental Virology
MIMM 384	(3)	Molecular Microbiology Laboratory
MIMM 385	(3)	Laboratory in Immunology

**U3 Required Course (3 credits)**

MIMM 413	(3)	Parasitology
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**U3 Complementary Courses (6 credits)**

6 credits selected from:

MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis

**Complementary Courses (9 credits)**

9 credits selected from:

\* Students may select either ANAT 458 or BIOC 458, but not both.

ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 262	(3)	Introductory Molecular and Cell Biology
ANAT 365	(3)	Cellular Trafficking
ANAT 458*	(3)	Membranes and Cellular Signaling
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
BIOC 458*	(3)	Membranes and Cellular Signaling
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 309	(3)	Mathematical Models in Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOT 505	(3)	Selected Topics in Biotechnology
CHEM 203	(3)	Survey of Physical Chemistry
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1
CHEM 302	(3)	Introductory Organic Chemistry 3
COMP 204	(3)	Computer Programming for Life Sciences
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
EXMD 504	(3)	Biology of Cancer
MIMM 387	(3)	The Business of Science
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis
MIMM 496D1	(3)	Microbiology Advanced Research Project
MIMM 496D2	(3)	Microbiology Advanced Research Project
MIMM 497D1	(3)	Immunology Advanced Research Project

MIMM 497D2	(3)	Immunology Advanced Research Project
MIMM 509	(3)	Inflammatory Processes
PATH 300	(3)	Human Disease
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

Revision, April 2018. End of revision.

### 13.23.6 Bachelor of Science (B.Sc.) - Honours Microbiology and Immunology (72 credits)

Revision, April 2018. Start of revision.

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 must follow the Major program in U1 and U2 and must obtain a CGPA of at least 3.50 at the end of their U2 year. For graduation in Honours, students must pass all required courses with a C or better, and achieve a sessional GPA of at least 3.30 in the U3 year.

#### U1 Required Courses (26 credits)

\* Students who have taken CHEM 212 in CEGEP are exempt and must replace these credits with an elective course(s).

\*\* Students who have taken CHEM 222 in CEGEP are exempt and must replace these credits with an elective course(s).

BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222**	(4)	Introductory Organic Chemistry 2
MIMM 211	(3)	Introductory Microbiology
MIMM 212	(3)	Laboratory in Microbiology
MIMM 214	(3)	Introductory Immunology: Elements of Immunity

One of:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

#### U1, U2, or U3 Required Course (3 credits)

One of:

BIOL 373	(3)	Biometry
MATH 203	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

#### U2 Required Courses (19 credits)

BIOC 311	(3)	Metabolic Biochemistry
MIMM 301	(1)	Scientific Writing Skills in MIMM
MIMM 314	(3)	Intermediate Immunology

MIMM 323	(3)	Microbial Physiology
MIMM 324	(3)	Fundamental Virology
MIMM 384	(3)	Molecular Microbiology Laboratory
MIMM 385	(3)	Laboratory in Immunology

**U3 Required Courses (15 credits)**

MIMM 413	(3)	Parasitology
MIMM 501D1*	(6)	Honours Research Project in Immunology
MIMM 501D2*	(6)	Honours Research Project in Immunology
MIMM 502D1*	(6)	Honours Research Project in Microbiology
MIMM 502D2*	(6)	Honours Research Project in Microbiology

\* Students take either MIMM 501D1 and MIMM 501D2 OR MIMM 502D1 and MIMM 502D2.

**U3 Complementary Courses (6 credits)**

6 credits selected from:

MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis

**Complementary Course (3 credits)**

3 credits selected from:

ANAT 458	(3)	Membranes and Cellular Signaling
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 404	(3)	Biophysical Methods in Biochemistry
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
BIOC 458	(3)	Membranes and Cellular Signaling
BIOL 309	(3)	Mathematical Models in Biology
BIOL 520	(3)	Gene Activity in Development
BIOT 505	(3)	Selected Topics in Biotechnology
CHEM 203	(3)	Survey of Physical Chemistry
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1
COMP 204	(3)	Computer Programming for Life Sciences
COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
MIMM 387	(3)	The Business of Science
MIMM 414	(3)	Advanced Immunology
MIMM 465	(3)	Bacterial Pathogenesis
MIMM 466	(3)	Viral Pathogenesis
MIMM 496D1	(3)	Microbiology Advanced Research Project
MIMM 496D2	(3)	Microbiology Advanced Research Project
MIMM 497D1	(3)	Immunology Advanced Research Project

MIMM 497D2	(3)	Immunology Advanced Research Project
MIMM 509	(3)	Inflammatory Processes
PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology
PSYT 455	(3)	Neurochemistry

Revision, April 2018. End of revision.

### 13.23.7 Microbiology and Immunology (MIMM) Related Programs

#### 13.23.7.1 Interdepartmental Honours in Immunology

For more information, see [section 13.18: Immunology](#).

This program is offered by the departments of Biochemistry, Microbiology and Immunology, and Physiology.

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 also be obtained from:

Dr. Monroe Cohen  
Department of Physiology  
McIntyre Medical Sciences Building, Room 1136  
Telephone: 514-398-4342  
Email: [monroe.cohen@mcgill.ca](mailto:monroe.cohen@mcgill.ca)

OR

Dr. Ciro Piccirillo  
Department of Microbiology and Immunology  
McGill University Health Centre, Glen Site  
1001 Decarie Boulevard, Bloc E, Office EM23248  
Telephone: 514-934-1934, ext. 76143  
Email: [ciro.piccirillo@mcgill.ca](mailto:ciro.piccirillo@mcgill.ca)

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### 13.24 Music

#### 13.24.1 Location

Strathcona Music Building  
555 Sherbrooke Street West  
Montreal QC H3A 1E3  
Telephone: 514-398-4535  
Fax: 514-398-1540  
Website: [www.mcgill.ca/music](http://www.mcgill.ca/music)

#### 13.24.2 About Music

The Schulich School of Music offers some programs that are open to students in the Faculty of Science. For more information, see [Schulich School of Music > Undergraduate > : Browse Academic Units & Programs](#).

#### 13.24.3 Music Faculty

##### Department of Music Research Chair

Roe-Min Kok; B.Mus.(Texas), M.A.(Duke), Ph.D.(Harv.)

##### Department of Performance Chair

Stéphane Lemelin; B.Mus., M.Mus.(Peabody), D.M.A.(Yale)

**Advisers (B.A./B.Sc. Music programs)**

Adelina Lameiras  
 Telephone: 514-398-4541  
 Email: [adelina.lameiras@mcgill.ca](mailto:adelina.lameiras@mcgill.ca)

Diana Toni Dutz; B.Mus.(W. Ont.), Grad.Dip.(C'dia)  
 Telephone: 514-398-6337  
 Email: [dino.dutz@mcgill.ca](mailto:dino.dutz@mcgill.ca)

**13.24.4 Music Related Programs****13.24.4.1 Minor in Musical Applications of Technology and Minor in Musical Science and Technology**

Science students may apply for admission to:

- **Minor in Musical Applications of Technology** – see [Schulich School of Music > Undergraduate > Browse Academic Units & Programs > Department of Music Research: Composition; Music Education; Music History; Theory; Faculty Program > : Bachelor of Music \(B.Mus.\) - Minor Musical Applications of Technology \(18 credits\)](#)
- **Minor in Musical Science and Technology** – see [Schulich School of Music > Undergraduate > Browse Academic Units & Programs > Department of Music Research: Composition; Music Education; Music History; Theory; Faculty Program > : Bachelor of Music \(B.Mus.\) - Minor Musical Science and Technology \(18 credits\)](#)

Enrolment in Music Technology programs is highly restricted. Interested applicants must submit an [online application](#) via the Schulich School of Music website by May 15 of each academic year. Late applications will not be accepted and no students will be admitted in January. Successful applicants will be notified by email before the end of June. Registration will be limited to available lab space.

**13.25 Neurology and Neurosurgery (NEUR)****13.25.1 Location**

Montreal Neurological Institute and Hospital  
 3801 University Street, Room 140  
 Montreal QC H3A 2B4  
 Website: [neurology.mcgill.ca](http://neurology.mcgill.ca)

**13.25.2 About Neurology and Neurosurgery**

There are no B.Sc. programs in Neurology and Neurosurgery, but the course NEUR 310 *Cellular Neurobiology*, which is part of the Minor in Neuroscience, is taught by the Faculty of Science.

**13.26 Neuroscience****13.26.1 Location****Director of Neuroscience**

Dr. Monroe Cohen  
 Department of Physiology  
 McIntyre Medical Sciences Building, Room 1150  
 3655 Promenade Sir-William-Osler  
 Montreal QC H3G 1Y6  
 Website: [www.mcgill.ca/neuroscience](http://www.mcgill.ca/neuroscience)

**Interdisciplinary Programs Adviser**

Ryan Bouma  
 Email: [ryan.bouma@mcgill.ca](mailto:ryan.bouma@mcgill.ca)

Telephone: 514-398-7330

**13.26.2 About Neuroscience**

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, and use methods of inquiry that are drawn from a number of disciplines, including molecular and cellular biology, physiology, behavioural sciences and cognitive psychology, computer science, and artificial intelligence. 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; and how neuronal function is influenced by pharmacological agents and during 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.



**Please note:** New students are required to attend an information session held at the end of August. Please consult the [Neuroscience website](#) in early August for the date and location.

**13.26.3 Bachelor of Science (B.Sc.) - Minor Neuroscience (25 credits)**

This Minor is intended to provide students with a basic understanding of how the nervous system functions. The Minor is composed of 24-25 credits: 9 required and 15-16 complementary. For the 15-16 complementary credits, at least 12-13 must be from outside the student's home department and at least 6 of the 12-13 must be at the 400 or 500 level.

All course selections for the Minor must be approved by the program's adviser, Ryan Bouma (Email: ryan.bouma@mcgill.ca; Office: Dawson Hall, Rm 405). Note 1: A maximum of 6-7 credits can be counted for both the student's primary program and for the Minor in Neuroscience.

**Required Courses (9 credits)**

BIOL 200	(3)	Molecular Biology
NSCI 200	(3)	Introduction to Neuroscience 1
NSCI 201	(3)	Introduction to Neuroscience 2

**Complementary Courses (16 credits)**

15-16 credits selected as follows:

- At least 12-13 credits must be from outside the student's home department.
- At least 6 of the 12-13 credits have to be at the 400 or 500 level.

0-10 credits from the following list of 200- and 300-level courses:

\* Students may select ANAT 212 or BIOC 212 or BIOL 201.

\*\* Students may select either BIOL 306 or PHGY 314.

Note 2: Since CHEM 212 is a prerequisite/corequisite for NSCI 200 and BIOL 200, students must take CHEM 212 if they have not yet done so.

ANAT 212*	(3)	Molecular Mechanisms of Cell Function
BIOC 212*	(3)	Molecular Mechanisms of Cell Function
BIOL 201*	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 306**	(3)	Neural Basis of Behaviour
BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 389	(3)	Laboratory in Neurobiology
CHEM 212	(4)	Introductory Organic Chemistry 1
LING 390	(3)	Neuroscience of Language
NEUR 310	(3)	Cellular Neurobiology

PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 314**	(3)	Integrative Neuroscience
PSYC 302	(3)	The Psychology of Pain
PSYC 311	(3)	Human Cognition and the Brain
PSYC 315	(3)	Computational Psychology
PSYC 317	(3)	Genes and Behaviour
PSYC 318	(3)	Behavioural Neuroscience 2
PSYC 342	(3)	Hormones and Behaviour

6-15 credits from the following list of 400- and 500-level courses:

\*\*\* Students may select either BIOL 514 or PSYC 514.

BIOL 514***	(3)	Neurobiology Learning and Memory
BIOL 530	(3)	Advances in Neuroethology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 580	(3)	Genetic Approaches to Neural Systems
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
NEUR 502	(3)	Basic and Clinical Aspects of Neuroimmunology
PHGY 425	(3)	Analyzing Physiological Systems
PHGY 451	(3)	Advanced Neurophysiology
PHGY 520	(3)	Ion Channels
PHGY 524	(3)	Chronobiology
PHGY 556	(3)	Topics in Systems Neuroscience
PSYC 410	(3)	Special Topics in Neuropsychology
PSYC 427	(3)	Sensorimotor Neuroscience
PSYC 433	(3)	Cognitive Science
PSYC 444	(3)	Sleep Mechanisms and Behaviour
PSYC 470	(3)	Memory and Brain
PSYC 501	(3)	Auditory Perception
PSYC 506	(3)	Cognitive Neuroscience of Attention
PSYC 514***	(3)	Neurobiology of Learning and Memory
PSYC 522	(3)	Neurochemistry and Behaviour
PSYC 526	(3)	Advances in Visual Perception
PSYT 455	(3)	Neurochemistry
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders
PSYT 505	(3)	Neurobiology of Schizophrenia

### 13.26.4 Bachelor of Science (B.Sc.) - Major Neuroscience (65 credits)

**Revision, April 2018. Start of revision.**

The Neuroscience Major is a focused program for students interested in how the nervous system functions. It is highly interdisciplinary and borrows principles and methodologies from a number of fields including: biology, biochemistry, physiology, psychology, mathematics, physics, computer science, and immunology. To ensure that they have the appropriate foundation, students are required to take 29 credits in lower-level courses from physiology, biology, mathematics, computer science, psychology, and ethics. The program offers students a concentrated selection of 15 credits to be taken from one of three areas of current scientific activities in the neurosciences: Cell/Molecular, Neurophysiology/Computation, or Cognition/Behaviour. In addition, students select 21 credits from a wide array of complementary courses to obtain more specialized training in areas of neuroscience that best suit their interests.

Enrolment in the Neuroscience Major is limited to a total of 50 students per year. UO students seeking admission to this program should consult the neuroscience website for admissions requirements and should have completed the courses listed below or their equivalents.

### Program Prerequisites

Notes on admission to the Neuroscience Major program: Enrolment in the Neuroscience Major is limited to a total of 50 students per year. UO students seeking admission to this program should consult the neuroscience website for admissions requirements and should have completed the courses listed below or equivalent.

\* Students complete one of MATH 139, MATH 140 OR MATH 150.

\*\* Students complete one of either MATH 141 OR MATH 151.

\*\*\* Students complete one of either PHYS 101 OR PHYS 131.

+++ Students complete one of either PHYS 102 OR PHYS 142.

BIOL 112	(3)	Cell and Molecular Biology
CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
MATH 139*	(4)	Calculus 1 with Precalculus
MATH 140*	(3)	Calculus 1
MATH 141**	(4)	Calculus 2
MATH 150*	(4)	Calculus A
MATH 151**	(4)	Calculus B
PHYS 101***	(4)	Introductory Physics - Mechanics
PHYS 102+++	(4)	Introductory Physics - Electromagnetism
PHYS 131***	(4)	Mechanics and Waves
PHYS 142+++	(4)	Electromagnetism and Optics

### Core Required Courses (20 credits)

Note: Students who have successfully completed an equivalent of CHEM 212 in CEGEP or elsewhere must replace these credits with a 3-credit elective course to satisfy the total credit requirement for the Neuroscience Major.

BIOL 200	(3)	Molecular Biology
CHEM 212	(4)	Introductory Organic Chemistry 1
NSCI 200	(3)	Introduction to Neuroscience 1
NSCI 201	(3)	Introduction to Neuroscience 2
NSCI 300	(3)	Neuroethics
NSCI 400D1	(.5)	Neuroscience Seminar
NSCI 400D2	(.5)	Neuroscience Seminar
PSYC 311	(3)	Human Cognition and the Brain

### Complementary Courses (45 credits)

9 core credits selected as follows:

3 credits from:

BIOL 373	(3)	Biometry
PSYC 305	(3)	Statistics for Experimental Design

3 credits from:



COMP 202	(3)	Foundations of Programming
COMP 204	(3)	Computer Programming for Life Sciences

3 credits from:

Note: Students who have successfully completed an equivalent to MATH 222 at CEGEP or elsewhere, must replace these credits with a 3-credit elective course to satisfy the total credit requirement for the Neuroscience Major.

BIOL 309	(3)	Mathematical Models in Biology
MATH 222	(3)	Calculus 3

### Streams

15 credits selected from one of the following streams:

#### A. Cell and Molecular Stream

15 credits selected as follows:

9 credits as follows:

BIOC 311	(3)	Metabolic Biochemistry
BIOL 202	(3)	Basic Genetics
PHGY 311	(3)	Channels, Synapses and Hormones

3 credits from:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits from:

MIMM 214	(3)	Introductory Immunology: Elements of Immunity
PHAR 300	(3)	Drug Action

#### B. Neurophysiology/Neural Computation Stream

15 credits selected as follows:

6 credits as follows:

ANAT 321	(3)	Circuitry of the Human Brain
PHGY 311	(3)	Channels, Synapses and Hormones

3 credits from:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits from:

BIOL 306	(3)	Neural Basis of Behaviour
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PHGY 314 (3) Integrative Neuroscience

3 credits from:

Note: Students who have successfully completed an equivalent to MATH 222 at CEGEP or elsewhere, must replace these credits with a 3-credit elective course to satisfy the total credit requirement for the Neuroscience Major.

BIOL 309 (3) Mathematical Models in Biology  
COMP 206\*\* (3) Introduction to Software Systems  
COMP 250 (3) Introduction to Computer Science  
MATH 222 (3) Calculus 3

### C. Cognitive/Behavioural Stream

15 credits selected as follows:

9 credits as follows:

ANAT 321 (3) Circuitry of the Human Brain  
PSYC 213 (3) Cognition  
PSYC 318 (3) Behavioural Neuroscience 2

3 credits from:

BIOL 306 (3) Neural Basis of Behaviour  
PHGY 314 (3) Integrative Neuroscience

3 credits from:

PSYC 302 (3) The Psychology of Pain  
PSYC 317 (3) Genes and Behaviour  
PSYC 342 (3) Hormones and Behaviour

### Other Complementary Courses

(21-23 credits)

3-16 credits from:

BIOL 301 (4) Cell and Molecular Laboratory  
BIOL 389 (3) Laboratory in Neurobiology  
NSCI 410 (6) Independent Research 1  
NSCI 420D1 (4.5) Independent Research 2  
NSCI 420D2 (4.5) Independent Research 2

The remainder of the credits should be taken from the following lists. At least 15 of the 21-23 credits must be at the 400- or 500-level, which could include the above NSCI 410 or NSCI 420D1/NSCI 420D2 research courses:

200- and 300-level courses:

\* Students take either BIOL 201 OR BIOC 212, but not both.

\*\* Students take either COMP 206 or COMP 250, but not both.

ANAT 321	(3)	Circuitry of the Human Brain
BIOC 212*	(3)	Molecular Mechanisms of Cell Function
BIOC 311	(3)	Metabolic Biochemistry
BIOL 201*	(3)	Cell Biology and Metabolism
BIOL 202	(3)	Basic Genetics
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 320	(3)	Evolution of Brain and Behaviour
CHEM 222	(4)	Introductory Organic Chemistry 2
COMP 206**	(3)	Introduction to Software Systems
COMP 250**	(3)	Introduction to Computer Science
MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
MATH 324	(3)	Statistics
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
MIMM 314	(3)	Intermediate Immunology
NEUR 310	(3)	Cellular Neurobiology
PHAR 300	(3)	Drug Action
PHGY 210	(3)	Mammalian Physiology 2
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 314	(3)	Integrative Neuroscience
PSYC 213	(3)	Cognition
PSYC 302	(3)	The Psychology of Pain
PSYC 315	(3)	Computational Psychology
PSYC 317	(3)	Genes and Behaviour
PSYC 318	(3)	Behavioural Neuroscience 2
PSYC 342	(3)	Hormones and Behaviour

400- and 500-level courses:

\*\*\*Students may take either BIOL 514 or PSYC 514, but not both.

BIOL 514***	(3)	Neurobiology Learning and Memory
BIOL 530	(3)	Advances in Neuroethology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 580	(3)	Genetic Approaches to Neural Systems
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
BMDE 519	(3)	Biomedical Signals and Systems
COMP 546	(4)	Computational Perception
MATH 437	(3)	Mathematical Methods in Biology
MIMM 414	(3)	Advanced Immunology
MIMM 509	(3)	Inflammatory Processes
NEUR 502	(3)	Basic and Clinical Aspects of Neuroimmunology

NEUR 507	(3)	Topics in Radionuclide Imaging
NEUR 550	(3)	Free Radical Biomedicine
PHAR 562	(3)	Neuropharmacology
PHGY 425	(3)	Analyzing Physiological Systems
PHGY 451	(3)	Advanced Neurophysiology
PHGY 513	(3)	Cellular Immunology
PHGY 520	(3)	Ion Channels
PHGY 524	(3)	Chronobiology
PHGY 556	(3)	Topics in Systems Neuroscience
PSYC 410	(3)	Special Topics in Neuropsychology
PSYC 427	(3)	Sensorimotor Neuroscience
PSYC 433	(3)	Cognitive Science
PSYC 444	(3)	Sleep Mechanisms and Behaviour
PSYC 470	(3)	Memory and Brain
PSYC 502	(3)	Psychoneuroendocrinology
PSYC 506	(3)	Cognitive Neuroscience of Attention
PSYC 513	(3)	Human Decision-Making
PSYC 514***	(3)	Neurobiology of Learning and Memory
PSYC 522	(3)	Neurochemistry and Behaviour
PSYC 526	(3)	Advances in Visual Perception
PSYT 455	(3)	Neurochemistry
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

**Revision, April 2018. End of revision.**

### 13.26.5 Bachelor of Science (B.Sc.) - Honours Neuroscience (74 credits)

**Revision, April 2018. Start of revision.**

The Honours program is intended for students who are interested in laboratory-based research and in acquiring a foundation in each of the 3 streams of the Neuroscience Major Program (cell and molecular; neurophysiology and computational; and cognition and behaviour). Students are admitted to the program after one year in a major.

Applicants must have taken a minimum of 27 graded credits in their U1 year, must have a CGPA of at least 3.5, and must have obtained minimum grades of B+ in both NSCI 200 and NSCI 201, as well as a minimum grade of C in BIOL 200, BIOC 212 or BIOL 201, and CHEM 212. Additional requirements for applying are provided on the Neuroscience website: ([www.mcgill.ca/neuroscience](http://www.mcgill.ca/neuroscience)). Meeting the minimum requirements does not guarantee admission to the Honours Neuroscience program.

To graduate from the program, students must have a CGPA of 3.30 and a minimum grade of B+ in NCSI 300, NCSI 400, and NCSI 430D1/D2.

"First Class Honours" is awarded to students who obtain a minimum cumulative grade point average of 3.70, a minimum program GPA of 3.30, and a minimum grade of B+ in NSCI 300, NSCI 400, and NSCI 430.

#### Required Courses (41 credits)

Note: Students who have successfully completed an equivalent of CHEM 212 in CEGEP or elsewhere must replace these credits with a 3-credit elective course to satisfy the total credit requirement for Honours Neuroscience.

ANAT 321	(3)	Circuitry of the Human Brain
BIOC 311	(3)	Metabolic Biochemistry
BIOL 200	(3)	Molecular Biology
CHEM 212	(4)	Introductory Organic Chemistry 1
NSCI 200	(3)	Introduction to Neuroscience 1
NSCI 201	(3)	Introduction to Neuroscience 2

NSCI 300	(3)	Neuroethics
NSCI 400D1	(.5)	Neuroscience Seminar
NSCI 400D2	(.5)	Neuroscience Seminar
NSCI 430D1	(4.5)	Honours Research Project
NSCI 430D2	(4.5)	Honours Research Project
PHGY 311	(3)	Channels, Synapses and Hormones
PSYC 311	(3)	Human Cognition and the Brain
PSYC 318	(3)	Behavioural Neuroscience 2

**Complementary Courses (33 credits)**

3 credits from:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits from:

COMP 202	(3)	Foundations of Programming
COMP 204	(3)	Computer Programming for Life Sciences

3 credits from:

BIOL 373	(3)	Biometry
PSYC 305	(3)	Statistics for Experimental Design

3 credits from:

Note: Students who have successfully completed an equivalent to MATH 222 at CEGEP or elsewhere, must replace these credits with a 3-credit elective course to satisfy the total credit requirement for Honours Neuroscience.

BIOL 309	(3)	Mathematical Models in Biology
MATH 222	(3)	Calculus 3

The remaining 21 credits should be taken from the following lists. At least 15 of the 21 credits must be taken at the 400- or 500-level.

200- and 300-level courses:

\*Students may take either COMP 206 or COMP 250, but not both.

BIOL 202	(3)	Basic Genetics
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 320	(3)	Evolution of Brain and Behaviour
BIOL 389	(3)	Laboratory in Neurobiology
CHEM 222	(4)	Introductory Organic Chemistry 2
COMP 206*	(3)	Introduction to Software Systems
COMP 250*	(3)	Introduction to Computer Science

MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
MATH 324	(3)	Statistics
MIMM 214	(3)	Introductory Immunology: Elements of Immunity
MIMM 314	(3)	Intermediate Immunology
NEUR 310	(3)	Cellular Neurobiology
PHAR 300	(3)	Drug Action
PHGY 210	(3)	Mammalian Physiology 2
PHGY 314	(3)	Integrative Neuroscience
PSYC 213	(3)	Cognition
PSYC 302	(3)	The Psychology of Pain
PSYC 315	(3)	Computational Psychology
PSYC 317	(3)	Genes and Behaviour
PSYC 342	(3)	Hormones and Behaviour

400- and 500-level courses:

\*\* Students may take either BIOL 514 OR PSYC 514, but not both.

BIOL 514**	(3)	Neurobiology Learning and Memory
BIOL 530	(3)	Advances in Neuroethology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 580	(3)	Genetic Approaches to Neural Systems
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
BMDE 519	(3)	Biomedical Signals and Systems
COMP 546	(4)	Computational Perception
MATH 437	(3)	Mathematical Methods in Biology
MIMM 414	(3)	Advanced Immunology
MIMM 509	(3)	Inflammatory Processes
NEUR 502	(3)	Basic and Clinical Aspects of Neuroimmunology
NEUR 507	(3)	Topics in Radionuclide Imaging
NEUR 550	(3)	Free Radical Biomedicine
PHAR 562	(3)	Neuropharmacology
PHGY 425	(3)	Analyzing Physiological Systems
PHGY 451	(3)	Advanced Neurophysiology
PHGY 513	(3)	Cellular Immunology
PHGY 520	(3)	Ion Channels
PHGY 524	(3)	Chronobiology
PHGY 556	(3)	Topics in Systems Neuroscience
PSYC 410	(3)	Special Topics in Neuropsychology
PSYC 427	(3)	Sensorimotor Neuroscience
PSYC 433	(3)	Cognitive Science
PSYC 444	(3)	Sleep Mechanisms and Behaviour
PSYC 470	(3)	Memory and Brain

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PSYC 502	(3)	Psychoneuroendocrinology
PSYC 506	(3)	Cognitive Neuroscience of Attention
PSYC 513	(3)	Human Decision-Making
PSYC 514**	(3)	Neurobiology of Learning and Memory
PSYC 522	(3)	Neurochemistry and Behaviour
PSYC 526	(3)	Advances in Visual Perception
PSYT 455	(3)	Neurochemistry
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

Revision, April 2018. End of revision.

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## 13.27 Nutrition (NUTR)

### 13.27.1 Location

School of Human Nutrition  
Macdonald-Stewart Building, Room MS2-045  
21,111 Lakeshore Road  
Sainte-Anne-de-Bellevue QC H9X 3V9  
Website: [www.mcgill.ca/nutrition](http://www.mcgill.ca/nutrition)

### 13.27.2 About Nutrition

The School of Human Nutrition offers a **Minor in Human Nutrition** which can be taken by Science students; see [Faculty of Agricultural and Environmental Sciences > Undergraduate > Overview of Programs Offered > : Bachelor of Science in Nutritional Sciences – B.Sc.\(Nutr.Sc.\) \(Overview\)](#).

NUTR 307 is considered as a course taught by the Faculty of Science.

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## 13.28 Pathology (PATH)

### 13.28.1 Location

Department of Pathology  
Duff Medical Building, B wing  
3775 University Street  
Montreal QC H3A 2B4  
Telephone: 514-398-3045  
Website: [www.mcgill.ca/pathology](http://www.mcgill.ca/pathology)

### 13.28.2 About Pathology

There are no B.Sc. programs in Pathology, but the course PATH 300 *Human Disease* is considered as taught by the Faculty of Science.

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## 13.29 Pharmacology and Therapeutics (PHAR)

### 13.29.1 Location

McIntyre Medical Building, Room 1325  
3655 Promenade Sir-William-Osler  
Montreal QC H3G 1Y6

Telephone: 514-398-3623

Website: [www.mcgill.ca/pharma](http://www.mcgill.ca/pharma)

### 13.29.2 About Pharmacology and Therapeutics

Pharmacology is the science that 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 multidisciplinary 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 encompasses a number of different areas such as:

- pharmacogenomics;
- molecular biology;
- bioinformatics;
- neuropharmacology;
- reproductive pharmacology;
- endocrine pharmacology;
- receptor pharmacology;
- cardiovascular pharmacology;
- toxicology;
- developmental pharmacology;
- autonomic pharmacology;
- biochemical pharmacology;
- 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, seven 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 provide students with knowledge concerning the actions of drugs on living systems and insight into approaches to basic pharmacological research.

### 13.29.3 Pharmacology and Therapeutics (PHAR) Faculty

#### Chair

Gerhard Multhaup

#### Emeritus Professors

Radan Capek; M.D., Ph.D.(Prague)

Hans H. Zingg; M.D., Ph.D.(McG.)

#### Professors

Daniel Bernard; Ph.D.(Johns Hop.)

Derek Bowie; B.Sc., Ph.D.(Lond.)

Paul B.S. Clarke; M.A.(Cant.), Ph.D.(Lond.)

A. Claudio Cuello; M.D.(Buenos Aires), M.A., D.Sc.(Oxf.), F.R.S.C.

Barbara Hales; M.Sc.(Phil. Coll. of Pharm. and Science), Ph.D.(McG.)

Terence Hébert; M.Sc.(Windsor), Ph.D.(Tor.)

Dusica Maysinger; Ph.D.(USC)

Anne McKinney; Ph.D.(Ulster)

Gerhard Multhaup; Ph.D.(Cologne)

Alfredo Ribeiro-da-Silva; M.D., Ph.D.(Oporto)



**Professors**

Bernard Robaire; B.A.(Calif.), Ph.D.(McG.)

H. Uri Saragovi; Ph.D.(Miami)

Moshe Szyf; M.Sc., Ph.D.(Hebrew)

Jacquetta Trasler; M.D.,C.M., Ph.D.(McG.)

**Associate Professors**

Jason Chaim Tanny; Ph.D.(Harv.)

**Assistant Professors**

Bastien Castagner; Ph.D.(Col.)

Maureen McKeague; Ph.D.(Carleton)

Lisa-Marie Munter; Ph.D.(Berlin)

Jean-François Trempe; D.Phil.(Oxf.)

**Associate Members**

Moulay Alaoui-Jamali; Ph.D.(Sorbonne)

Carolyn Baglole; M.Sc.(PEI), Ph.D.(Calg.)

Luda Diatchenko; M.D., Ph.D.(RNRMU)

Serge Gauthier; M.D.(Montr.)

Timothy Geary; Ph.D.(Mich.)

Bertrand Jean-Claude; M.Sc.(Moncton), Ph.D.(McG.)

Brigitte Keiffer; Ph.D.(Louis Pasteur)

Sarah Kimmins; Ph.D.(Dal.)

Stephane Laporte; Ph.D.(Sher.)

Stanley Nattel; B.Sc., M.D., C.M.(McG.)

Cristian O'Flaherty; Ph.D.(McG.)

Pedro Rosa-Neto; M.D.(Lisbon), Ph.D.(Aarhus)

Simon Rousseau; Ph.D.(Laval)

Laura Stone; Ph.D.(Minn.)

Marc Ware; M.D.(Univ. West Indies, Kingston)

Edith A. Zorychta; B.Sc.(St. FX), M.Sc., Ph.D.(McG.)

**Adjunct Professors**

Bruce Allen; Ph.D.(Br. Col.)

Sylvain Chemtob; M.D.(Montr.), Ph.D.(McG.)

Yves De Koninck; Ph.D.(McG.)

Jean-Sebastien Joyal; M.D., Ph.D.(McG.)

Thomas Sanderson; Ph.D.(Br. Col.)

**Affiliate Members**

Mathieu Boucher; Ph.D.(Montr.)

Lionel Breton; Ph.D.(Paris V)

Lorella Garofalo; Ph.D.(McG.)

John Gillard; Ph.D.(Tasmania)

Joseph Mancini; M.Sc., Ph.D.(McG.)

**Affiliate Members**

Karen Meerovitch; Ph.D.(McG.)

**13.29.4 Bachelor of Science (B.Sc.) - Minor Pharmacology (24 credits)**

The Minor 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 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. Please contact the Student Affairs Coordinator: Chantal Grignon (undergradstudies.pharmacology@mcgill.ca; 514-398-3622).

All courses in the Minor program must be passed with a minimum grade C or better. Generally, no more than 6 credits of overlap are permitted between the Minor and the primary program.

**Required Courses (6 credits)**

PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease

**Complementary Courses (18 credits)**

18 credits selected as follows:

3 credits from:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 200	(3)	Molecular Biology
BIOL 201	(3)	Cell Biology and Metabolism

3 credits from:

PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2

3 credits from:

PHAR 503	(3)	Drug Discovery and Development 1
PHAR 505	(3)	Structural Pharmacology

3 credits from:

PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology

6 credits from:

PHAR 303	(3)	Principles of Toxicology
PHAR 504	(3)	Drug Discovery and Development 2
PHAR 508	(3)	Drug Discovery and Development 3
PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology

PHAR 565	(3)	Epigenetic Drugs and Targets
PHAR 599	(6)	Pharmacology Research Project

### 13.29.5 Bachelor of Science (B.Sc.) - Major Pharmacology (67 credits)

This program incorporates extensive studies in Pharmacology with a strong component of related biomedical sciences, providing a solid preparation for employment opportunities or for entry into graduate or professional training programs. Students must consult the Student Affairs Coordinator upon entering the program and every year thereafter to verify courses and progress.

#### U1 Required Courses (24 credits)

BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2
PHAR 200	(1)	Introduction to Pharmacology 1
PHAR 201	(1)	Introduction to Pharmacology 2
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 212	(1)	Introductory Physiology Laboratory 1
PHGY 213	(1)	Introductory Physiology Laboratory 2

\* Students who have taken the equivalent of CHEM 212, CHEM 222, and/or MATH 203 in CEGEP (as defined at: <http://www.mcgill.ca/students/transferecredit/prospective/cegep>) are exempt and may not take these courses at McGill. Students must replace these credits with appropriate complementary course credits to satisfy the total credit requirements for their degree.

#### U2 Required Courses (16 credits)

BIOC 311	(3)	Metabolic Biochemistry
BIOL 301	(4)	Cell and Molecular Laboratory
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHAR 303	(3)	Principles of Toxicology

#### Complementary Courses (27 credits)

15 credits selected as follows:

3 credits, one of (highly recommended in Year 1):

ANAT 212	(3)	Molecular Mechanisms of Cell Function
BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits, one of (usually in Year 2):

CHEM 203	(3)	Survey of Physical Chemistry
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1

3 credits, one of (usually in Year 2):

BIOL 373	(3)	Biometry
COMP 204	(3)	Computer Programming for Life Sciences
MATH 203*	(3)	Principles of Statistics 1
PSYC 204	(3)	Introduction to Psychological Statistics

3 credits, one of (usually in Year 3):

PHAR 503	(3)	Drug Discovery and Development 1
PHAR 505	(3)	Structural Pharmacology

3 credits, one of (usually in Year 3):

PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology

12 credits selected from the following upper-level science courses:

Committee approval is required to substitute an upper-level science course not in the list below.

PHAR 599D1 and PHAR 599D2 are taken together.

ANAT 321	(3)	Circuitry of the Human Brain
ANAT 322	(3)	Neuroendocrinology
ANAT 365	(3)	Cellular Trafficking
ANAT 381***	(3)	Experimental Embryology
ANAT 458*	(3)	Membranes and Cellular Signaling
BIEN 510	(3)	Engineered Nanomaterials for Biomedical Applications
BIOC 312	(3)	Biochemistry of Macromolecules
BIOC 450	(3)	Protein Structure and Function
BIOC 454	(3)	Nucleic Acids
BIOC 458*	(3)	Membranes and Cellular Signaling
BIOC 470**	(3)	Lipids and Lipoproteins in Disease
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 370	(3)	Human Genetics Applied
BIOT 505	(3)	Selected Topics in Biotechnology
CHEM 302	(3)	Introductory Organic Chemistry 3
CHEM 334	(3)	Advanced Materials
CHEM 462***	(3)	Green Chemistry
CHEM 482	(3)	Organic Chemistry: Natural Products
CHEM 502	(3)	Advanced Bio-Organic Chemistry
CHEM 503	(3)	Drug Discovery
CHEM 504	(3)	Drug Design
CHEM 522	(3)	Stereochemistry

CHEM 552	(3)	Physical Organic Chemistry
EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
EXMD 504	(3)	Biology of Cancer
EXMD 509**	(3)	Gastrointestinal Physiology and Pathology
EXMD 511	(3)	Joint Venturing with Industry
HGEN 400**	(3)	Genetics in Medicine
MIMM 387	(3)	The Business of Science
MIMM 414	(3)	Advanced Immunology
MIMM 466+	(3)	Viral Pathogenesis
NEUR 310	(3)	Cellular Neurobiology
PARA 410	(3)	Environment and Infection
PATH 300	(3)	Human Disease
PHAR 504	(3)	Drug Discovery and Development 2
PHAR 508	(3)	Drug Discovery and Development 3
PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology
PHAR 565	(3)	Epigenetic Drugs and Targets
PHAR 599D1	(3)	Pharmacology Research Project
PHAR 599D2	(3)	Pharmacology Research Project
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience
PHGY 425***	(3)	Analyzing Physiological Systems
PHGY 520	(3)	Ion Channels
PHGY 524	(3)	Chronobiology
PPHS 501	(3)	Population Health and Epidemiology
PSYC 302	(3)	The Psychology of Pain
PSYC 305**	(3)	Statistics for Experimental Design
PSYC 311	(3)	Human Cognition and the Brain
PSYC 317**	(3)	Genes and Behaviour
PSYC 318**	(3)	Behavioural Neuroscience 2
PSYT 301	(3)	Issues in Drug Dependence
PSYT 455	(3)	Neurochemistry
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders
REDM 410	(3)	Writing Research Articles

Note: \* Students may take either ANAT 458 or BIOC 458

\*\* Access to these courses is not guaranteed

\*\*\* Open to students who have the Prerequisites

+ Access to these courses is not guaranteed. Open to students who have the Pre-requisites

**13.29.6 Bachelor of Science (B.Sc.) - Honours Pharmacology (76 credits)**

The Honours program is designed as a preparation for graduate studies and research. In addition to the strong training provided by the Major program, it requires students to have direct research experience in a chosen area during their final year of study. Acceptance into the Honours program takes place in the Winter term of U2 and requires a CGPA of 3.50. Students who wish to enter the Honours program should follow the Major program; those who satisfactorily complete the first three terms with a CGPA of at least 3.50 and a mark of B+ or higher in core Pharmacology courses (PHAR 300, PHAR 301, and PHAR 303) are eligible for admission. Applications can be obtained from the office of the Department of Pharmacology in the McIntyre Medical Building or on the Departmental website.

**U1 Required Courses (24 credits)**

BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2
PHAR 200	(1)	Introduction to Pharmacology 1
PHAR 201	(1)	Introduction to Pharmacology 2
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 212	(1)	Introductory Physiology Laboratory 1
PHGY 213	(1)	Introductory Physiology Laboratory 2

\* Students who have taken the equivalent of CHEM 212, CHEM 222, and/or MATH 203 in CEGEP (as defined at: <http://www.mcgill.ca/students/transferecredit/prospective/cegep>) are exempt and may not take these courses at McGill. Students must replace these credits with appropriate complementary course credits to satisfy the total credit requirements for their degree.

**U2 Required Courses (16 credits)**

BIOC 311	(3)	Metabolic Biochemistry
BIOL 301	(4)	Cell and Molecular Laboratory
PHAR 300	(3)	Drug Action
PHAR 301	(3)	Drugs and Disease
PHAR 303	(3)	Principles of Toxicology

**U3 Required Courses (6 credits)**

PHAR 598D1	(3)	Honours Pharmacology Research Project
PHAR 598D2	(3)	Honours Pharmacology Research Project

**Complementary Courses (30 credits)**

15 credits selected as follows:

3 credits, one of (highly recommended in Year 1):

ANAT 212	(3)	Molecular Mechanisms of Cell Function
BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits, one of (usually in Year 2):

CHEM 203	(3)	Survey of Physical Chemistry
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CHEM 204 (3) Physical Chemistry/Biological Sciences 1

3 credits, one of (usually in Year 2):

BIOL 373 (3) Biometry  
 COMP 204 (3) Computer Programming for Life Sciences  
 MATH 203\* (3) Principles of Statistics 1  
 PSYC 204 (3) Introduction to Psychological Statistics

3 credits, one of (usually in Year 3):

PHAR 503 (3) Drug Discovery and Development 1  
 PHAR 505 (3) Structural Pharmacology

3 credits, one of (usually in Year 3):

PHAR 562 (3) Neuropharmacology  
 PHAR 563 (3) Endocrine Pharmacology

15 credits selected from the following upper-level science courses:

Committee approval is required to substitute an upper-level science course not in the list below.

ANAT 321 (3) Circuitry of the Human Brain  
 ANAT 322 (3) Neuroendocrinology  
 ANAT 365 (3) Cellular Trafficking  
 ANAT 381\*\*\* (3) Experimental Embryology  
 ANAT 458\* (3) Membranes and Cellular Signaling  
 BIEN 510 (3) Engineered Nanomaterials for Biomedical Applications  
 BIOC 312 (3) Biochemistry of Macromolecules  
 BIOC 450 (3) Protein Structure and Function  
 BIOC 454 (3) Nucleic Acids  
 BIOC 458\* (3) Membranes and Cellular Signaling  
 BIOC 470\*\* (3) Lipids and Lipoproteins in Disease  
 BIOL 300 (3) Molecular Biology of the Gene  
 BIOL 303 (3) Developmental Biology  
 BIOL 306 (3) Neural Basis of Behaviour  
 BIOL 314 (3) Molecular Biology of Oncogenes  
 BIOL 370 (3) Human Genetics Applied  
 BIOT 505 (3) Selected Topics in Biotechnology  
 CHEM 302 (3) Introductory Organic Chemistry 3  
 CHEM 334 (3) Advanced Materials  
 CHEM 462\*\*\* (3) Green Chemistry  
 CHEM 482 (3) Organic Chemistry: Natural Products  
 CHEM 502 (3) Advanced Bio-Organic Chemistry  
 CHEM 503 (3) Drug Discovery

CHEM 504	(3)	Drug Design
CHEM 522	(3)	Stereochemistry
CHEM 552	(3)	Physical Organic Chemistry
EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
EXMD 504	(3)	Biology of Cancer
EXMD 509**	(3)	Gastrointestinal Physiology and Pathology
EXMD 511	(3)	Joint Venturing with Industry
HGEN 400**	(3)	Genetics in Medicine
MIMM 387	(3)	The Business of Science
MIMM 414	(3)	Advanced Immunology
MIMM 466+	(3)	Viral Pathogenesis
NEUR 310	(3)	Cellular Neurobiology
PARA 410	(3)	Environment and Infection
PATH 300	(3)	Human Disease
PHAR 390	(3)	Laboratory in Pharmacology
PHAR 504	(3)	Drug Discovery and Development 2
PHAR 508	(3)	Drug Discovery and Development 3
PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology
PHAR 565	(3)	Epigenetic Drugs and Targets
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience
PHGY 425***	(3)	Analyzing Physiological Systems
PHGY 520	(3)	Ion Channels
PHGY 524	(3)	Chronobiology
PPHS 501	(3)	Population Health and Epidemiology
PSYC 302	(3)	The Psychology of Pain
PSYC 305**	(3)	Statistics for Experimental Design
PSYC 311	(3)	Human Cognition and the Brain
PSYC 317**	(3)	Genes and Behaviour
PSYC 318**	(3)	Behavioural Neuroscience 2
PSYT 301	(3)	Issues in Drug Dependence
PSYT 455	(3)	Neurochemistry
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders
REDM 410	(3)	Writing Research Articles

Note: \* Students may take either ANAT 458 or BIOC 458

\*\* Access to these courses is not guaranteed

\*\*\* Open to students who have the Pre-requisites

+ Access to these courses is not guaranteed. Open to students who have the Pre-requisites



## 13.30 Physics (PHYS)

### 13.30.1 Location

Rutherford Physics Building, Room 108  
 3600 University Street  
 Montreal QC H3A 2T8  
 Telephone: 514-398-6477  
 Fax: 514-398-8434  
 Email: [chairsec.physics@mcgill.ca](mailto:chairsec.physics@mcgill.ca)  
 Website: [www.physics.mcgill.ca](http://www.physics.mcgill.ca)

### 13.30.2 About Physics

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 three multidisciplinary honours programs—in Mathematics and Physics, in Physics and Chemistry, and in Physics and Computer Science—are even more specialized and demanding. They are intended for students who wish to develop a strong basis in both physics and the other discipline and are intended as preparation for graduate work and a professional or academic career. Although these programs have a bias for theoretical work, they are broad enough and strong enough to prepare students for further study in either experimental physics or respectively mathematics, chemistry, or computer science.

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.

It is possible for students to transfer from the Major program to the Honours program after the first year of studies; see [section 13.30.9: Bachelor of Science \(B.Sc.\) - Major Physics \(60 credits\)](#).

There are also a number of other **major** programs, offered jointly with other departments:

- Atmospheric Sciences and Physics;
- Physics and Computer Science;
- Physics and Geophysics;
- Physiology and Physics;

and **minor** programs:

- Electrical Engineering, available only to students in the Physics Major;
- Minor in Physics.

The **Concentration** program allows students a greater focus in biological physics. There is also a core Physics component of the **Liberal Science** program, for students less interested in a specialized education.

Students from outside of the Province of Quebec will ordinarily register in the **Science Freshman** program. Physics offers two sequences of courses for this program, described below.

The list of pre- and corequisites 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.

Students interested in any of the Physics programs should contact the [Department](#) for an adviser.

A Science **Major Concentration** in physics is available to students pursuing the B.A. & Sc. degree. This Major Concentration is described in [Bachelor of Arts & Science > Undergraduate > Browse Academic Units & Programs > : Physics \(PHYS\)](#).

### 13.30.3 Internship Year in Science (IYS)

IYS is a pregraduate work experience program available to eligible students and normally taken between their U2 and U3 years. For more information, see [section 12: Science Internships and Field Studies](#).

The following programs are also available with an internship component:

- Major in Physics
- Major Program in Atmospheric Science and Physics
- Major Program in Physics and Computer Science
- Major Program in Physics and Geophysics
- Honours in Physics
- Honours Program in Physics and Chemistry
- Honours Program in Physics and Computer Science
- Honours Program in Physics and Mathematics

### 13.30.4 Science Freshman Program

Students entering McGill with a Quebec CEGEP profile in Science will normally begin their programs in Physics with courses at the 200 level.

Students without this profile should normally take courses PHYS 131 and PHYS 142 if they have previously taken physics at the high school level and should be taking differential calculus concurrently with PHYS 131 and integral calculus concurrently with PHYS 142. 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 PHYS 101 and PHYS 102. All students are expected to have reasonable fluency in algebra, geometry, and trigonometry at the high school level. If this is not the case, then MATH 112 should be taken concurrently with PHYS 101. Those for whom this is not necessary are advised to take MATH 139 concurrently with PHYS 101.

### 13.30.5 Physics Faculty

#### Chair

P. Grutter

#### Director of Graduate Studies

T. Webb

#### Emeritus Professors

J. Barrette; M.Sc., Ph.D.(Montr.)

J.E. Crawford; B.A., M.A.(Tor.), Ph.D.(McG.)

S. Das Gupta; B.Sc., M.Sc.(Calc.), Ph.D.(McM.) (*Macdonald Emeritus Professor of Physics*)

N.B. de Takacsy; B.Sc., M.Sc.(Montr.), Ph.D.(McG.)

R. Harris; B.A.(Oxf.), Ph.D.(Sus.)

C.S. Lam; B.Sc.(McG.), Ph.D.(MIT)

D.G. Stairs; B.Sc., M.Sc.(Qu.), Ph.D.(Harv.) (*Macdonald Emeritus Professor of Physics*)

J.O. Strom-Olsen; B.A., M.S., Ph.D.(Camb.)

M.J. Zuckermann; M.A., D.Phil.(Oxf.), F.R.S.C.

#### Post-Retirement Professors

Z. Altounian; Ph.D.(McM.)

F. Buchinger; Ph.D.(Johannes Gutenberg)

#### Professors

R. Brandenberger; Dip.(ETH), A.M., Ph.D.(Harv.) (*Canada Research Chair*)

A. Clerk; B.Sc.(Tor.), Ph.D.(Cornell) (*Canada Research Chair*)

J. Cline; B.S.(Harvey Mudd), M.Sc., Ph.D.(Cal. Tech.)

F. Corriveau; B.Sc.(Laval), M.Sc.(Br. Col.), Ph.D.(ETH) (*Affiliated I.P.P. Scientist*)

C. Gale; B.Sc.(Ott.), M.Sc., Ph.D.(McG.) (*James McGill Professor*)

G. Gervais; B.Sc.(Sher.), M.Sc.(McM.), Ph.D.(N'western)

M. Grant; B.Sc.(PEI), M.Sc., Ph.D.(Tor.), F.R.S.C. (*James McGill Professor*)

P. Grutter; Dip., Ph.D.(Basel), F.R.S.C. (*James McGill Professor*)

**Professors**

H. Guo; B.Sc.(Sichuan), M.Sc., Ph.D.(Pitt.), F.R.S.C. (*James McGill Professor*)  
 D. Hanna; B.Sc.(McG.), A.M., Ph.D.(Harv.) (*Macdonald Professor of Physics*)  
 S. Jeon; B.Sc.(Seoul National), M.Sc., Ph.D.(Wash.)  
 V. Kaspi; B.Sc.(McG.), M.A., Ph.D.(Princ.), F.R.S.C. (*Canada Research Chair*) (*Lorne Trottier Chair in Astrophysics and Cosmology*)  
 S. Lovejoy; B.Sc.(Camb.), Ph.D.(McG.)  
 N. Provatas; Ph.D.(McG.) (*Canada Research Chair*)  
 K. Ragan; B.Sc.(Alta.), Ph.D.(Geneva) (*Macdonald Professor of Physics*)  
 D.H. Ryan; B.A., Ph.D.(Dub.)  
 M. Sutton; B.Sc., M.Sc., Ph.D.(Tor.) (*James McGill Professor*) (*Rutherford Professor*)  
 P. Wiseman; B.Sc.(St. FX), Ph.D.(W. Ont.) (*joint appt. with Chemistry*)

**Associate Professors**

B. Coish; Ph.D.(Basel)  
 A. Cumming; B.A.(Camb.), Ph.D.(Calif., Berk.)  
 K. Dasgupta; M.Sc., Ph.D.(TIFR)  
 M. Dobbs; B.Sc.(McG.), Ph.D.(Vic., BC) (*Canada Research Chair*)  
 P. Francois; Ph.D.(Paris VII)  
 M. Hilke; B.Sc., M.Sc., Ph.D.(Geneva)  
 A. Maloney; B.S., M.S.(Stan.), Ph.D.(Harv.) (*William Dawson Scholar*)  
 W. Reisner; B.A.(Reed), Ph.D.(Princ.)  
 S. Robertson; B.Sc.(Calg.), M.Sc., Ph.D.(Vic., BC) (*Affiliated I.P.P. Scientist*)  
 R. Rutledge; B.Sc.(USC), Ph.D.(MIT)  
 B. Siwick; B.Sc., M.Sc., Ph.D.(Tor.) (*Canada Research Chair*) (*joint appt. with Chemistry*)  
 B. Vachon; B.Sc.(McG.), Ph.D.(Vic., BC)  
 A. Warburton; B.Sc.(Vic., BC), M.Sc., Ph.D.(Tor.)  
 T. Webb; B.Sc.(Tor.), M.Sc.(McM.), Ph.D.(Tor.)

**Assistant Professors**

T. Brunner; Dip., Ph.D.(Munich)  
 S. Caron-Huot; B.Sc.(Laval), M.Sc., Ph.D.(McGill)  
 L. Childress; Ph.D.(Harv.) (*Canada Research Chair*)  
 D. Cooke; Ph.D.(Alta.)  
 N. Cowan; B.Sc.(McG.), Ph.D.(Wash.) (*joint appt. with Earth and Planetary Sciences*)  
 D. Haggard; B.Sc.(USF), M.Sc., Ph.D.(Wash.)  
 S. Leslie; Ph.D.(Calif., Berk.)  
 T. Pereg-Barnea; Ph.D.(Br. Col.)  
 J. Sankey; Ph.D.(Cornell) (*Canada Research Chair*)

**Associate Members**

M. Chacron (*Physiology*)  
 S. Devic (*Oncology*)  
 S. Enger (*Oncology*)  
 K. Gehring (*Biochemistry*)  
 P. Kambhampati (*Chemistry*)

**Associate Members**

A. Khadra (*Physiology*)  
 J. Kildea (*Medical Physics*)  
 I. Levesque (*Medical Physics*)  
 M. Mackey (*Physiology*)  
 J. Nadeau (*Biomedical Engineering*)  
 G.B. Pike (*MNI and Biomedical Engineering*)  
 E. Podgorsak (*Radiation Oncology*)  
 D. Rassier (*Kinesiology*)  
 D. Ronis (*Chemistry*)  
 J. Seuntjens (*Medical Physics*)  
 T. Szkopek (*Electrical and Computer Engineering*)

**Adjunct Professors**

F. Drolet, M. Dubé, O. Hernandez, G. Holder, B. Palmieri, G.B. Pike, V. Tabard Cossa

**Curator (Rutherford Museum and McPherson Collection)**

J. Barrette

**13.30.6 Bachelor of Science (B.Sc.) - Minor Physics (18 credits)**

The 18-credit Minor permits no overlap with any other programs. It contains no Mathematics courses, although many of the courses in it have Math pre- or corequisites. It will, therefore, be particularly appropriate to students in Mathematics, but it is also available to any Science student with the appropriate mathematical background.

Students in certain programs (e.g., the Major Chemistry) will find that there are courses in the Minor that are already part of their program, or that they may not take for credit because of a substantial overlap of material with a course or courses in their program. After consultation with an adviser, such students may complete the Minor by substituting any other physics course(s) from the Major or Honours Physics programs.

**Required Course (3 credits)**

PHYS 257 (3) Experimental Methods 1

**Complementary Courses (15 credits)**

15 credits to be selected as follows:

One of:

PHYS 230 (3) Dynamics of Simple Systems  
 PHYS 251 (3) Honours Classical Mechanics 1

One of:

PHYS 232 (3) Heat and Waves  
 PHYS 253 (3) Thermal Physics

One of:

PHYS 241 (3) Signal Processing  
 PHYS 258 (3) Experimental Methods 2

One of:

PHYS 214	(3)	Introductory Astrophysics
PHYS 224	(3)	Physics of Music
PHYS 228	(3)	Energy and the Environment
PHYS 260	(3)	Modern Physics and Relativity
PHYS 446	(3)	Majors Quantum Physics

One of:

PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 350	(3)	Honours Electricity and Magnetism

### 13.30.7 Bachelor of Science (B.Sc.) - Minor Electrical Engineering (24 credits)

[Program registration done by Student Affairs Office]

The Minor program does not carry professional recognition. Only students who satisfy the requirements of the Major Physics are eligible for this Minor. Students registered for this option cannot count PHYS 241 toward the requirements of the Major in Physics, and should replace this course by another Physics or Mathematics course. Students who select ECSE 334 in the Minor cannot count PHYS 328 toward the requirements of the Major in Physics, and should replace this course by another Physics or Mathematics course.

#### Required Courses (12 credits)

ECSE 200	(3)	Electric Circuits 1
ECSE 210	(3)	Electric Circuits 2
ECSE 303	(3)	Signals and Systems 1
ECSE 330	(3)	Introduction to Electronics

#### Complementary Courses (12 credits)

3 credits from the following and 9 credits of ECSE courses at the 200, 300, or 400 level subject to approval by the Department of Electrical and Computer Engineering.

ECSE 305	(3)	Probability and Random Signals 1
ECSE 334	(3)	Introduction to Microelectronics

### 13.30.8 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Physics (48 credits)

#### Program Prerequisites

Students entering Physics programs from the Freshman program must have successfully completed the courses below or their equivalents. Quebec students must have completed the DEC with appropriate science and mathematics courses.

CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
PHYS 131	(4)	Mechanics and Waves
PHYS 142	(4)	Electromagnetism and Optics

One of:

BIOL 111	(3)	Principles: Organismal Biology
BIOL 112	(3)	Cell and Molecular Biology

MATH 133 and either MATH 140/141 or MATH 150/151.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2
MATH 150	(4)	Calculus A
MATH 151	(4)	Calculus B

**Required Courses (39 credits)**

MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
PHYS 230	(3)	Dynamics of Simple Systems
PHYS 232	(3)	Heat and Waves
PHYS 241	(3)	Signal Processing
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 333	(3)	Thermal and Statistical Physics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 446	(3)	Majors Quantum Physics
PHYS 447	(3)	Applications of Quantum Mechanics

**Complementary Courses (9 credits)**

9 credits selected from:

PHYS 328	(3)	Electronics
PHYS 331	(3)	Topics in Classical Mechanics
PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 434	(3)	Optics
PHYS 439	(3)	Majors Laboratory in Modern Physics

**13.30.9 Bachelor of Science (B.Sc.) - Major Physics (60 credits)****Program Prerequisites**

Students entering Physics programs from the Freshman program must have successfully completed the courses below or their equivalents. Quebec students must have completed the DEC with appropriate science and mathematics courses.

CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
PHYS 131	(4)	Mechanics and Waves
PHYS 142	(4)	Electromagnetism and Optics

One of:

BIOL 111	(3)	Principles: Organismal Biology
BIOL 112	(3)	Cell and Molecular Biology

MATH 133 and either MATH 140/141 or MATH 150/151.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2
MATH 150	(4)	Calculus A
MATH 151	(4)	Calculus B

### U1 Required Courses (21 credits)

MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
PHYS 230	(3)	Dynamics of Simple Systems
PHYS 232	(3)	Heat and Waves
PHYS 241	(3)	Signal Processing
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2

### U2 Required Courses (24 credits)

MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
PHYS 328	(3)	Electronics
PHYS 331	(3)	Topics in Classical Mechanics
PHYS 333	(3)	Thermal and Statistical Physics
PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 342	(3)	Majors Electromagnetic Waves

### U3 Required Courses (15 credits)

PHYS 434	(3)	Optics
PHYS 439	(3)	Majors Laboratory in Modern Physics
PHYS 446	(3)	Majors Quantum Physics
PHYS 447	(3)	Applications of Quantum Mechanics
PHYS 449	(3)	Majors Research Project

It is possible for students to transfer from the Major to the Honours program after the U1 year if they have passed all U1 Required courses and MATH 314 and MATH 315 with a C or better, and obtained a GPA of 3.5 or better in these courses. The written permission of an adviser is required for this change of program.

Note: The missing MATH 249 and PHYS 260 from the U1 Honours Year should be taken in U2.

**13.30.10 Bachelor of Science (B.Sc.) - Major Physics: Biological Physics (82 credits)**

The B.Sc. Major Physics: Biological Physics program keeps a strong core of foundational physics and specializes through courses in biology, mathematics, physiology, computer science, and chemistry. Complementary courses provide background in molecular and cell biology, computer science, and organic chemistry, whereas introductory and advanced biophysics courses offered by the Physics Department as integrative courses. This program provides students with the skills necessary to continue on to graduate studies in biophysics/biological physics, or for research careers in hospital, industrial, or university settings.

**Required Courses (63 credits)**

## Bio-Physical Science Core (27 credits)

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
MATH 222*	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
PHYS 319	(3)	Introduction to Biophysics
PHYS 329	(3)	Statistical Physics with Biophysical Applications

\* Students who have taken the equivalent of CHEM 212 or MATH 222 can make up the credits with complementary 3 or 4 credits courses in consultation with the program adviser.

## Biology and Mathematics (6 credits)

BIOL 202	(3)	Basic Genetics
MATH 314	(3)	Advanced Calculus

## Physics (30 credits)

PHYS 230	(3)	Dynamics of Simple Systems
PHYS 232	(3)	Heat and Waves
PHYS 241	(3)	Signal Processing
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 446	(3)	Majors Quantum Physics
PHYS 449	(3)	Majors Research Project
PHYS 519	(3)	Advanced Biophysics

**Complementary Courses**

(18-19 credits)

3 credits selected from:

COMP 202	(3)	Foundations of Programming
COMP 250	(3)	Introduction to Computer Science



3 credits selected from:

PHYS 328	(3)	Electronics
PHYS 331	(3)	Topics in Classical Mechanics

3 credits selected from:

PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 439	(3)	Majors Laboratory in Modern Physics

3 credits selected from:

CHEM 514	(3)	Biophysical Chemistry
MATH 437	(3)	Mathematical Methods in Biology
PHGY 425	(3)	Analyzing Physiological Systems
PHYS 432	(3)	Physics of Fluids
PHYS 434	(3)	Optics
PHYS 447	(3)	Applications of Quantum Mechanics

6 to 7 credits selected from:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 316	(3)	Biomembranes and Organelles
BIOL 551	(3)	Principles of Cellular Control

### 13.30.11 Bachelor of Science (B.Sc.) - Major Physics and Geophysics (69 credits)

This joint 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.

#### Program Prerequisites

Students entering Physics programs from the Freshman program must have successfully completed the courses below or their equivalents. Quebec students must have completed the DEC with appropriate science and mathematics courses.

CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
PHYS 131	(4)	Mechanics and Waves
PHYS 142	(4)	Electromagnetism and Optics

One of:

BIOL 111	(3)	Principles: Organismal Biology
BIOL 112	(3)	Cell and Molecular Biology

MATH 133 and either MATH 140/141 or MATH 150/151.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2
MATH 150	(4)	Calculus A
MATH 151	(4)	Calculus B

**Required Courses (60 credits)**

EPSC 203	(3)	Structural Geology
EPSC 210	(3)	Introductory Mineralogy
EPSC 231	(3)	Field School 1
EPSC 320	(3)	Elementary Earth Physics
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
MATH 319	(3)	Introduction to Partial Differential Equations
PHYS 230	(3)	Dynamics of Simple Systems
PHYS 232	(3)	Heat and Waves
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 331	(3)	Topics in Classical Mechanics
PHYS 333	(3)	Thermal and Statistical Physics
PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 342	(3)	Majors Electromagnetic Waves
PHYS 432	(3)	Physics of Fluids
PHYS 446	(3)	Majors Quantum Physics

**Complementary Courses (9 credits)**

EPSC 330	(3)	Earthquakes and Earth Structure
EPSC 350	(3)	Tectonics
EPSC 435	(3)	Applied Geophysics
EPSC 510	(3)	Geodynamics
EPSC 520	(3)	Earthquake Physics and Geology

**13.30.12 Bachelor of Science (B.Sc.) - Major Physics and Computer Science (66 credits)**

The Major Physics and Computer Science is designed to give motivated students the opportunity to combine the two fields in a way that will distinguish them from the graduates of either field by itself. The two disciplines complement each other, with physics providing an analytic problem-solving outlook and basic understanding of nature, while computer science enhances the ability to make practical and marketable applications, in addition to having its own theoretical interest. Graduates of this program may be able to present themselves as being more immediately useful than a pure physics major, but with more breadth than just a programmer. They will be able to demonstrate their combined expertise in the Special Project course which is the centrepiece of the final year of the program.

**Program Prerequisites**

Students entering Physics programs from the Freshman program must have successfully completed the courses below or their equivalents. Quebec students must have completed the DEC with appropriate science and mathematics courses.

CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
PHYS 131	(4)	Mechanics and Waves
PHYS 142	(4)	Electromagnetism and Optics

One of:

BIOL 111	(3)	Principles: Organismal Biology
BIOL 112	(3)	Cell and Molecular Biology

MATH 133 and either MATH 140/141 or MATH 150/151.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2
MATH 150	(4)	Calculus A
MATH 151	(4)	Calculus B

**U1 Required Courses (21 credits)**

COMP 250	(3)	Introduction to Computer Science
MATH 222	(3)	Calculus 3
MATH 223	(3)	Linear Algebra
MATH 240	(3)	Discrete Structures 1
PHYS 230	(3)	Dynamics of Simple Systems
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2

**U2 Required Courses (24 credits)**

COMP 206	(3)	Introduction to Software Systems
COMP 251	(3)	Algorithms and Data Structures
COMP 302	(3)	Programming Languages and Paradigms
COMP 350	(3)	Numerical Computing
MATH 314	(3)	Advanced Calculus
MATH 315	(3)	Ordinary Differential Equations
PHYS 232	(3)	Heat and Waves
PHYS 241	(3)	Signal Processing

**U3 Required Courses (21 credits)**

COMP 360	(3)	Algorithm Design
MATH 323	(3)	Probability

PHYS 331	(3)	Topics in Classical Mechanics
PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 446	(3)	Majors Quantum Physics
PHYS 489	(3)	Special Project

**13.30.13 Bachelor of Science (B.Sc.) - Honours 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 MATH 222 must take it in the first term without receiving credit 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 (unless it is improved to a C or higher in a supplementary examination or by retaking the course), may not register in the Honours program the following year, or graduate with the Honours degree, except with the permission of the Department.

**Program Prerequisites**

Students entering Physics programs from the Freshman program must have successfully completed the courses below or their equivalents. Quebec students must have completed the DEC with appropriate science and mathematics courses.

CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
PHYS 131	(4)	Mechanics and Waves
PHYS 142	(4)	Electromagnetism and Optics

One of:

BIOL 111	(3)	Principles: Organismal Biology
BIOL 112	(3)	Cell and Molecular Biology

MATH 133 and either MATH 140/141 or MATH 150/151.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2
MATH 150	(4)	Calculus A
MATH 151	(4)	Calculus B

**U1 Required Courses (27 credits)**

MATH 247	(3)	Honours Applied Linear Algebra
MATH 248	(3)	Honours Advanced Calculus
MATH 249	(3)	Honours Complex Variables
MATH 325	(3)	Honours Ordinary Differential Equations
PHYS 241	(3)	Signal Processing
PHYS 251	(3)	Honours Classical Mechanics 1
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 260	(3)	Modern Physics and Relativity

**U2 Required Courses (24 credits)**

MATH 475	(3)	Honours Partial Differential Equations
PHYS 253	(3)	Thermal Physics
PHYS 350	(3)	Honours Electricity and Magnetism
PHYS 351	(3)	Honours Classical Mechanics 2
PHYS 357	(3)	Honours Quantum Physics 1
PHYS 359	(3)	Honours Laboratory in Modern Physics 1
PHYS 362	(3)	Statistical Mechanics
PHYS 457	(3)	Honours Quantum Physics 2

**U3 Required Courses (6 credits)**

PHYS 352	(3)	Honours Electromagnetic Waves
PHYS 551	(3)	Quantum Theory

**U3 Complementary Courses (21 credits)**

6 credits selected from:

Note: PHYS 459D1 and PHYS 459D2 are taken together.

PHYS 459D1	(3)	Honours Research Thesis
PHYS 459D2	(3)	Honours Research Thesis
PHYS 469	(3)	Honours Laboratory in Modern Physics 2
PHYS 479	(3)	Honours Research Project

15 credits selected from the list below (students may substitute one or more courses with any 3-credit course approved by the Department of Physics):

PHYS 432	(3)	Physics of Fluids
PHYS 434	(3)	Optics
PHYS 479	(3)	Honours Research Project
PHYS 514	(3)	General Relativity
PHYS 519	(3)	Advanced Biophysics
PHYS 521	(3)	Astrophysics
PHYS 557	(3)	Nuclear Physics
PHYS 558	(3)	Solid State Physics
PHYS 559	(3)	Advanced Statistical Mechanics
PHYS 562	(3)	Electromagnetic Theory
PHYS 567	(3)	Particle Physics

**13.30.14 Bachelor of Science (B.Sc.) - Honours Physics: Biological Physics (82 credits)**

The B.Sc. Honours Physics: Biological Physics program keeps a strong core of foundational physics and specializes through courses in biology, mathematics, physiology, computer science, and chemistry. The Honours program offers a more rigorous preparation, with additional research experience, for students with a strong interest in biophysics. In the final year, students will have an opportunity to carry out a research project within a biophysics lab in the department. This program provides a very strong foundation for students wishing to pursue graduate studies in biophysics, as well as for research careers in industrial, hospital, or academic laboratory settings.

**Required Courses (63 credits)**

## Bio-Physical Sciences Core (24 credits)

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 395	(1)	Quantitative Biology Seminar 1
CHEM 212*	(4)	Introductory Organic Chemistry 1
MATH 247	(3)	Honours Applied Linear Algebra
MATH 315	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
PHYS 319	(3)	Introduction to Biophysics
PHYS 329	(3)	Statistical Physics with Biophysical Applications

\* Students who have taken the equivalent of CHEM 212 can make up the credits with complementary 3 or 4 credit courses in consultation with the program adviser.

## Biology and Mathematics (6 credits)

BIOL 202	(3)	Basic Genetics
MATH 248	(3)	Honours Advanced Calculus

## Physics (33 credits)

PHYS 241	(3)	Signal Processing
PHYS 251	(3)	Honours Classical Mechanics 1
PHYS 253	(3)	Thermal Physics
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 350	(3)	Honours Electricity and Magnetism
PHYS 352	(3)	Honours Electromagnetic Waves
PHYS 446	(3)	Majors Quantum Physics
PHYS 459D1	(3)	Honours Research Thesis
PHYS 459D2	(3)	Honours Research Thesis
PHYS 519	(3)	Advanced Biophysics

**Complementary Courses**

(18-19 credits)

3 credits selected from:

COMP 202	(3)	Foundations of Programming
COMP 250	(3)	Introduction to Computer Science

3 credits selected from:

PHYS 328	(3)	Electronics
PHYS 351	(3)	Honours Classical Mechanics 2

3 credits selected from:

PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 359	(3)	Honours Laboratory in Modern Physics 1

3 credits selected from:

CHEM 514	(3)	Biophysical Chemistry
MATH 437	(3)	Mathematical Methods in Biology
PHGY 425	(3)	Analyzing Physiological Systems
PHYS 432	(3)	Physics of Fluids
PHYS 434	(3)	Optics
PHYS 447	(3)	Applications of Quantum Mechanics

6 to 7 credits selected from:

BIOL 300	(3)	Molecular Biology of the Gene
BIOL 301	(4)	Cell and Molecular Laboratory
BIOL 303	(3)	Developmental Biology
BIOL 306	(3)	Neural Basis of Behaviour
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 316	(3)	Biomembranes and Organelles
BIOL 551	(3)	Principles of Cellular Control

### 13.30.15 Bachelor of Science (B.Sc.) - Honours 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 mathematics.

The minimum requirement for entry into the program is completion with high standing of the usual CEGEP courses in physics and in mathematics, or the Physics Program Prerequisites as explained below. In addition, a student who has not completed the equivalent of MATH 222 must take it in the first term without receiving credit toward the 81 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 (unless the student improves the grade to a C or higher through a supplemental exam or by retaking the course), may not register in the Honours program the following year, or graduate with the Honours degree, except with the permission of both departments. The student will have two advisers, one from Mathematics and the other from Physics.

#### Program Prerequisites

Students entering Physics programs from the Freshman program must have successfully completed the courses below or their equivalents. Quebec students must have completed the DEC with appropriate science and mathematics courses.

CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
PHYS 131	(4)	Mechanics and Waves
PHYS 142	(4)	Electromagnetism and Optics

One of:

BIOL 111	(3)	Principles: Organismal Biology
BIOL 112	(3)	Cell and Molecular Biology

MATH 133 and either MATH 140/141 or MATH 150/151.

MATH 133	(3)	Linear Algebra and Geometry
MATH 140	(3)	Calculus 1
MATH 141	(4)	Calculus 2
MATH 150	(4)	Calculus A
MATH 151	(4)	Calculus B

**U1 Required Courses (27 credits)**

MATH 235	(3)	Algebra 1
MATH 248	(3)	Honours Advanced Calculus
MATH 249	(3)	Honours Complex Variables
MATH 325	(3)	Honours Ordinary Differential Equations
PHYS 241	(3)	Signal Processing
PHYS 251	(3)	Honours Classical Mechanics 1
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 260	(3)	Modern Physics and Relativity

**U2 Required Courses (24 credits)**

MATH 255	(3)	Honours Analysis 2
MATH 475	(3)	Honours Partial Differential Equations
PHYS 253	(3)	Thermal Physics
PHYS 350	(3)	Honours Electricity and Magnetism
PHYS 351	(3)	Honours Classical Mechanics 2
PHYS 357	(3)	Honours Quantum Physics 1
PHYS 362	(3)	Statistical Mechanics
PHYS 457	(3)	Honours Quantum Physics 2

**U3 Required Courses (12 credits)**

MATH 454	(3)	Honours Analysis 3
MATH 458	(3)	Honours Differential Geometry
PHYS 352	(3)	Honours Electromagnetic Waves
PHYS 359	(3)	Honours Laboratory in Modern Physics 1

**Complementary Courses (18 credits)****U1 Complementary Course (3 credits)**

MATH 247	(3)	Honours Applied Linear Algebra
MATH 251	(3)	Honours Algebra 2

**U2 Complementary Courses (3 credits)**



MATH 242	(3)	Analysis 1
MATH 254**	(3)	Honours Analysis 1

\*\* It is strongly recommended that students take MATH 254.

### U3 Complementary Courses (12 credits)

12 credits are selected as follows:

3 credits from:

MATH 455	(3)	Honours Analysis 4
MATH 456	(3)	Honours Algebra 3

6 credits selected from:

PHYS 432	(3)	Physics of Fluids
PHYS 479	(3)	Honours Research Project
PHYS 514	(3)	General Relativity
PHYS 519	(3)	Advanced Biophysics
PHYS 521	(3)	Astrophysics
PHYS 551	(3)	Quantum Theory
PHYS 557	(3)	Nuclear Physics
PHYS 558	(3)	Solid State Physics
PHYS 559	(3)	Advanced Statistical Mechanics
PHYS 562	(3)	Electromagnetic Theory
PHYS 567	(3)	Particle Physics

3 credits in Honours Mathematics.

### 13.30.16 Bachelor of Science (B.Sc.) - Honours Physics and Chemistry (80 credits)

This is a specialized and demanding program intended primarily, although not exclusively, for students with a theoretical bias who are interested in working in fields of study at the crossroads of physical chemistry and physics. The program will prepare students for either theoretical or experimental graduate work in departments where there is an emphasis on such cross-disciplinary areas as condensed matter physics, chemical physics, or material science.

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 (unless the student improves the grade to a C or above by taking a supplemental exam or retaking the course), may not register in this Honours program the following year, or graduate with the Honours degree, except with permission of both departments.

The student will have two advisers, one from Chemistry and the other from Physics.

#### Program Prerequisites

Students entering Physics programs from the Freshman program must have successfully completed the courses below or their equivalents. Quebec students must have completed the DEC with appropriate science and mathematics courses.

CHEM 110	(4)	General Chemistry 1
CHEM 120	(4)	General Chemistry 2
PHYS 131	(4)	Mechanics and Waves
PHYS 142	(4)	Electromagnetism and Optics

One of:

BIOL 111	(3)	Principles: Organismal Biology
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BIOL 112 (3) Cell and Molecular Biology

MATH 133 and either MATH 140/141 or MATH 150/151.

MATH 133 (3) Linear Algebra and Geometry

MATH 140 (3) Calculus 1

MATH 141 (4) Calculus 2

MATH 150 (4) Calculus A

MATH 151 (4) Calculus B

### Required Courses (68 credits)

CHEM 212 (4) Introductory Organic Chemistry 1

CHEM 213 (3) Introductory Physical Chemistry 1: Thermodynamics

CHEM 273 (3) Introductory Physical Chemistry 2: Kinetics and Methods

CHEM 281 (3) Inorganic Chemistry 1

CHEM 355 (3) Applications of Quantum Chemistry

CHEM 365 (2) Statistical Thermodynamics

CHEM 493 (2) Advanced Physical Chemistry Laboratory

CHEM 556 (3) Advanced Quantum Mechanics

CHEM 574 (3) Introductory Polymer Chemistry

COMP 208 (3) Computers in Engineering

MATH 247 (3) Honours Applied Linear Algebra

MATH 248 (3) Honours Advanced Calculus

MATH 249 (3) Honours Complex Variables

MATH 325 (3) Honours Ordinary Differential Equations

PHYS 241 (3) Signal Processing

PHYS 251 (3) Honours Classical Mechanics 1

PHYS 257 (3) Experimental Methods 1

PHYS 258 (3) Experimental Methods 2

PHYS 350 (3) Honours Electricity and Magnetism

PHYS 352 (3) Honours Electromagnetic Waves

PHYS 357 (3) Honours Quantum Physics 1

PHYS 457 (3) Honours Quantum Physics 2

PHYS 558 (3) Solid State Physics

### Complementary Courses (12 credits)

(with at least 3 credits in Chemistry and 3 credits in Physics)

3 credits selected from:

CHEM 593 (3) Statistical Mechanics

PHYS 559 (3) Advanced Statistical Mechanics

9 credits selected from the list below:

CHEM 480D1	(1.5)	Undergraduate Research Project 2
CHEM 480D2	(1.5)	Undergraduate Research Project 2
CHEM 531	(3)	Chemistry of Inorganic Materials
CHEM 575	(3)	Chemical Kinetics
CHEM 585	(3)	Colloid Chemistry
PHYS 351	(3)	Honours Classical Mechanics 2
PHYS 434	(3)	Optics
PHYS 469	(3)	Honours Laboratory in Modern Physics 2
PHYS 479	(3)	Honours Research Project
PHYS 562	(3)	Electromagnetic Theory

### 13.30.17 Bachelor of Science (B.Sc.) - Honours Physics and Computer Science (81 credits)

\*\* NEW PROGRAM \*\*

This program provides essential background in physics and computer science at a level sufficient to pursue courses at the 400- and 500-level in either discipline. The program is intended to be flexible to allow students to take either more physics or more computer science courses at the advanced level.

Students entering this Joint Honours program should have high standing in mathematics, physics, and computer science. To continue in this Joint Honours program, an average GPA of 3.00 in required and complementary courses is required. For Honours standing, the CGPA at graduation must be at least 3.00; for First-Class Honours, the CGPA must be above 3.50.

Note: COMP 202—or an equivalent introduction to computer programming course—is a program prerequisite. U0 students may take COMP 202 as a Freshman Science course; new U1 students should take it as an elective in their first semester.

#### Required Courses (63 credits)

\*Note: A student who has not taken MATH 222 (or equivalent) prior to entering the program must take it in their first semester, increasing the program credits from 78 to 81. The student must then take MATH 314 in their second semester instead of MATH 248, if scheduling requires it.

COMP 206	(3)	Introduction to Software Systems
COMP 250	(3)	Introduction to Computer Science
COMP 252	(3)	Honours Algorithms and Data Structures
COMP 273	(3)	Introduction to Computer Systems
COMP 302	(3)	Programming Languages and Paradigms
COMP 350	(3)	Numerical Computing
MATH 240	(3)	Discrete Structures 1
MATH 247	(3)	Honours Applied Linear Algebra
MATH 248*	(3)	Honours Advanced Calculus
MATH 249	(3)	Honours Complex Variables
MATH 314*	(3)	Advanced Calculus
MATH 325	(3)	Honours Ordinary Differential Equations
PHYS 241	(3)	Signal Processing
PHYS 251	(3)	Honours Classical Mechanics 1
PHYS 253	(3)	Thermal Physics
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 350	(3)	Honours Electricity and Magnetism
PHYS 352	(3)	Honours Electromagnetic Waves
PHYS 357	(3)	Honours Quantum Physics 1

PHYS 362	(3)	Statistical Mechanics
PHYS 457	(3)	Honours Quantum Physics 2

**Complementary Courses (15 credits)**

At least 6 of the 15 complementary credits must come from a course at the 400- or 500-level (excluding COMP 400 and PHYS 479), and of these at least 3 must be from a COMP course.

3 or 4 credits selected from:

COMP 400	(4)	Project in Computer Science
PHYS 479	(3)	Honours Research Project

6 or 7 credits selected from:

COMP 303	(3)	Software Design
COMP 310	(3)	Operating Systems
COMP 330	(3)	Theory of Computation
COMP 362	(3)	Honours Algorithm Design

Any COMP course at the 400- or 500-level (excluding COMP 400) (3 or 4 credits)

At least 4 credits selected from:

MATH 323	(3)	Probability
MATH 340	(3)	Discrete Structures 2
PHYS 351	(3)	Honours Classical Mechanics 2
PHYS 359	(3)	Honours Laboratory in Modern Physics 1
PHYS 432	(3)	Physics of Fluids
PHYS 434	(3)	Optics

Any number of PHYS courses at the 500 level (3 credits each)

Any number of COMP courses at the 400 or 500-level (excluding COMP 400) (3 or 4 credits each)

**13.30.18 Physics (PHYS) Related Programs****13.30.18.1 Major in Atmospheric Science and Physics**

See [section 13.3: Atmospheric and Oceanic Sciences \(ATOC\)](#). This program 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. Students should consult undergraduate advisers in both departments.

**13.30.18.2 Major in Physiology and Physics**

See [section 13.31: Physiology \(PHGY\)](#). This program provides a firm basis for graduate work in bio-physics and other interdisciplinary fields involving the physical and biological sciences.

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**13.31 Physiology (PHGY)****13.31.1 Location**

McIntyre Medical Sciences Building, Room 1021  
3655 Promenade Sir-William-Osler  
Montreal QC H3G 1Y6

Telephone: 514-398-4316

Website: [www.mcgill.ca/physiology](http://www.mcgill.ca/physiology)

### 13.31.2 About Physiology

Physiology has its roots in many of the basic sciences including biology, chemistry, mathematics, and physics, and overlaps with other biomedical sciences such as anatomy, biochemistry, pathology, pharmacology, psychology, and biomedical engineering. Physiology is one of the prime contributors of basic scientific knowledge to the clinical medical sciences.

Members of the Department of Physiology at McGill are engaged in studies dealing with molecules, single cells, or entire systems in a variety of vertebrates, including humans. A wide range of interest and expertise is represented, including:

- cardiovascular;
- respiratory;
- gastrointestinal and renal physiology;
- the physiology of exercise;
- neurophysiology;
- endocrinology;
- immunology;
- biophysics;
- biomathematics.

Some faculty members have formal or informal links with the departments of mathematics, physics, electrical engineering, and chemistry, and with clinical departments (medicine, surgery, pediatrics, neurology, obstetrics, psychiatry, anesthesia), reflecting and reinforcing the close ties between physiology and other disciplines.

Graduates at the B.Sc. level have found rewarding **careers** in secondary school and CEGEP teaching, government service, and laboratory technical assistance such as in pharmaceutical houses, hospitals, and institutions of higher learning. Moreover, physiology provides an excellent background for medicine, dentistry or other postgraduate work, in such fields as physiology, experimental medicine, pharmacology, biochemistry, or physiological psychology.

The **programs** offered in Physiology differ in their orientation but they all have a common core of material covering:

- cardiovascular;
- respiratory;
- gastrointestinal and renal physiology;
- neurophysiology;
- endocrinology;
- immunology.

The specified U1 courses are identical for all programs except the Joint Major programs in Physiology and Physics, Physiology and Mathematics, and the Joint Honours program in Immunology, and thus afford students maximal flexibility before deciding on a particular program to follow in U2 and U3.

All **new students** to the Department, Freshman and CEGEP, must contact the Student Affairs Officer at 514-398-3689 for advising; further information is available on the [Physiology website](#).

**Returning students** are encouraged to consult with the Student Affairs Officer regularly throughout the year; in particular, at the beginning of their final year to ensure they have met all departmental requirements.



**PLEASE NOTE:** Complementary courses are not electives.

The difference between complementary courses and required courses is that complementary courses are defined as offering an element of choice, however small that choice may be. Students may choose from the two (or more) courses specified within complementary course segments of a program description, but **ONLY** from those. For further information, refer to [University Regulations & Resources > Undergraduate > Registration > : Course Information and Regulations](#).

### 13.31.3 Physiology Faculty

#### Chair

John White

#### Graduate Program Director

Alvin Shrier

**Emeritus Professors**

Thomas M.S. Chang; B.Sc., M.D.,C.M., Ph.D.(McG.), F.R.C.P.(C)  
 Kresimir Krnjevic; O.C., B.Sc., Ph.D., M.B., Ch.B.(Edin.), F.R.S.C.  
 Wayne S. Lapp; M.S.A.(Tor.), Ph.D.(McG.)  
 Mortimer Levy; B.Sc., M.D.,C.M.(McG.), F.R.C.P.(C) (*joint appt with Medicine*)  
 George Mandl; B.Sc.(C'dia); Ph.D.(McG.)  
 Michael Mackey; B.A., Ph.D.(Wash.) (*Joseph Morley Professor of Physiology*)  
 Geoffrey Melvill Jones; B.A., M.A., M.B., B.Ch., M.D.(Cant.)  
 Joseph Milic-Emili; M.D.(Milan) (*joint appt with Medicine*)  
 Canio Polosa; M.D., Ph.D.(McG.)  
 Douglas G.D. Watt; M.D., Ph.D.(McG.)

**Professors**

Maurice Chacron; Ph.D.(Ott.)  
 Monroe W. Cohen; B.Sc., Ph.D.(McG.)  
 Ellis J. Cooper; B.Eng.(Sir G. Wms.), M.Sc.(Surr.), Ph.D.(McM.)  
 Leon Glass; B.S.(Brooklyn), Ph.D.(Chic.) (*Rosenfeld Professor of Medicine*) (*joint appt. with Medicine*)  
 Phil Gold; C.C., B.Sc., M.Sc., Ph.D., M.D.,C.M.(McG.), F.R.C.P.(C), F.R.S.C. (*Douglas G. Cameron Professor of Medicine*) (*joint appt. with Medicine*)  
 John Hanrahan; Ph.D.(Br. Col.)  
 David Goltzman; B.Sc., M.D.,C.M.(McG.) (*Antoine G. Massabki Professor of Medicine*) (*joint appt. with Medicine*)  
 Gergely Lukacs; M.D., Ph.D.(Budapest)  
 Sheldon Magder; M.D.(Tor.) (*joint appt. with Medicine*)  
 Jacopo P. Mortola; M.D.(Milan)  
 John Orłowski; B.Sc.(McG.), M.Sc., Ph.D.(Qu.) (*James McGill Professor*)  
 Premysl Ponka; M.D., Ph.D.(Prague) (*joint appt. with Medicine*)  
 Alvin Shrier; B.Sc.(C'dia), Ph.D.(Dal.) (*Hosmer Professor of Physiology*)  
 John White; B.Sc., M.Sc.(Car.), Ph.D.(Harv.) (*joint appt. with Medicine*)

**Associate Professors**

Erik Cook; Ph.D.(Baylor Coll., Tx)  
 Mladen Glavinovic; B.Sc.(Zagreb), M.Sc.(Tor.), Ph.D.(McG.)  
 Michael Guevara; Ph.D.(McG.)  
 Russell Jones; Ph.D.(Tor.)  
 Ursula Stochaj; Ph.D.(Cologne)

**Associate Professor (Part-time)**

Nicole Bernard; B.Sc.(McG.), Ph.D.(Duke)

**Assistant Professors**

Claire Brown; B.Sc.(St. Mary's), Ph.D.(W. Ont.)  
 Gil Bub; B.Sc., Ph.D.(McG.)  
 Anmar Khadra; B.Sc.(C'dia), M.Sc., Ph.D.(Wat.)  
 Connie Krawczyk; B.Sc.(Guelph), Ph.D.(Tor.) (*joint appt. with Microbiology & Immunology*)  
 Arjun Krishnaswamy; B.Sc. Ph.D.(McG.)  
 Judith Natalia Mandl; B.Sc.(Warw.), Ph.D.(Emory)

**Assistant Professors**

Anastasia Nijnik; M.Biochem., Ph.D.(Oxf.)  
 Masha Prager-Khoutorsky; B.Sc., Ph.D.(Hebrew)  
 Daniela Quail; B.Sc., Ph.D.(W.Ont.)  
 Reza Sharif-Naeini; B.Sc.(Montr.), M.Sc., Ph.D.(McG.)  
 Melissa Vollrath; B.Sc.(Wisc.), Ph.D. (Baylor Coll., Houston)

**Associate Members**

*Anaesthesia:* Steven Backman  
*Biomedical Engineering:* Robert Kearney, Satya Prakash  
*Biomedical Ethics:* Jennifer Fishman  
*Kinesiology and Physical Education:* Dilson Rassier  
*Mathematics:* Anthony Humphries  
*Medicine:* Nicole Bernard, Volker Blank, Mark Blostein, Andrey Cybulsky, Geoffrey Hendy, Louise Larose, Anne-Marie Lauzon, Serge Lemay, James Martin, Barry Posner, Shafaat Rabbani, Simon Rousseau, Mary Stevenson, Tomoko Takano, Elena Torban, Simon Wing  
*Microbiology and Immunology:* Jörg Fritz  
*Neurology and Neurosurgery:* Jack Antel, Massimo Avoli, Daniel Guitton, Christopher Pack, David Ragsdale, Ed Ruthazer, Amir Shmuel, Jesper Sjöström  
*Ophthalmology:* Curtis Baker  
*Otolaryngology:* Bernard Segal  
*Pediatrics:* Charles Rohlicek  
*Pharmacology and Therapeutics:* Daniel Bernard, Terence Hebert  
*Psychiatry:* Nicolas Cermakian  
*Research in Neuroscience:* Charles Bourque, Sal. T. Carbonetto

**Adjunct Professors**

K. Cullen, P. Haghighi, J. Martinez-Trujillo

**Associate Professor Post-Retirement**

Ann Wechsler; B.A.(Tor.), M.Sc., Ph.D.(McG.)

**13.31.4 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Physiology (50 credits)****Required Courses (38 credits)**

\* Students who have taken CHEM 212 and/or CHEM 222 in CEGEP are exempted and must replace these credits with 4 or 8 credits of elective course(s).

BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
BIOL 301	(4)	Cell and Molecular Laboratory
CHEM 212*	(4)	Introductory Organic Chemistry 1
CHEM 222*	(4)	Introductory Organic Chemistry 2
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 212	(1)	Introductory Physiology Laboratory 1
PHGY 213	(1)	Introductory Physiology Laboratory 2
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology

PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience

**Complementary Courses (12 credits)**

12 credits selected as follows:

3 credits selected from:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits selected from:

BIOL 309	(3)	Mathematical Models in Biology
BIOL 373	(3)	Biometry
COMP 202	(3)	Foundations of Programming
COMP 250	(3)	Introduction to Computer Science
PSYC 305	(3)	Statistics for Experimental Design

**Upper-Level Physiology (ULP) Courses**

6 credits selected from the Upper-Level Physiology (ULP) course list as follows:

\* The 6-credit course PHGY 459D1/D2 equals 3 credits of ULP and 3 credits of electives.

\*\* The 9-credit course PHGY 461D1/D2 equals 3 credits of ULP and 6 credits of electives.

BIOL 532	(3)	Developmental Neurobiology Seminar
BMDE 505	(3)	Cell and Tissue Engineering
BMDE 519	(3)	Biomedical Signals and Systems
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
EXMD 506	(3)	Advanced Applied Cardiovascular Physiology
EXMD 507	(3)	Advanced Applied Respiratory Physiology
EXMD 508	(3)	Advanced Topics in Respiration
MIMM 414	(3)	Advanced Immunology
MIMM 509	(3)	Inflammatory Processes
PHGY 425	(3)	Analyzing Physiological Systems
PHGY 451	(3)	Advanced Neurophysiology
PHGY 459D1*	(3)	Physiology Seminar
PHGY 459D2*	(3)	Physiology Seminar
PHGY 461D1**	(4.5)	Experimental Physiology
PHGY 461D2**	(4.5)	Experimental Physiology
PHGY 488	(3)	Stem Cell Biology
PHGY 502	(3)	Exercise Physiology
PHGY 508	(3)	Advanced Renal Physiology
PHGY 513	(3)	Cellular Immunology
PHGY 515	(3)	Physiology of Blood 1



PHGY 516	(3)	Physiology of Blood 2
PHGY 518	(3)	Artificial Cells
PHGY 520	(3)	Ion Channels
PHGY 524	(3)	Chronobiology
PHGY 531	(3)	Topics in Applied Immunology
PHGY 550	(3)	Molecular Physiology of Bone
PHGY 552	(3)	Cellular and Molecular Physiology
PHGY 556	(3)	Topics in Systems Neuroscience
PHGY 560	(3)	Light Microscopy-Life Science
PSYC 470	(3)	Memory and Brain
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

### 13.31.5 Bachelor of Science (B.Sc.) - Major Physiology (65 credits)

The Major program includes, in addition to some intensive studies in Physiology, a strong core content of related biomedical 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, CHEM 212 "Introductory Organic Chemistry 1" must be completed in addition to the 64-65 program credits.

Students may complete this program with a minimum of 64 credits or a maximum of 65 credits depending on their choice of complementary courses.

#### U1 Required Courses (18 credits)

BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
CHEM 222	(4)	Introductory Organic Chemistry 2
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 212	(1)	Introductory Physiology Laboratory 1
PHGY 213	(1)	Introductory Physiology Laboratory 2

#### U2 and U3 Required Courses (19 credits)

BIOC 311	(3)	Metabolic Biochemistry
BIOL 301	(4)	Cell and Molecular Laboratory
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience

#### Complementary Courses (28 credits)

12-13 credits selected as follows:

3 credits, one of:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits, one of:

BIOL 309	(3)	Mathematical Models in Biology
BIOL 373	(3)	Biometry
COMP 202	(3)	Foundations of Programming
COMP 250	(3)	Introduction to Computer Science
PSYC 305	(3)	Statistics for Experimental Design

3 credits, one of:

BIOC 312	(3)	Biochemistry of Macromolecules
CHEM 203	(3)	Survey of Physical Chemistry
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1

3-4 credits, one of:

ANAT 214	(3)	Systemic Human Anatomy
ANAT 261	(4)	Introduction to Dynamic Histology
ANAT 316	(3)	Clinical Human Visceral Anatomy

**9 credits selected from the Upper-Level Physiology (ULP) course list as follows:**

BIOL 532	(3)	Developmental Neurobiology Seminar
BMDE 505	(3)	Cell and Tissue Engineering
BMDE 519	(3)	Biomedical Signals and Systems
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
EXMD 506	(3)	Advanced Applied Cardiovascular Physiology
EXMD 507	(3)	Advanced Applied Respiratory Physiology
EXMD 508	(3)	Advanced Topics in Respiration
MIMM 414	(3)	Advanced Immunology
MIMM 509	(3)	Inflammatory Processes
PHGY 425	(3)	Analyzing Physiological Systems
PHGY 451	(3)	Advanced Neurophysiology
PHGY 459D1*	(3)	Physiology Seminar
PHGY 459D2*	(3)	Physiology Seminar
PHGY 461D1**	(4.5)	Experimental Physiology
PHGY 461D2**	(4.5)	Experimental Physiology
PHGY 488	(3)	Stem Cell Biology
PHGY 502	(3)	Exercise Physiology
PHGY 508	(3)	Advanced Renal Physiology
PHGY 513	(3)	Cellular Immunology
PHGY 515	(3)	Physiology of Blood 1
PHGY 516	(3)	Physiology of Blood 2
PHGY 518	(3)	Artificial Cells
PHGY 520	(3)	Ion Channels

PHGY 524	(3)	Chronobiology
PHGY 531	(3)	Topics in Applied Immunology
PHGY 550	(3)	Molecular Physiology of Bone
PHGY 552	(3)	Cellular and Molecular Physiology
PHGY 556	(3)	Topics in Systems Neuroscience
PHGY 560	(3)	Light Microscopy-Life Science
PSYC 470	(3)	Memory and Brain
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

\* the 6-credit course equals 3 credits of ULP and 6 credits of electives.

\*\* the 9-credit course equals 3 credits of ULP and 6 credits of electives.

### 6 credits selected from the Upper-Level Science (ULS)

Note: For Chemistry, Neurology, and Neurosurgery: select from all courses 300 level and above and the ULS courses listed below.

For Biochemistry, Computer Science, Microbiology and Immunology, Mathematics, Physics, and Pathology: select from all courses 300 level and above.

For Anatomy, Biology, Experimental Medicine, Pharmacology, and Psychology: select from the ULS courses listed below:

ANAT 321	(3)	Circuitry of the Human Brain
ANAT 322	(3)	Neuroendocrinology
ANAT 365	(3)	Cellular Trafficking
ANAT 381	(3)	Experimental Embryology
ANAT 416	(3)	Development, Disease and Regeneration
ANAT 458*	(3)	Membranes and Cellular Signaling
ANAT 541	(3)	Cell and Molecular Biology of Aging
ANAT 542	(3)	Transmission Electron Microscopy
ANAT 565	(3)	Diseases-Membrane Trafficking
BIOC 458*	(3)	Membranes and Cellular Signaling
BIOL 300	(3)	Molecular Biology of the Gene
BIOL 303	(3)	Developmental Biology
BIOL 309	(3)	Mathematical Models in Biology
BIOL 313	(3)	Eukaryotic Cell Biology
BIOL 314	(3)	Molecular Biology of Oncogenes
BIOL 324	(3)	Ecological Genetics
BIOL 370	(3)	Human Genetics Applied
BIOL 373	(3)	Biometry
BIOL 389	(3)	Laboratory in Neurobiology
BIOL 416	(3)	Genetics of Mammalian Development
BIOL 468	(6)	Independent Research Project 3
BIOL 518	(3)	Advanced Topics in Cell Biology
BIOL 520	(3)	Gene Activity in Development
BIOL 524	(3)	Topics in Molecular Biology
BIOL 532	(3)	Developmental Neurobiology Seminar
BIOL 544	(3)	Genetic Basis of Life Span
BIOL 546	(3)	Genetics of Model Systems
BIOL 551	(3)	Principles of Cellular Control

BIOL 575	(3)	Human Biochemical Genetics
BIOL 588	(3)	Advances in Molecular/Cellular Neurobiology
CHEM 214	(3)	Physical Chemistry/Biological Sciences 2
EXMD 401	(3)	Physiology and Biochemistry Endocrine Systems
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
EXMD 504	(3)	Biology of Cancer
EXMD 506	(3)	Advanced Applied Cardiovascular Physiology
EXMD 507	(3)	Advanced Applied Respiratory Physiology
EXMD 508	(3)	Advanced Topics in Respiration
EXMD 510	(3)	Bioanalytical Separation Methods
NEUR 310	(3)	Cellular Neurobiology
PHAR 503	(3)	Drug Discovery and Development 1
PHAR 504	(3)	Drug Discovery and Development 2
PHAR 562	(3)	Neuropharmacology
PHAR 563	(3)	Endocrine Pharmacology
PPHS 501	(3)	Population Health and Epidemiology
PSYC 302	(3)	The Psychology of Pain
PSYC 311	(3)	Human Cognition and the Brain
PSYC 317	(3)	Genes and Behaviour
PSYC 318	(3)	Behavioural Neuroscience 2
PSYC 342	(3)	Hormones and Behaviour
PSYC 410	(3)	Special Topics in Neuropsychology
PSYC 427	(3)	Sensorimotor Neuroscience
PSYC 470	(3)	Memory and Brain
PSYC 522	(3)	Neurochemistry and Behaviour
PSYC 526	(3)	Advances in Visual Perception
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

\* Students may take ANAT 458 or BIOC 458 but not both.

Note: Students may opt to replace 3 credits of the 6 credits of Upper Level Science with 3 credits selected from the following list:

COMP 364	(3)	Computer Tools for Life Sciences
PHIL 341	(3)	Philosophy of Science 1
PHIL 343	(3)	Biomedical Ethics
REDM 410	(3)	Writing Research Articles

### 13.31.6 Bachelor of Science (B.Sc.) - Major Physiology and Mathematics (79 credits)

#### Required Courses (70 credits)

#### Bio-Physical Sciences Core

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 395	(1)	Quantitative Biology Seminar 1

MATH 222	(3)	Calculus 3
MATH 223*	(3)	Linear Algebra
MATH 247*	(3)	Honours Applied Linear Algebra
MATH 315**	(3)	Ordinary Differential Equations
MATH 323	(3)	Probability
MATH 325**	(3)	Honours Ordinary Differential Equations

\* Students may take either MATH 223 or MATH 247.

\*\* Students may take either MATH 315 or MATH 325.

### Physiology and Mathematics Core

BIOL 309	(3)	Mathematical Models in Biology
BMDE 519	(3)	Biomedical Signals and Systems
MATH 242	(3)	Analysis 1
MATH 243	(3)	Analysis 2
MATH 248***	(3)	Honours Advanced Calculus
MATH 314***	(3)	Advanced Calculus
MATH 317	(3)	Numerical Analysis
MATH 319	(3)	Introduction to Partial Differential Equations
MATH 324	(3)	Statistics
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 437	(3)	Mathematical Methods in Biology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 212	(1)	Introductory Physiology Laboratory 1
PHGY 213	(1)	Introductory Physiology Laboratory 2
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 461D1	(4.5)	Experimental Physiology
PHGY 461D2	(4.5)	Experimental Physiology

\*\*\* Students may take either MATH 248 or MATH 314.

### Complementary Courses (9 credits)

3 credits, one of:

COMP 202	(3)	Foundations of Programming
COMP 250	(3)	Introduction to Computer Science

3 credits, one of:

PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 314	(3)	Integrative Neuroscience

3 credits, one of:

PHYS 413	(3)	Physical Basis of Physiology
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PHYS 519 (3) Advanced Biophysics

### 13.31.7 Bachelor of Science (B.Sc.) - Major Physiology and Physics (82 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.

#### Required Courses (76 credits)

##### Bio-Physical Sciences Core

BIOL 219	(4)	Introduction to Physical Biology of the Cell
BIOL 395	(1)	Quantitative Biology Seminar 1
MATH 222	(3)	Calculus 3
MATH 223*	(3)	Linear Algebra
MATH 247*	(3)	Honours Applied Linear Algebra
MATH 315**	(3)	Ordinary Differential Equations
MATH 325**	(3)	Honours Ordinary Differential Equations
PHYS 329	(3)	Statistical Physics with Biophysical Applications

\* Students may take either MATH 223 or MATH 247.

\*\* Students may take either MATH 315 or MATH 325.

##### Physiology and Physics Core

BMDE 519	(3)	Biomedical Signals and Systems
MATH 248***	(3)	Honours Advanced Calculus
MATH 314***	(3)	Advanced Calculus
MATH 326	(3)	Nonlinear Dynamics and Chaos
MATH 437	(3)	Mathematical Methods in Biology
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 212	(1)	Introductory Physiology Laboratory 1
PHGY 213	(1)	Introductory Physiology Laboratory 2
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 461D1	(4.5)	Experimental Physiology
PHGY 461D2	(4.5)	Experimental Physiology
PHYS 230	(3)	Dynamics of Simple Systems
PHYS 232	(3)	Heat and Waves
PHYS 241	(3)	Signal Processing
PHYS 257	(3)	Experimental Methods 1
PHYS 258	(3)	Experimental Methods 2
PHYS 339	(3)	Measurements Laboratory in General Physics
PHYS 340	(3)	Majors Electricity and Magnetism
PHYS 446	(3)	Majors Quantum Physics

\*\*\* Students may take either MATH 248 or MATH 314.

**Complementary Courses (6 credits)**

3 credits, one of:

PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 314	(3)	Integrative Neuroscience

3 credits, one of:

PHYS 413	(3)	Physical Basis of Physiology
PHYS 519	(3)	Advanced Biophysics

**13.31.8 Bachelor of Science (B.Sc.) - Honours Physiology (75 credits)**

All admissions to the Honours program will be in U2, and the student must have a U1 GPA of 3.30, with no less than a B in PHGY 209 and PHGY 210. Admission to U3 requires a U2 CGPA of 3.20 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 program. 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 August 15, 2018. Application forms are available online at [physiology.med@mcgill.ca](mailto:physiology.med@mcgill.ca) or a hard copy can be picked up at McIntyre 1021. Please contact Sonia Viselli, Student Affairs Officer ([sonia.viselli@mcgill.ca](mailto:sonia.viselli@mcgill.ca); 514-398-3689) for more information. An email will be sent to acknowledge receipt of your application.

Graduation: To graduate from the Honours Physiology program, the student will have a CGPA of 3.20 with a mark no less than a B in all Physiology courses.

If not previously taken, CHEM 212 Introductory Organic Chemistry 1 must be completed in addition to the 75 program credits.

**Required Courses (60 credits)**

ANAT 261	(4)	Introduction to Dynamic Histology
BIOC 311	(3)	Metabolic Biochemistry
BIOL 200	(3)	Molecular Biology
BIOL 202	(3)	Basic Genetics
BIOL 301	(4)	Cell and Molecular Laboratory
CHEM 222	(4)	Introductory Organic Chemistry 2
PHGY 209	(3)	Mammalian Physiology 1
PHGY 210	(3)	Mammalian Physiology 2
PHGY 212	(1)	Introductory Physiology Laboratory 1
PHGY 213	(1)	Introductory Physiology Laboratory 2
PHGY 311	(3)	Channels, Synapses and Hormones
PHGY 312	(3)	Respiratory, Renal, & Cardiovascular Physiology
PHGY 313	(3)	Blood, Gastrointestinal, & Immune Systems Physiology
PHGY 314	(3)	Integrative Neuroscience
PHGY 351	(3)	Research Techniques: Physiology
PHGY 359D1	(.5)	Tutorial in Physiology
PHGY 359D2	(.5)	Tutorial in Physiology
PHGY 459D1	(3)	Physiology Seminar
PHGY 459D2	(3)	Physiology Seminar
PHGY 461D1	(4.5)	Experimental Physiology
PHGY 461D2	(4.5)	Experimental Physiology

**Complementary Courses (15 credits)**

9 credits selected as follows:

3 credits, one of:

BIOC 212	(3)	Molecular Mechanisms of Cell Function
BIOL 201	(3)	Cell Biology and Metabolism

3 credits, one of:

BIOL 309	(3)	Mathematical Models in Biology
BIOL 373	(3)	Biometry
COMP 202	(3)	Foundations of Programming
COMP 250	(3)	Introduction to Computer Science
PSYC 305	(3)	Statistics for Experimental Design

3 credits, one of:

BIOC 312	(3)	Biochemistry of Macromolecules
CHEM 203	(3)	Survey of Physical Chemistry
CHEM 204	(3)	Physical Chemistry/Biological Sciences 1

**6 credits selected from the Upper-Level Physiology (ULP) course list as follows:**

BIOL 532	(3)	Developmental Neurobiology Seminar
BMDE 519	(3)	Biomedical Signals and Systems
EXMD 502	(3)	Advanced Endocrinology 1
EXMD 503	(3)	Advanced Endocrinology 02
EXMD 506	(3)	Advanced Applied Cardiovascular Physiology
EXMD 507	(3)	Advanced Applied Respiratory Physiology
EXMD 508	(3)	Advanced Topics in Respiration
MIMM 414	(3)	Advanced Immunology
MIMM 509	(3)	Inflammatory Processes
PHGY 425	(3)	Analyzing Physiological Systems
PHGY 451	(3)	Advanced Neurophysiology
PHGY 488	(3)	Stem Cell Biology
PHGY 502	(3)	Exercise Physiology
PHGY 508	(3)	Advanced Renal Physiology
PHGY 513	(3)	Cellular Immunology
PHGY 515	(3)	Physiology of Blood 1
PHGY 516	(3)	Physiology of Blood 2
PHGY 518	(3)	Artificial Cells
PHGY 520	(3)	Ion Channels
PHGY 524	(3)	Chronobiology
PHGY 531	(3)	Topics in Applied Immunology



PHGY 550	(3)	Molecular Physiology of Bone
PHGY 552	(3)	Cellular and Molecular Physiology
PHGY 556	(3)	Topics in Systems Neuroscience
PHGY 560	(3)	Light Microscopy-Life Science
PSYC 470	(3)	Memory and Brain
PSYT 500	(3)	Advances: Neurobiology of Mental Disorders

### 13.31.9 Physiology (PHGY) Related Programs

#### 13.31.9.1 Interdepartmental Honours in Immunology

For more information, see [section 13.18: Immunology](#). This program is offered by the Departments of Biochemistry, Microbiology and Immunology, and Physiology.

Students interested in the program should contact:

Dr. Monroe Cohen  
Physiology  
Telephone: 514-398-4342  
Email: [monroe.cohen@mcgill.ca](mailto:monroe.cohen@mcgill.ca)

OR

Dr. C. Piccirillo  
Microbiology and Immunology  
Telephone: 514-934-1934, ext. 76143  
Email: [ciro.piccirillo@mcgill.ca](mailto:ciro.piccirillo@mcgill.ca)

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### 13.32 Psychiatry (PSYT)

#### 13.32.1 Location

1033 Pine Avenue West, Room 104  
Montreal QC H3A 1A1  
Telephone: 514-398-4176  
Website: [www.mcgill.ca/psychiatry/education](http://www.mcgill.ca/psychiatry/education)

#### 13.32.2 About Psychiatry

There are no B.Sc. programs in Psychiatry, but the PSYT courses listed below are administered by the Faculty of Science and are open to Arts and Science students and to graduate students, subject to the regulations and restrictions of their home faculty.

##### Courses

PSYT 199	FYS: Mental Illness and the Brain
PSYT 301	Issues in Drug Dependence
PSYT 400D1/PSYT 400D2	Research Project in Psychiatry
PSYT 455	Neurochemistry
PSYT 500	Advances: Neurobiology of Mental Disorders
PSYT 502	Brain Evolution and Psychiatry
PSYT 503	Mental Health Services and Policy
PSYT 504	Issues in Forensic Mental Health
PSYT 515	Advanced Studies in Addiction

## 13.33 Psychology (PSYC)

### 13.33.1 Location

2001 McGill College, Room 740  
Montreal QC H3A 1G1  
Telephone: 514-398-6100  
Fax: 514-398-4896  
Email: [info@psych.mcgill.ca](mailto:info@psych.mcgill.ca)  
Website: [www.mcgill.ca/psychology](http://www.mcgill.ca/psychology)

### 13.33.2 About Psychology

**The Department of Psychology offers programs in both Arts and Science. All B.A. programs in Psychology can be found in [Faculty of Arts > Undergraduate > Browse Academic Units & Programs > : Psychology \(PSYC\)](#).**

Psychology is the scientific study of mind and behaviour. It is both a **social** and a **biological** science.

- As a **social science**, psychology examines the social nature of human beings and the influence that culture, group membership, and relationships have on individual personality, thought, and behaviour.
- As a **biological science**, psychology seeks to identify the neural basis of human behaviour, both directly, through the study of humans, and indirectly, through the study of other species.

The data of psychology are collected within the psychological laboratory by the use of experimental methods in the study of behaviour, and outside the laboratory by systematic observation of the behaviour of humans and animals. The aim is to formulate general principles of perception, learning, motivation, cognition, and social psychology that are relevant to different aspects of human life. Experimentation, laboratory techniques, observational procedures, measurement, and statistical methods are important tools of the psychologist.

Psychology has many interdisciplinary aspects. The study of psychological problems often involves knowledge drawn from other disciplines such as biology, physiology, linguistics, sociology, philosophy, and mathematics. For this reason, a student with varied interests can frequently find a place for these in psychology.

Psychology is a young science, so explanations of the processes underlying observed phenomena are often theoretical and speculative. The major objectives of psychological study are to reduce the discrepancy between theory and fact and to provide better answers about why humans think and behave as they do.

#### Undergraduate Studies

Although a number of undergraduate courses in psychology have applied implications, applied training is not the purpose of the undergraduate curriculum. Its purpose is to introduce the student to an understanding of the basic core of psychological knowledge, theory, and method, regardless of questions of practical application.

The B.Sc. or B.A. with a **Major** or **Honours** degree in psychology is not a professional qualification; it does not qualify the individual to carry on professional work in psychology. In the province of Quebec, the minimum requirement for membership in the Order of Psychologists, the professional association governing the work of psychologists in the province, is a doctoral degree. However, the Order also has a number of undergraduate course requirements that you should consult in planning your degree if you ultimately hope to apply for membership in the [Order of Psychologists of Quebec](#). All students planning to practise in the province of Quebec will also be examined on their proficiency in French before being admitted to the professional association. Undergraduate courses in psychology may prove of considerable value to students planning careers in professional fields other than psychology. These include, but are not restricted to, medicine, education, social work, human communication sciences, and business and industry.

The essential differences between the Honours and the Major program are an emphasis on research methodology courses and practice in the Honours program, and that higher academic standards are required of Honours students. Honours students also have an opportunity to work in small groups closely with staff members.

#### Graduate Studies

Students who are interested in psychology as a career must pursue graduate studies. Persons who hold graduate degrees in Psychology, usually the Ph.D., may find employment in universities, research institutes, hospitals, community agencies, government departments, large corporations, or may act as self-employed consultants. At the graduate level, psychology has many specialized branches including social psychology, physiological psychology, experimental psychology, clinical psychology, child psychology, industrial psychology, community psychology, educational psychology, and others.

Requirements for admission to graduate studies in Psychology vary from one university to another and from one country to another. Nonetheless, both the Honours and Major degrees in Psychology may qualify the student for admission to many graduate schools, provided that sufficiently high grades are obtained and, in some cases, that research experience has been obtained. During the U2 year, undergraduate students are strongly advised to verify the admission requirements of various graduate programs. This is to ensure that sufficient time is available for students to complete all necessary requirements for admission to their preferred graduate programs.

### 13.33.3 Information Meetings for New Students

All new students entering the Psychology undergraduate program should attend an information meeting prior to registration. Newly admitted students from CEGEPs should attend the information session in June. There will be an identical information session in August for all other students and for any CEGEP students who could not attend the earlier meeting. Please check the [Psychology Department website](#) for the specific dates. Students accepted into a Bachelor of Arts program must attend a different information meeting from the one offered to students in the Faculty of Science. (For details, see [Faculty of Arts > Undergraduate > Browse Academic Units & Programs > : Psychology \(PSYC\)](#)). At this meeting, Paola Carvajal, 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 can make appointments for individual advising sessions.

Entering students can bring a copy of their collegial transcript(s). They will also need access to this [eCalendar](#) and a preliminary Class Schedule before their individual advising session.

Students entering the Psychology program in January are strongly encouraged to visit the Academic Adviser, Paola Carvajal, in early December to clarify their course selections.

### 13.33.4 Admission Requirements to the Bachelor of Science (B.Sc.) – Honours Psychology

Applications are available on the Psychology Department's website at [www.mcgill.ca/psychology/undergraduate/current-students/research-opportunities/research-courses](http://www.mcgill.ca/psychology/undergraduate/current-students/research-opportunities/research-courses). The deadline is specified on the application form. Candidates will be advised of the Department's decision via email before classes begin in September.

Students should note that awarding of the Honours degree will depend on the criteria listed below.

**Honours** is awarded to students with a minimum CGPA of 3.00, a minimum program GPA of 3.00, and a minimum grade of B in the required Honours courses, namely PSYC 380D1/PSYC 380D2 and PSYC 482. Moreover, the awarding of the Honours degree normally requires completion of two full years of study, U2 and U3, in the Honours program. Students with particularly strong academic records may be admitted for the U3 year only on the basis of their marks and research experience. These students must complete all Honours program requirements.

**First Class Honours** is awarded to students who obtain a minimum CGPA of 3.50, a minimum program GPA of 3.50, and a minimum grade of A- in the required Honours courses, namely PSYC 380D1/PSYC 380D2 and PSYC 482.

For more information, see [section 13.33.9: Bachelor of Science \(B.Sc.\) - Honours Psychology \(60 credits\)](#).

### 13.33.5 Psychology Faculty

#### Chair

J. Lydon

#### Graduate Program Director

D. Titone

#### Clinical Program Director

B. Ditto

#### Undergraduate Program Director

G. O'Driscoll

#### Emeritus Professors

F.E. Aboud; B.A.(Tor.), M.A., Ph.D.(McG.)

A.S. Bregman; M.A.(Tor.), Ph.D.(Yale)

D. Donderi; B.A., B.Sc.(Chic.), Ph.D.(Cornell)

K.B.J. Franklin; B.A., M.A.(Auck.), Ph.D.(Lond.)

F.H. Genesee; B.A.(W. Ont.), M.A., Ph.D.(McG.)

D.J. Levitin; A.B.(Stan.), M.S., Ph.D.(Ore.) (James McGill Professor )

A.A.J. Marley; B.Sc.(Birm.), Ph.D.(Penn.)

R. Melzack; B.Sc., M.Sc., Ph.D.(McG.) (*E.P. Taylor Emeritus Professor of Psychology*)

P. Milner; B.Sc.(Leeds), M.Sc., Ph.D.(McG.)

D.S. Moskowitz; B.S.(Kirkland), M.A., Ph.D.(Conn.)

Y. Oshima-Takane; B.A.(Tokyo Women's Christian Univ.), M.A.(Tokyo), Ph.D.(McG.)

**Emeritus Professors**

R.O. Pihl; B.A.(Lawrence), Ph.D.(Ariz.)  
 J.O. Ramsay; B.Ed.(Alta.), Ph.D.(Princ.)  
 B. Sherwin; B.A., M.A., Ph.D.(C'dia) (*Canada Research Chair in Hormones, Brain and Cognition*)  
 Y. Takane; B.L., M.A.(Tokyo), Ph.D.(N. Carolina)  
 D.M. Taylor; M.A., Ph.D.(W. Ont.)  
 N. White; B.A.(McG.), M.A., Ph.D.(Pitt.)

**Retired**

Andrew G. Baker; B.A.(Br. Col.), M.A., Ph.D.(Dal.)  
 M.J. Mendelson; B.Sc.(McG.), M.A., Ph.D.(Harv.)

**Professors**

M. Baldwin; B.A.(Tor.), M.A., Ph.D.(Wat.)  
 I.M. Binik; B.A.(NYU), M.A., Ph.D.(Penn.)  
 B. Ditto; B.S.(Iowa), Ph.D.(Ind.)  
 B. Knauper; D.Phil.(Mannheim)  
 R. Koestner; B.A., Ph.D.(Roch.)  
 H. Hwang; B.A.(Chung-Ang), Ph.D.(McG.)  
 D.J. Levitin; A.B.(Stan.), M.S., Ph.D.(Ore.) (*James McGill Professor*)  
 J. Lydon; B.A.(Notre Dame), M.A., Ph.D.(Wat.)  
 J. Mogil; B.Sc.(Tor.), Ph.D.(Calif.-LA) (*E.P. Taylor Professor of Psychology*) (*Canada Research Chair in Genetics of Pain*)  
 K. Nader; B.Sc., Ph.D.(Tor.) (*James McGill Professor*)  
 D.J. Ostry; B.A.Sc., M.A.Sc., Ph.D.(Tor.)  
 C. Palmer; B.Sc.(Mich.), M.Sc.(Rutg.), Ph.D.(Cornell) (*Canada Research Chair in Cognitive Neuropsychology Performance*)  
 M. Petrides; B.Sc., M.Sc.(Lond.), Ph.D.(Cant.)  
 T.R. Shultz; B.A.(Minn.), Ph.D.(Yale)  
 M. Sullivan; B.A.(McG.), M.A., Ph.D.(C'dia)  
 D. Titone; B.A.(NYU), M.A., Ph.D.(SUNY, Binghamton)  
 D.C. Zuroff; B.A.(Harv.), M.A., Ph.D.(Conn.)

**Associate Professors**

J. Bartz; B.A.(C'dia), M.A., Ph.D.(McG.)  
 M. Dirks; B.A.(McM.), M.S., M.Phil., Ph.D.(Yale)  
 G. O'Driscoll; B.A.(Welles.), Ph.D.(Harv.) (*William Dawson Scholar*)  
 K. Onishi; B.A.(Brown), M.A., Ph.D.(Ill.)  
 J. Ristic; B.A., M.A., Ph.D.(Br. Col.) (*William Dawson Scholar*)

**Assistant Professors**

R. Bagot; B.Sc.(S. Wales), Ph.D.(McG.)  
 J. Britt; B.A.(Colo.), Ph.D.(Balt.)  
 C. Falk; B.Sc.(Wisc.), M.A., Ph.D.(Br. Col.)  
 J. Flake; B.Sc.(NKU), M.A.(JMU), Ph.D.(Conn.)  
 O. Hardt; B.Sc., M.Sc.(Trier), Ph.D.(Ariz.)  
 E. Hehman; B.A.(Mass.), Ph.D.(Delaware)

**Assistant Professors**

L. Human; B.A., M.A., Ph.D.(Br. Col.)  
 R. Otto; B.Sc.(Calif.), Ph.D.(Texas)  
 S. Racine; B.Sc.(McG.), M.A., Ph.D.(Mich. St.)  
 M. Roy; B.Sc., Ph.D.(Montr.)  
 S. Sheldon; B.Sc.(Alta.), M.A., Ph.D.(Tor.)  
 D. Vachon; B.Sc.(Tor.), M.Sc., Ph.D.(Purd.)  
 A. Weinberg; B.A.(Wesl.), M.A., Ph.D.,(Stony Brook) (*Canada Research Chair*)

**Lecturer**

P. Carvajal

**Professionals**

Rhonda Amsel; B.Sc., M.Sc.(McG.) (*Associate*)  
 Ian F. Bradley; B.Sc., M.Sc.(Tor.), Ph.D.(Wat.) (*Assistant*)  
 Judith LeGallais; B.A., M.A., Ph.D.(McG.) (*Faculty Lecturer*)  
 Jennifer Russell; B.A., Ph.D.(McG.) (*Assistant*)

**Associate Members**

*Anesthesia*: T. Coderre  
*Douglas Mental Health University Institute Research Centre*: S. King, N. Rajah, H. Steiger  
*Jewish General Hospital*: B Thombs, P. Zelkowitz  
*McGill Vision Research Centre*: C. Baker, R. Hess, F.A.A. Kingdom, K. Mullen  
*Montreal Neurological Institute and Hospital*: J. Armony, A. Dagher, L.K. Fellows, D. Guitton, M. Jones-Gotman, M. Lepage, B. Milner, E. Ruthazer, W. Sossin, V. Sziklas, R. Zatorre  
*Schulich School of Music*: S. MacAdams  
*Psychiatry*: D. Dunkley, F. Elgar, M. Leyton

**Adjunct Professors**

M. Bruck, Y. Chudasama, P. Delisle, S. Harnad, D.J. Levitin, Z. Pleszewski, H.-T. Yu, P. Zelazo

**13.33.6 Bachelor of Science (B.Sc.) - Minor Psychology (24 credits)**

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.

A separate minor concentration exists for students registered in a program in the Faculty of Arts.

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 PSYC 204 or equivalent.

**Complementary Courses (24 credits)**

at least 3, but no more than 6, credits selected from:

PSYC 211	(3)	Introductory Behavioural Neuroscience
PSYC 212	(3)	Perception
PSYC 213	(3)	Cognition
PSYC 215	(3)	Social Psychology

18-21 credits selected from Psychology courses at the 300 level or above.

**13.33.7 Bachelor of Science (B.Sc.) - Liberal Program - Core Science Component Psychology (45 credits)**

This Core Science Component Psychology requires the completion of 45 credits in Psychology, all of which need to be passed with a minimum grade of C. A prerequisite to the program is PSYC 100 or equivalent. Students completing a Liberal Program with a Core Science Component Psychology must also complete at least one breadth component in a second area.

**Recommended Background**

It is expected that most students who enter the Liberal 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 or equivalent; Biology CEGEP objective 00UK, 00XU or equivalent; and Statistics (Mathematics) 201-307 or 201-337 or equivalent. Students must obtain a minimum grade of 75% in their CEGEP-level statistics course to be exempt from PSYC 204. In the first year, those students who have not taken the recommended collegial-level statistics course, or those who have obtained a grade below 75%, must take Psychology PSYC 204. Those who have not taken Introductory Psychology in CEGEP must take PSYC 100.

**Required Course (3 credits)**

PSYC 204	(3)	Introduction to Psychological Statistics
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**Complementary Courses (42 credits)**

9 credits from:

PSYC 211	(3)	Introductory Behavioural Neuroscience
PSYC 212	(3)	Perception
PSYC 213	(3)	Cognition
PSYC 215	(3)	Social Psychology

**List A**

6 credits in Psychology from List A (Behavioural Neuroscience, Cognition and Quantitative Methods).

NSCI 201	(3)	Introduction to Neuroscience 2
PSYC 301	(3)	Animal Learning and Theory
PSYC 302	(3)	The Psychology of Pain
PSYC 310	(3)	Intelligence
PSYC 311	(3)	Human Cognition and the Brain
PSYC 315	(3)	Computational Psychology
PSYC 317	(3)	Genes and Behaviour
PSYC 318	(3)	Behavioural Neuroscience 2
PSYC 329	(3)	Introduction to Auditory Cognition
PSYC 340	(3)	Psychology of Language
PSYC 341	(3)	The Psychology of Bilingualism
PSYC 342	(3)	Hormones and Behaviour
PSYC 352	(3)	Cognitive Psychology Laboratory
PSYC 403	(3)	Modern Psychology in Historical Perspective
PSYC 406	(3)	Psychological Tests
PSYC 410	(3)	Special Topics in Neuropsychology
PSYC 413	(3)	Cognitive Development
PSYC 427	(3)	Sensorimotor Neuroscience
PSYC 433	(3)	Cognitive Science
PSYC 444	(3)	Sleep Mechanisms and Behaviour

PSYC 451	(3)	Human Factors Research and Techniques
PSYC 470	(3)	Memory and Brain
PSYC 501	(3)	Auditory Perception
PSYC 502	(3)	Psychoneuroendocrinology
PSYC 506	(3)	Cognitive Neuroscience of Attention
PSYC 513	(3)	Human Decision-Making
PSYC 514	(3)	Neurobiology of Learning and Memory
PSYC 522	(3)	Neurochemistry and Behaviour
PSYC 526	(3)	Advances in Visual Perception
PSYC 529	(3)	Music Cognition
PSYC 531	(3)	Structural Equation Models
PSYC 536	(3)	Correlational Techniques
PSYC 537	(3)	Advanced Seminar in Psychology of Language
PSYC 538	(3)	Categorization, Communication and Consciousness
PSYC 541	(3)	Multilevel Modelling
PSYC 545	(3)	Topics in Language Acquisition
PSYC 561	(3)	Methods: Developmental Psycholinguistics
PSYC 562	(3)	Measurement of Psychological Processes

**List B**

6 credits in Psychology from List B (Social, Health, and Developmental Psychology).

PSYC 304	(3)	Child Development
PSYC 316	(3)	Psychology of Deafness
PSYC 328	(3)	Health Psychology
PSYC 331	(3)	Inter-Group Relations
PSYC 332	(3)	Introduction to Personality
PSYC 333	(3)	Personality and Social Psychology
PSYC 337	(3)	Introduction to Psychopathology
PSYC 351	(3)	Research Methods in Social Psychology
PSYC 408	(3)	Principles of Cognitive Behaviour Therapy
PSYC 409	(3)	Positive Psychology
PSYC 412	(3)	Developmental Psychopathology
PSYC 414	(3)	Social Development
PSYC 436	(3)	Human Sexuality and Its Problems
PSYC 471	(3)	Human Motivation
PSYC 473	(3)	Social Cognition and the Self
PSYC 474	(3)	Interpersonal Relationships
PSYC 475	(3)	Neuroscience of Social Psychology
PSYC 483	(3)	Seminar in Experimental Psychopathology
PSYC 491D1	(3)	Advanced Study: Behavioural Disorders
PSYC 491D2	(3)	Advanced Study: Behavioural Disorders
PSYC 507	(3)	Emotions, Stress, and Illness
PSYC 509	(3)	Diverse Clinical Populations

PSYC 512	(3)	Advanced Personality Seminar
PSYC 528	(3)	Vulnerability to Depression and Anxiety
PSYC 530	(3)	Applied Topics in Deafness
PSYC 533	(3)	International Health Psychology
PSYC 535	(3)	Advanced Topics in Social Psychology

15 credits in Psychology at the 300 level or above.

6 credits in Psychology at the 400 or 500 level.

### 13.33.8 Bachelor of Science (B.Sc.) - Major Psychology (54 credits)

Students majoring in Psychology must obtain a minimum grade of C in all 54 credits of the program. A grade lower than C may be made up by taking another equivalent course (if there is one), by successfully repeating the course, or by successfully writing a supplemental examination (if there is one).

#### Recommended Background

It is expected that most students who enter the Major 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 or equivalent; Biology CEGEP objective 00UK, 00XU or equivalent; and Statistics (Mathematics) 201-307 or 201-337 or equivalent. Students must obtain a minimum grade of 75% in their CEGEP-level statistics course. In the first year those students who have not taken the recommended collegial-level statistics course, or those who have obtained a grade below 75%, must take Psychology PSYC 204. Those who have not taken the recommended collegial-level biology must take BIOL 111 or BIOL 112, and those who have not taken Introductory Psychology in college must take PSYC 100.

#### U1 Required Courses (12 credits)

Note: PSYC 100 may be taken as a corequisite with these basic courses.

PSYC 211	(3)	Introductory Behavioural Neuroscience
PSYC 212	(3)	Perception
PSYC 213	(3)	Cognition
PSYC 215	(3)	Social Psychology

#### U1 or U2 Required Course (3 credits)

PSYC 305	(3)	Statistics for Experimental Design
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#### Complementary Courses (39 credits)

##### List A

6 credits in Psychology from List A (Behavioural Neuroscience, Cognition and Quantitative Methods).

NSCI 201	(3)	Introduction to Neuroscience 2
PSYC 301	(3)	Animal Learning and Theory
PSYC 302	(3)	The Psychology of Pain
PSYC 310	(3)	Intelligence
PSYC 311	(3)	Human Cognition and the Brain
PSYC 315	(3)	Computational Psychology
PSYC 317	(3)	Genes and Behaviour
PSYC 318	(3)	Behavioural Neuroscience 2
PSYC 329	(3)	Introduction to Auditory Cognition
PSYC 340	(3)	Psychology of Language



PSYC 341	(3)	The Psychology of Bilingualism
PSYC 342	(3)	Hormones and Behaviour
PSYC 352	(3)	Cognitive Psychology Laboratory
PSYC 403	(3)	Modern Psychology in Historical Perspective
PSYC 406	(3)	Psychological Tests
PSYC 410	(3)	Special Topics in Neuropsychology
PSYC 413	(3)	Cognitive Development
PSYC 427	(3)	Sensorimotor Neuroscience
PSYC 433	(3)	Cognitive Science
PSYC 444	(3)	Sleep Mechanisms and Behaviour
PSYC 451	(3)	Human Factors Research and Techniques
PSYC 470	(3)	Memory and Brain
PSYC 501	(3)	Auditory Perception
PSYC 502	(3)	Psychoneuroendocrinology
PSYC 506	(3)	Cognitive Neuroscience of Attention
PSYC 513	(3)	Human Decision-Making
PSYC 514	(3)	Neurobiology of Learning and Memory
PSYC 522	(3)	Neurochemistry and Behaviour
PSYC 526	(3)	Advances in Visual Perception
PSYC 529	(3)	Music Cognition
PSYC 531	(3)	Structural Equation Models
PSYC 536	(3)	Correlational Techniques
PSYC 537	(3)	Advanced Seminar in Psychology of Language
PSYC 538	(3)	Categorization, Communication and Consciousness
PSYC 541	(3)	Multilevel Modelling
PSYC 545	(3)	Topics in Language Acquisition
PSYC 561	(3)	Methods: Developmental Psycholinguistics
PSYC 562	(3)	Measurement of Psychological Processes

**List B**

6 credits in Psychology from List B (Social, Health, and Developmental Psychology).

PSYC 304	(3)	Child Development
PSYC 316	(3)	Psychology of Deafness
PSYC 328	(3)	Health Psychology
PSYC 331	(3)	Inter-Group Relations
PSYC 332	(3)	Introduction to Personality
PSYC 333	(3)	Personality and Social Psychology
PSYC 337	(3)	Introduction to Psychopathology
PSYC 351	(3)	Research Methods in Social Psychology
PSYC 408	(3)	Principles of Cognitive Behaviour Therapy
PSYC 409	(3)	Positive Psychology
PSYC 412	(3)	Developmental Psychopathology
PSYC 414	(3)	Social Development

PSYC 436	(3)	Human Sexuality and Its Problems
PSYC 471	(3)	Human Motivation
PSYC 473	(3)	Social Cognition and the Self
PSYC 474	(3)	Interpersonal Relationships
PSYC 483	(3)	Seminar in Experimental Psychopathology
PSYC 491D1	(3)	Advanced Study: Behavioural Disorders
PSYC 491D2	(3)	Advanced Study: Behavioural Disorders
PSYC 507	(3)	Emotions, Stress, and Illness
PSYC 509	(3)	Diverse Clinical Populations
PSYC 512	(3)	Advanced Personality Seminar
PSYC 528	(3)	Vulnerability to Depression and Anxiety
PSYC 530	(3)	Applied Topics in Deafness
PSYC 533	(3)	International Health Psychology
PSYC 535	(3)	Advanced Topics in Social Psychology

6 credits at the 300 level or above.

9 credits in Psychology at the 400 or 500 level.

12 credits at the 300 level or above in any of the following disciplines: Psychology (PSYC), Anatomy and Cell Biology (ANAT), Biology (BIOL), Biochemistry (BIOC), Chemistry (CHEM), Computer Science (COMP), Mathematics (MATH), Physiology (PHGY), Psychiatry (PSYT).

### 13.33.9 Bachelor of Science (B.Sc.) - Honours Psychology (60 credits)

Honours in Psychology prepares students for graduate study, and so emphasizes practise in the research techniques which are used in graduate school and professionally later on. Students are normally accepted into Honours at the beginning of their U2 year, and the two-year sequence of Honours courses continues through U3.

#### Recommended Background

It is expected that most students who enter the Honours 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 or equivalent; Biology CEGEP objective 00UK, 00XU or equivalent; and Statistics (Mathematics) 201-307 or 201-337 or equivalent. Students must obtain a minimum grade of 75% in their CEGEP-level statistics course. In the first year, those students who have not taken the recommended collegial-level statistics course, or those who have obtained a grade below 75%, must take Psychology PSYC 204. Those who have not taken the recommended collegial-level biology must take BIOL 111 or BIOL 112, and those who have not taken Introductory Psychology in CEGEP must take PSYC 100.

The application is available on the Psychology Dept website at:

<http://www.mcgill.ca/psychology/undergraduate/current-students/research-opportunities/research-courses>. The deadline is specified on the application form. Candidates will be informed of the Department's decision via email before classes begin in September.

#### Program Prerequisites

Admission to Honours is selective. Students with a cumulative grade point average (CGPA) of 3.00 or better are eligible to apply; however, since enrolment is limited, the usual CGPA for admission to this program is 3.50. Students must complete 27 graded credits in their U1 academic year to be eligible to apply to the Honours program.

Students must complete the following courses in their U1 year to be eligible to apply to the Honours program: PSYC 204, PSYC 211, PSYC 212, PSYC 213, and PSYC 215. Students are advised to complete PSYC 305 in their U1 year. Once in the Honours program, the student must obtain a GPA of 3.00 in the U2 year in order to continue in the program for U3. Honours students are encouraged to take at least 27 graded credits per academic year. This is also usually the minimum number of credits required to be eligible for fellowships and awards.

#### U1 Required Courses (12 credits)

Note: PSYC 100 may be taken as a corequisite with these basic courses.

PSYC 211	(3)	Introductory Behavioural Neuroscience
PSYC 212	(3)	Perception

PSYC 213	(3)	Cognition
PSYC 215	(3)	Social Psychology

**U1 or U2 Required Course (3 credits)**

PSYC 305	(3)	Statistics for Experimental Design
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**U2 Required Courses (9 credits)**

PSYC 380D1	(4.5)	Honours Research Project Seminar
PSYC 380D2	(4.5)	Honours Research Project Seminar

**U3 Required Course (3 credits)**

PSYC 482	(3)	Advanced Honours Seminar
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**Complementary Courses (33 credits)**

12 credits to be selected from the list below and any Psychology course at the 500 level.

PSYC 403	(3)	Modern Psychology in Historical Perspective
PSYC 483	(3)	Seminar in Experimental Psychopathology
PSYC 495	(6)	Psychology Research Project 2
PSYC 496	(6)	Senior Honours Research 1
PSYC 497	(6)	Senior Honours Research 2
PSYC 498D1	(4.5)	Senior Honours Research
PSYC 498D2	(4.5)	Senior Honours Research

**List A**

6 credits in Psychology from List A (Behavioural Neuroscience, Cognition, and Quantitative Methods).

NSCI 201	(3)	Introduction to Neuroscience 2
PSYC 301	(3)	Animal Learning and Theory
PSYC 302	(3)	The Psychology of Pain
PSYC 310	(3)	Intelligence
PSYC 311	(3)	Human Cognition and the Brain
PSYC 315	(3)	Computational Psychology
PSYC 317	(3)	Genes and Behaviour
PSYC 318	(3)	Behavioural Neuroscience 2
PSYC 329	(3)	Introduction to Auditory Cognition
PSYC 340	(3)	Psychology of Language
PSYC 341	(3)	The Psychology of Bilingualism
PSYC 342	(3)	Hormones and Behaviour
PSYC 352	(3)	Cognitive Psychology Laboratory
PSYC 403	(3)	Modern Psychology in Historical Perspective
PSYC 406	(3)	Psychological Tests
PSYC 410	(3)	Special Topics in Neuropsychology

PSYC 413	(3)	Cognitive Development
PSYC 427	(3)	Sensorimotor Neuroscience
PSYC 433	(3)	Cognitive Science
PSYC 444	(3)	Sleep Mechanisms and Behaviour
PSYC 451	(3)	Human Factors Research and Techniques
PSYC 470	(3)	Memory and Brain
PSYC 501	(3)	Auditory Perception
PSYC 502	(3)	Psychoneuroendocrinology
PSYC 506	(3)	Cognitive Neuroscience of Attention
PSYC 513	(3)	Human Decision-Making
PSYC 514	(3)	Neurobiology of Learning and Memory
PSYC 522	(3)	Neurochemistry and Behaviour
PSYC 526	(3)	Advances in Visual Perception
PSYC 529	(3)	Music Cognition
PSYC 531	(3)	Structural Equation Models
PSYC 536	(3)	Correlational Techniques
PSYC 537	(3)	Advanced Seminar in Psychology of Language
PSYC 538	(3)	Categorization, Communication and Consciousness
PSYC 541	(3)	Multilevel Modelling
PSYC 545	(3)	Topics in Language Acquisition
PSYC 561	(3)	Methods: Developmental Psycholinguistics
PSYC 562	(3)	Measurement of Psychological Processes

**List B**

6 credits in Psychology from List B (Social, Health, and Developmental Psychology)

PSYC 304	(3)	Child Development
PSYC 316	(3)	Psychology of Deafness
PSYC 328	(3)	Health Psychology
PSYC 331	(3)	Inter-Group Relations
PSYC 332	(3)	Introduction to Personality
PSYC 333	(3)	Personality and Social Psychology
PSYC 337	(3)	Introduction to Psychopathology
PSYC 351	(3)	Research Methods in Social Psychology
PSYC 408	(3)	Principles of Cognitive Behaviour Therapy
PSYC 409	(3)	Positive Psychology
PSYC 412	(3)	Developmental Psychopathology
PSYC 414	(3)	Social Development
PSYC 436	(3)	Human Sexuality and Its Problems
PSYC 471	(3)	Human Motivation
PSYC 473	(3)	Social Cognition and the Self
PSYC 474	(3)	Interpersonal Relationships
PSYC 475	(3)	Neuroscience of Social Psychology
PSYC 483	(3)	Seminar in Experimental Psychopathology

PSYC 491D1	(3)	Advanced Study: Behavioural Disorders
PSYC 491D2	(3)	Advanced Study: Behavioural Disorders
PSYC 507	(3)	Emotions, Stress, and Illness
PSYC 509	(3)	Diverse Clinical Populations
PSYC 512	(3)	Advanced Personality Seminar
PSYC 528	(3)	Vulnerability to Depression and Anxiety
PSYC 530	(3)	Applied Topics in Deafness
PSYC 533	(3)	International Health Psychology
PSYC 535	(3)	Advanced Topics in Social Psychology

9 credits at the 300 level or above selected from:

Anatomy and Cell Biology (ANAT), Biochemistry (BIOC), Biology (BIOL), Chemistry (CHEM), Computer Science (COMP), Mathematics (MATH), Physiology (PHGY), Psychiatry (PYST), Psychology (PSYC).

### 13.34 Redpath Museum (REDM)

#### 13.34.1 Location

Redpath Museum  
859 Sherbrooke Street West  
Montreal QC H3A 0C4  
Telephone: 514-398-4086 ext. 3188  
Fax: 514-398-3185  
Email: [redpath.museum@mcgill.ca](mailto:redpath.museum@mcgill.ca)  
Website: [www.mcgill.ca/redpath](http://www.mcgill.ca/redpath)

#### 13.34.2 About the Redpath Museum

The Redpath Museum fosters the study of the history and diversity of the natural world. Its mandate includes biological, geological, and cultural diversity, and science education. It conducts academic teaching and research activities and also provides academic services to other units. The Redpath Museum offers a B.Sc. **Minor** program in Natural History. REDM courses listed below are considered as ones taught by the Faculty of Science.

##### Redpath Museum Courses

REDM 396	Undergraduate Research Project
REDM 400	Science and Museums
REDM 405	Natural History of East Africa
REDM 511	Advanced Museum-Based Science

#### 13.34.3 Redpath Museum Faculty

##### Director

Hans C.E. Larsson

##### Emeritus Professor

Robert L. Carroll; B.Sc.(Mich.), Ph.D.(Harv.), F.R.S.C., F.L.S.

##### Professors

David M. Green; B.Sc.(Br. Col.), M.Sc., Ph.D.(Guelph), F.L.S.

Andrew Hendry; B.Sc.(Vic., BC), M.Sc., Ph.D.(Wash.) (*joint appt. with Biology*)

**Professors**

Anthony Ricciardi; B.Sc.(Agr.), M.Sc., Ph.D.(McG.) (*joint appt. with McGill School of Environment*)

**Associate Professors**

Hans C.E. Larsson; B.Sc.(McG.), Ph.D.(Chic.)

Virginie Millien; Maîtrise(Paris VI), DEA, Ph.D.(Montpellier II)

**Assistant Professor**

Rowan Barrett; B.Sc.(Guelph), M.Sc.(McG.), Ph.D.(Br. Col.) (*CRC Tier 2 Chair in Biodiversity Science*)

**Associate Members**

*Biology:* Graham A.C. Bell, Lauren Chapman

*Chemistry:* David N. Harpp (*Tomlinson Chair in University Science Teaching*)

*Earth & Planetary Sciences:* Jeanne Paquette

*McGill School of Environment:* Colin Chapman

**Adjunct Professors**

Robert Holmes, Henry M. Reiswig, Michael Woloch

**13.34.4 Bachelor of Science (B.Sc.) - Minor Natural History (24 credits)**

The Minor Natural History involves the exploration of the natural world via specimen-based studies, object-oriented investigations and field studies. Museum collections are used to provide hands-on experience with real objects and specimens. The required course brings students to the Redpath Museum and other McGill natural science museums and exposes them to natural history methodologies and the value of specimen-based studies. Complementary course lists are drawn from a variety of disciplines to emphasize breadth and integration with the inclusion of specimen- or object-based courses and field courses in zoology, botany, and earth and environmental sciences. To ensure breadth, students are required to choose courses from among these lists. A compulsory field course component rounds out the program.

**Required Course (3 credits)**

REDM 400	(3)	Science and Museums
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**Complementary Courses (21 credits)**

Students select 21 credits from among four course lists (A (Zoology), B (Botany), C (Earth and Environmental Sciences), and D (Field Courses)) with the following specifications.

- At least 3 credits and no more than 9 credits from each of Lists A, B, and C.
- At least 3 credits from List D.
- No more than 3 credits from any one list may be at the 200 level.

Note: Students may take up to a maximum of 9 credits of courses outside the Faculties of Arts and of Science.

**List A: Zoology**

\* Note: BIOL 205 and BIOL 215 may be applied to either List A or List B.

\*\* Note: Students may take either ENTO 330 or one of the cross-listed courses BIOL 350 and ENTO 350 as these courses have similar content.

AEBI 211	(3)	Organisms 2
ANTH 312	(3)	Zooarchaeology
BIOL 205*	(3)	Biology of Organisms
BIOL 215*	(3)	Introduction to Ecology and Evolution
BIOL 305	(3)	Animal Diversity
BIOL 350**	(3)	Insect Biology and Control
BIOL 352	(3)	Dinosaur Biology

BIOL 418	(3)	Freshwater Invertebrate Ecology
BIOL 427	(3)	Herpetology
BIOL 463	(3)	Mammalian Evolution
ENTO 330**	(3)	Insect Biology
ENTO 350**	(3)	Insect Biology and Control
ENTO 440	(3)	Insect Diversity
ENTO 535	(3)	Aquatic Entomology
EPSC 334	(3)	Invertebrate Paleontology
WILD 307	(3)	Natural History of Vertebrates
WILD 350	(3)	Mammalogy
WILD 420	(3)	Ornithology

**List B: Botany**

\* Note: BIOL 205 and BIOL 215 may be applied to either List A or List B.

AEBI 210	(3)	Organisms 1
BIOL 205*	(3)	Biology of Organisms
BIOL 215*	(3)	Introduction to Ecology and Evolution
BIOL 240	(3)	Monteregian Flora
BIOL 355	(3)	Trees: Ecology & Evolution
PLNT 304	(3)	Biology of Fungi
PLNT 353	(3)	Plant Structure and Function
PLNT 358	(3)	Flowering Plant Diversity
PLNT 460	(3)	Plant Ecology

**List C: Earth and Environmental Sciences**

BIOL 540	(3)	Ecology of Species Invasions
ENVR 200	(3)	The Global Environment
ENVR 202	(3)	The Evolving Earth
EPSC 210	(3)	Introductory Mineralogy
EPSC 233	(3)	Earth and Life History
ESYS 200	(3)	Earth System Processes
ESYS 300	(3)	Investigating the Earth System
GEOG 203	(3)	Environmental Systems
GEOG 272	(3)	Earth's Changing Surface
GEOG 470	(3)	Wetlands
GEOG 550	(3)	Historical Ecology Techniques

**List D: Field Studies**

\* Note: Students may take either of the cross-listed courses NRSC 405 and REDM 405, but not both.

Students may also take other field courses with the permission of the Program Adviser.

BIOL 331	(3)	Ecology/Behaviour Field Course
BIOL 334	(3)	Applied Tropical Ecology

BIOL 335	(3)	Marine Mammals
BIOL 573	(3)	Vertebrate Palaeontology Field Course
ENTO 340	(3)	Field Entomology
EPSC 231	(3)	Field School 1
NRSC 405*	(3)	Natural History of East Africa
REDM 405*	(3)	Natural History of East Africa
WILD 475	(3)	Desert Ecology

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### 13.35 Science or Mathematics for Teachers

#### 13.35.1 Location

Dawson Hall, Room 405  
853 Sherbrooke Street West  
Montreal QC H3A 0G5  
Email: [pete.barry@mcgill.ca](mailto:pete.barry@mcgill.ca)  
Website: [www.mcgill.ca/scienceforteachers](http://www.mcgill.ca/scienceforteachers)

#### 13.35.2 About Science or Mathematics for Teachers



**Note:** The Concurrent B.Sc. and B.Ed. degree has been retired effective 2018.

The training and certification of school teachers has traditionally been the responsibility of the Faculty of Education and requires the completion of a Bachelor of Education, subject to regulations set by the Government of Quebec. The Faculties of Education and of Science offer the **Minor** in Education for Science Students for students in the B.Sc. who wish to combine Science or Mathematics with Education at McGill. The **Minor** allows Science students to develop or explore an interest in Education without committing themselves to completing a B.Ed. degree. Science students who have taken this Minor will have completed some of the necessary credits for the B.Ed. degree should they wish to enrol in that program. For details, see [section 13.35.4: Bachelor of Science \(B.Sc.\) - Minor Education for Science Students \(18 credits\)](#).

The traditional **Bachelor of Education**, Secondary Program, Science and Technology, or Secondary Program, Mathematics is available within the Faculty of Education; see [Faculty of Education > Undergraduate > Browse Academic Units & Programs > Department of Integrated Studies in Education > : Overview of Programs \(Integrated Studies in Education\)](#). Additionally, the **Master of Arts in Teaching and Learning** (MATL) is available in the Faculty of Education (see [Faculty of Education > Graduate > Browse Academic Units & Programs > : Integrated Studies in Education](#)).

#### 13.35.3 Science or Mathematics for Teachers Faculty

##### Concurrent B.Sc. and B.Ed.

Coordinator, Pete Barry  
Faculty of Science  
Telephone: 514-398-3202

##### Minor in Education for Science Students

Program Adviser, Vanessa Smith  
Faculty of Education  
Telephone: 514-398-7042  
Website: [www.mcgill.ca/isa](http://www.mcgill.ca/isa)

#### 13.35.4 Bachelor of Science (B.Sc.) - Minor Education for Science Students (18 credits)

This Minor allows Science students to develop or explore an interest in Education without committing themselves to completing a B.Ed. degree. Science students who have taken this Minor in Education will have completed some of the credits for the B.Ed. degree should they wish to enrol in that program.



Students graduating with a B.Sc. should also consider the Master of Arts in Teaching and Learning (<http://www.mcgill.ca/dise/grad/>) if they are interested in obtaining a teaching license.

This minor program requires an application due to limited enrolment space. Please see <http://www.mcgill.ca/isa/faculty-advising/minor-programs> for procedures and deadlines.

For more information please contact:

Vanessa Smith

Internships & Student Affairs Office, Faculty of Education

General Information: 514-398-7042

Website: <http://www.mcgill.ca/isa>

### Required Course (3 credits)

EDPE 300	(3)	Educational Psychology
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### Complementary Courses (15 credits)

9 credits selected from:

One of:

EDEC 233	(3)	Indigenous Education
EDEC 248	(3)	Equity and Education
EDEC 249	(3)	Global Education and Social Justice

One of:

EDEC 260	(3)	Philosophical Foundations
EDEC 261	(3)	Philosophy of Catholic Education

One of:

EDEC 247	(3)	Policy Issues in Quebec Education
EDEM 220	(3)	Contemporary Issues in Education

6 credits from the list below:

\* Note: Students select either EDES 335 or EDES 353.

EDEC 262	(3)	Media, Technology and Education
EDES 335*	(3)	Teaching Secondary Science 1
EDES 353*	(3)	Teaching Secondary Mathematics 1
EDPE 304	(3)	Measurement and Evaluation
EDPI 341	(3)	Instruction in Inclusive Schools

