Chemistry

Faculty

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Program Overview

The Chemistry Department offers three distinct programs — Chemistry Honours, Chemistry Major, and Chemistry Minor. Our three chemistry programs provide students with a balanced, rich, and practical education in all sub-disciplines of Chemistry (Analytical, Biochemical, Inorganic, Organic, and Physical) and students graduating with a Chemistry degree from Bishop's University have had an excellent record of being admitted to graduate schools and professional programs (Medicine, Dentistry, Pharmacy, Education, etc.) or in finding employment in their field.

Class sizes in chemistry science courses are small, which promotes close personal interaction between members of the faculty and students. The faculty are also directly involved in all undergraduate laboratories, which enhances personal contact and results in a friendly and very productive learning in experimental chemistry.

The Chemistry Department has an excellent set of modern instruments, such as a Benchtop NMR, a GC/MS, a MP-AES and a HPLC/MS which are used by undergraduates in their laboratory courses and in research projects. This is in contrast to most universities where many instruments are reserved for graduate students. Hands-on, extensive training on this modern instrumentation and equipment greatly benefits our students and ensures that they are very well prepared for graduate studies or future employment.

Humanities requirement

Students must complete six course credits of humanities studies, normally in their first year at Bishop's. Students who have a Québec Collegial Diploma (DEC), students admitted as "Mature Students", and 2nd Bachelor's degree students are all exempt from this requirement. The two Humanities optional courses (6 credits) can be selected from any Humanities courses. It is recommended that at least one of these courses be a writing intensive course (course codes ending by W).

Arts and Science requirement

In addition to the Humanities requirement above, all students are required to complete at least three credits in either the Faculty of Humanities or the Faculty of Social Sciences. Students with program combinations which require more than 72 credits are exempt from this requirement. Please refer to the Natural Sciences Division page for information on Divisional Requirements.

Undergraduate Programs

It is strongly recommended that students enrolled in Department of Chemistry programs follow the order of courses outlined in the tables below. Some Chemistry courses are offered on two-year rotations, so failure to follow the suggested course sequence may result in students not being able to fulfill their degree requirements in the normal time frame.

Table 1. First year of study in the 4-year Chemistry Honours and Major programs

Fall Semester	Winter Semester
CHM 191 and CHL 191	CHM 192 and CHL 192
BIO 196 and BIL 196	PHY 192 and PHL 192
PHY 191 and PHL 191	MAT 192
MAT 191	Humanities Option
Humanities Option	Arts and Science Option

Chemistry Honours (87 credits) HONCHE

The Chemistry Honours program fulfills the academic requirements for membership in the Chemical Institute of Canada and for accreditation by l'Ordre des chimistes du Québec. (For membership in the latter, it is necessary to possess a working knowledge of the French language.) The Chemistry Honours program is a four-year program that prepares a student for graduate studies in chemistry, as well as for direct professional employment. The program requires 20 three-credit one-semester courses, two 3-credit full year course, one 3-credit Chemistry optional course, one 3-credit Science optional course, and a full year, 6-credit research project in the final year, six credits for the Humanities requirement and one 3-credit one-semester course for the Arts and Science Requirement for a total of 87 course credits. In addition, students must also complete the 13 co-requisite lab courses and 33 credits of free electives (including two lecture courses from any of the Sciences). The Chemistry Honours degree program is shown in Table 2.

Entrance Requirements for Honours

To be eligible to enter the third year of the Honours Chemistry program, a student must achieve a minimum average of 70% in the required second year Chemistry courses (and co-requisite labs). To be eligible to enter the final year of the Honours Chemistry program, a student must achieve a minimum average of 70% in the third year required Chemistry courses (and co-requisite labs).

Table 2. Honours Chemistry Program[1]

	Fall Semester	Winter Semester
Year 2	CHM 111 and CHL 111	CHM 211 and CHL 211
	CHM 121[2]	CHM 135 and CHL 135[4]
	CHM 141 and CHL 141	CHM 225 and CHL 225[5]
	BIO 201	BCH 210
	Option[3]	Option[3]
Year 3	CHM 311	Chem. Option[8]
	CHM 350[6]	CHM 350[6]
	Science option[7]	CHM 341 and CHL 341[4]
		CHM 245[5] and CHL 245[5]
	Option[3]	BCH 313 and BCL 313
	Option[3]	Option[3]
Year 4	CHM 471[9]	CHM 471[9]
	CHM 499[10]	CHM 499[10]
	BIO 386[11]	Option[3]
	Option[3]	Option[3]
	Option[3]	Option[3]
		Option[3]

1 *All Chemistry students must take any two Humanities lecture courses in the first year, unless they received advanced credits for them (ELE), and one lecture course from the Humanities or the Social Sciences (Arts and Science requirement). For details, please refer to the Faculty section of the Academic Calendar.*

2 *CHM 121 is offered every other year, so students will take it either in their second or third year depending on the year the students entered the program.*

3 *Chemistry Honours students must take two lecture courses from any of the Sciences. All other options are free electives. If a course has a co-requisite lab then the lab must be taken as well.*

4 *CHM 341/CHL 341 and CHM 135/CHL 135 are offered on a rotating basis, so the order in which they are taken may flip depending on the year the student entered the program.*

5 *CHM 225/CHL 225 and CHM 245/CHL 245 are offered on a rotating basis, so the order in which they are taken may flip depending on the year the student entered the program.*

6 *CHM 350 is a full-year, 3-credit integrative project course.*

7 *Students doing honours are encouraged to take a science option based on the field of their specialization:*

***Physical chemistry:** MAT 108 or PHY 206 or MAT 206*

***Analytical chemistry:** MAT 103 or MAT 310*

***Organic chemistry:** BCH 311 or BIO 208*

***Environment:** MAT 103*

8 *Students registered in the honours program will have to complete a CHM 400 level course in the field of their honours research project as an independent study.*

9 *CHM 471 is a full-year, 3-credit course.*

10 *CHM 499 is a full-year, 6-credit research project.*

11 *Honours students should register in BIO 386 – Scientific writing. Permission from the instructor is required. If denied, this course can be replaced by a free elective.*

Chemistry Major (72 credits) MAJCHE

The Chemistry Major program prepares students for industrial or other employment that requires an extensive knowledge of chemistry. The program has sufficient flexibility to allow students to obtain a second major or a minor in another academic discipline. The program fulfills the academic requirements for membership in the Chemical Institute of Canada and for accreditation by l'Ordre des Chimistes du Québec. (For membership in the latter, it is necessary to possess a working knowledge of the French language.) The four-year Chemistry Major program requires 19 three-credit one-semester courses, two 3-credit full year course, six credits for the Humanities requirement and one 3-credit one-semester course for the Arts and Science Requirement for a total of 72 course credits. In addition, students must complete the 13 co-requisite lab courses and 48 credits of free electives (including six lecture courses from any of the Sciences). The Chemistry Major degree program is shown in Table 3. Students in a minor program in another division may, with permission of the Department, reduce science options to a minimum of 9 credits.

Table 3. Chemistry Major Program[1]

	Fall Semester	Winter Semester
Year 2	CHM 111 and CHL 111	CHM 211 and CHL 211
	CHM 121[2]	CHM 135 and CHL 135[4]
	CHM 141 and CHL 141	CHM 225 and CHL 225[5]
	BIO 201	BCH 210
	Option[3]	Option[3]
Year 3	CHM 311	CHM 245 and CHL 245[5]
	CHM 350[6]	CHM 350[6]
	Option[3]	CHM 341 and CHL 341[4]
	Option[3]	BCH 313 and BCL 313
	Option[3]	Option[3]
	Option[3]	
Year 4	CHM 371[7]	CHM 371[7]
	Option[3]	Option[3]
	Option[3]	Option[3]
	Option[3]	Option[3]
	Option[3]	Option[3]
	Option[3]	

1 *All Chemistry students must take any two Humanities lecture courses in the first year, unless they received advanced credits for them (ELE), and one lecture course from the Humanities or the Social Sciences (Arts and Science requirement). For details, please refer to the Faculty section of the Academic Calendar.*

2 *CHM 121 is offered every other year, so students will take it either in their second or third year depending on the year the students entered the program.*

3 *Chemistry Major students must take six lecture courses from any of the Sciences. All other options are free electives. If a course has a co-requisite lab then the lab must be taken as well.*

4 *CHM 341/CHL 341 and CHM 135/CHL 135 are offered on a rotating basis, so the order in which they are taken may flip depending on the year the student entered the program.*

5 *CHM 225/CHL 225 and CHM 245/CHL 245 are offered on a rotating basis, so the order in which they are taken may flip depending on the year the student entered the program.*

6 *CHM 350 is a full-year, 3-credit integrative project-course.*

7 *CHM 371 is a full-year, 3-credit course.*

Recommended Electives

MAT 108, MAT 206 and PHY 206 are recommended electives for students pursuing a career in Physical Chemistry.

MAT 103, MAT 310 and PHY 206 are recommended electives for students pursuing a career in Analytical Chemistry.

BCH 311 and BIO 208 are recommended electives for students pursuing a career in Organic Chemistry.

MAT 103 is a recommended elective for students pursuing a career in Environmental Chemistry.

Chemistry Minor (24 credits) MINCHE

A Chemistry Minor will be awarded for the completion of CHM 111, CHM 211, CHM 121, CHM 135, CHM 141, and their co-requisite labs, together with three 3-credit courses (and their co-requisite labs) chosen from CHM 311, CHM 411, CHM 245, CHM 341, CHM 350, BCH 210 or BCH 313.

Accreditation by l'Ordre des Chimistes du Québec and the Canadian Institute for Chemistry

The OCQ and CIC are professional orders that oversee and accredit Chemistry, Biochemistry, and related disciplines in Quebec and Canada respectively. In order to meet the accreditation standards of these orders, a student must meet the following criteria.

L'Ordre des Chimistes du Québec

A student must earn a minimum of 55 credits in Chemistry, of which 18 credits must be for laboratory work and 30 credits must be for lecture courses. The OCQ considers 3 credits of course or lab work to be the equivalent of 45 hours of class time and personal work (3 course credits in Chemistry at Bishop's is 36 hours of class time) and 1 credit of laboratory work to be the equivalent of 45 hours of lab time (1 lab-credit in Chemistry at Bishop's is 40-50 hours and thus is equivalent to 3 credits for the OCQ). The chemistry credits offered at Bishop's are divided in the following manner.

1. 6 course credits and 2 lab credits of general chemistry.
2. 3 course credits and 1 lab credit of physical chemistry.
3. 9 course credits and 3 lab credits of analytical chemistry.
4. 9 course credits and 2 lab credits of organic chemistry.
5. 6 course credits and 1 lab credit of inorganic chemistry.
6. 6 course credits and 1 lab credit of biochemistry.
7. 3 course credits on scientific writing.
8. 3 course credits as integrative project in chemistry.

Canadian Institute for Chemistry

The CIC expects a program to involve a total of about 1000 hours of laboratory and classroom work in chemistry, with the minimum hours of each being about 400. The laboratory hours should be distributed in such a way that every student is exposed to meaningful laboratory experience in at least four (and preferably five) of the five sub-disciplines (analytical chemistry, biochemistry, inorganic, organic and physical chemistry).

The core program beyond the first-year level shall include the equivalent of 12 chemistry courses including at least one in each of the five sub-disciplines of chemistry. In addition, there should be a selection of advanced offerings in the core disciplines and in other subjects such as for instance theoretical chemistry, solid state chemistry, natural products, polymers, advanced instrumentation, research thesis, etc. to bring the total number of hours of instruction to that described above. The program must also include at least 15 course credits in two or more of mathematics (algebra, calculus, statistics), physics, computer science and biology. In the case of pure chemistry programs, at least 6 credits in each of calculus and physics will be required. The inclusion of other cognate subjects as well as some liberal arts requirements is to be encouraged.

List of Chemistry Courses

CHM 111 Organic Chemistry I: Introductory 3-3-0
An introduction to organic chemistry with an emphasis on basic organic chemistry concepts such as resonance, structure and bonding, acid-base reactions of organic compounds, conformations and stereochemistry, the naming and structures of organic compounds, functional groups and chemical reactivity, and some basic chemistry relevant to biological processes.
Prerequisites: CHM 191 and CHM 192 or Collegial Chemistry NYA and NYB
Co-requisite: CHL 111

CHL 111 Organic Chemistry Laboratory I 1-0-4
Experiments in the separation and purification of organic compounds including the use of chromatography. Introduction to functional group analysis and organic synthesis.
Co-requisite: CHM 111

CHM 121 Inorganic Chemistry I 3-3-0
The principles of nuclear, atomic, metallic, ionic, molecular structure. Valence bond and molecular orbital theory. Molecular and orbital symmetry**.**
Prerequisites: CHM 191 and CHM 192 or Collegial Chemistry NYA and NYB

CHM 135 Physical Chemistry - Thermal and Fluid Physics 3-3-0
Pressure, hydrostatics, and hydrodynamics. Properties of materials and Young's Modulus. Temperature and heat. Kinetic theory of gases. Energy, work, heat. First, second, and third laws of thermodynamics. Entropy and disorder. Specific heat of solids, black body radiation, statistical thermodynamics involving different distributions and their applications.
Prerequisites: PHY 191, PHY 192, and CHM 192
Co-requisite: CHL 135

CHL 135 Physical Chemistry Laboratory 1-0-4
A series of experiments in Physical Chemistry to complement CHM 135.
This course cannot be taken by students who have received credits for PHY 207.
Prerequisites: PHY 191, PHY 192, and CHM 192
Co-requisite: CHM 135

CHM 141 Analytical Chemistry 3-3-0
Data handling, stoichiometric calculations, gravimetric analysis, acid-base equilibria and titrations, redox equilibria and titrations, complexometric titrations, precipitation reactions and titrations, electrochemical cells and electrode potentials.
Prerequisites: CHM 191 and CHM 192 or Collegial Chemistry NYA and NYB
Co-requisite: CHL 141

CHL 141 Analytical Chemistry Laboratory 1-0-4
Quantitative analysis of unknown samples by volumetric, gravimetric, and spectrometric methods will be carried out.
Co-requisite: CHM 141

CHM 181 The Chemistry of Everyday Life 3-3-0
This course will discuss the chemistry underlying some everyday, or easily recognizable, products, processes, and policies. These may include: the chemistry of pollution, warfare, polymers and plastics, household products, and food.
This course cannot be taken for credit by students who have received credit for CHM 191 or the collegial equivalent course, Chemistry NYA, or equivalent credit elsewhere.
Course registration requires the instructor's permission.

CHM 182 The History and Science of Beer and Brewing 3-3-0
Beer is among the world's most popular beverages and the industry continues to grow at both the megabrewery and microbrewery levels. This course is a general interest course on the nature of beer from a historical, sociological, and scientific perspective. The diverse nature of beer will be explored, as well as how the beverage has developed from its origins many thousands of years ago to what it has become today. Of particular emphasis will be the development of a general understanding of the brewing process, and the science and engineering involved. Various examples of beer's impact on society and culture will also be discussed.
For science students, this course cannot be taken for science credit, but only for free elective credits. For non-science students, this course can count as a science elective course.

CHM 185 The Science of Cooking 3-3-0
Food processing is one of the most common activities worldwide, but do we really know what is happening at the molecular level? This course is a general interest course on the chemistry of cooking and is designed to answer questions such as: Why does plunging food in ice water not stop the cooking process? What is happening when baking? And why does deep-fried food taste best and brown better when the oil is older? A particular emphasis will be placed on understanding what chemical transformations are involved during food processing.
For science students, this course cannot be taken for science credit, but only for free elective credits. For non-science students, this course can count as a science elective course.

CHM 191 General Chemistry I 3-3-0
A course for students lacking Collegial Chemistry NYA or its equivalent.
Atoms, molecules, and ions. Chemical formulae and equations. Thermochemistry. Electronic structure of atoms. Periodic Table and properties of elements. Chemical bonds. Physical properties and structure. Chemical kinetics
Co-requisite: CHL 191

CHL 191 Introductory Chemistry Laboratory I 1-0-4
A series of experiments in Introductory Chemistry to complement Chemistry 191 which must be taken concurrently.
Co-requisite: CHM 191

CHM 192 General Chemistry II 3-3-0
A course for students lacking Collegial Chemistry NYB or its equivalent. Solutions. Chemical equilibrium. Acids and Bases. Gases, Solids, and Liquids. Ionic equilibria.
Prerequisite: CHM 191 (or permission of instructor) or Collegial Chemistry
Co-requisite: CHL 192

CHL 192 Introductory Chemistry Laboratory II 1-0-4
A series of experiments in Introductory Chemistry to complement CHM 192 which must be taken concurrently.
Co-requisite: CHM 192

CHM 211 Organic Chemistry II: Introductory 3-3-0
This course is a continuation of CHM 111 and will elaborate upon the chemistry of the organic functional groups and their involvement in organic synthesis, emphasizing the importance of electronic factors (resonance, induction, acidity, electrophiles, nucleophiles, leaving groups, and carbenium ions) in influencing organic reaction mechanisms. Factors influencing nucleophilic substitutions, eliminations and nucleophilic additions to carbonyls will be discussed.
Prerequisite: CHM 111 or Collegial Chemistry BFB
Co-requisite: CHL 211

CHL 211 Organic Chemistry Laboratory II 1-0-4
Further experiments in organic synthesis and in chromatographic separations. An introduction to multi-step synthesis.
Co-requisite: CHM 211

CHM 225 Inorganic Chemistry II 3-3-0
This course provides students with a survey of inorganic chemistry. The course begins with the general chemistry of the inorganic elements (properties, oxidation states, introduction to their chemistry). This is followed up with two distinct sections. 1) Transition Metal Chemistry will look at crystal and ligand field theory, Werner complexes, and introduce organometallic complexes. 2) Main Group Chemistry will look at the structure and bonding of a selection of compounds from each group of the p-block.
Prerequisites: CHM 111 / CHL 111, CHM 121
Co-requisite: CHL 225

CHL 225 Inorganic Chemistry II Lab 1-0-4
This lab is comprised of experiments that provide an illustration of many of the topics covered in CHM 225. It combines experimental methods typical of inorganic chemistry (e.g. inert atmosphere) with the use of the instrumentation necessary to probed the properties of interest (e.g. FT-IR, UV-Vis, Magnetochemistry
Co-requisite: CHM 225

CHM 245 Instrumental Analysis 3-3-0
This course provides students within depth coverage of the theory of instrumental methods of analysis. The topics covered will be chromatography theory and chromatographic methods, atomic absorption and emission spectrometry, and electrochemical methods.
Prerequisites: CHM 141 and CHL 141

CHL 245 Instrumental Analysis Laboratory 1-0-4
This lab focuses mainly on learning to use the Department's extensive suite of chromatographic instrumentation (GC, GC-MS, HPLC, LC-MS) by performing numerous analyses on each instrument. The analyses will illustrate the importance of chromatography as an analytical method by using examples from forensic, environmental, and food and beverage science.
Co-requisite: CHM 245

CHM 311 Organic Chemistry III 3-3-0
A more advanced discussion of organic reaction mechanisms; enolate chemistry; electrophilic aromatic substitutions; oxidations; and unpolarized π-bonds as nucleophiles. Concepts of retrosynthesis will be introduced.
Prerequisites: CHM 111 and CHM 211

CHL 311 Organic Chemistry Laboratory III 1-0-4
Laboratory and spectroscopic techniques used in the synthesis, separation, and purification of simple organic compounds.

CHM 341 Principles and Practices of Chemical Spectroscopy and Mass Spectrometry 3-3-0
Theory and applications of multinuclear magnetic resonance, UV/VIS, EPR, and electron spectroscopies for chemical analysis. Mass spectrometry and hyphenated methods. Use of chemical spectroscopy and mass spectrometry for the identification of organic compounds. 2D- and imaging techniques, including MRI. This course may be taken online.
Prerequisites: CHM 111 and CHM 141
Co-requisite: CHL 341

CHL 341 Principles and Practices of Chemical Spectroscopy and Mass Spectrometry Laboratory 1-0-4
Experiments related to topics of CHM 341, which must be taken concurrently by chemistry and biochemistry students.
Co-requisite: CHM 341

CHM 350F Integrative Project in Chemistry 3-1-4
This course will provide students with the opportunity to engage in a project that integrates at least two disciplines of chemistry. Key aspects of the course will include literature search, experimental design, chemical synthesis, chemical analysis and communication of results.
CHM 350 is a full-year (Fall and Winter), 3-credit course. Chemistry students must enrol in CHM 350 as part of their degree program and may only take this course in their third year.
Prerequisites or co-requisites: CHM 111, CHM 211, CHM 141, CHM 121, CHM 135

CHM 371F Scientific Writing and Chemical Literature for Major Students 3-0-0
This course introduces the Chemistry Major student to chemical information retrieval and requires two major term papers – one in the Fall semester, one in the Winter semester – each presented also in two short oral presentations. Students will use SciFinder/Chemical Abstracts to perform searching in structure/substructure, reaction, and bibliographic databases. The literature searching will be used in preparing the two term papers, chosen from a list of topics approved by the Chemistry Department, under the direction of a different member of faculty for each.
Chemistry Major students must enrol in CHM 371 as part of their degree program and may only take this course in their final year. Students receiving credit for CHM 371 cannot also receive credit for CHM 471

CHM 381 Experiential Learning Project in Chemistry 3-0-9
This course is designed as an opportunity for science students to gain experience in a research lab and be involved in modern research in the different fields of chemistry. Students will engage in a research project under the supervision of a faculty member in the Chemistry Department.

CHM 411 Organic Chemistry IV 3-3-0
Selected advanced topics in organic chemistry are introduced; pericyclic reactions, organometallic chemistry; radical chemistry; and/or stereoselective reactions.
Pre-requisite: CHM 311

CHM 421 Advanced Inorganic Chemistry 3-3-0
Selected topics in inorganic chemistry covering all aspects of inorganic chemistry from the alkali metals to the noble gases.
Prerequisite: CHM 225

CHM 435 Advanced Topics in Organic Chemistry 3-3-0
Advanced topics in organic chemistry like stereoselective chemistry, radical chemistry and organometallic chemistry will be introduced through discussions and analysis of representative chemical transformations.

CHM 436 Total Synthesis in Organic Chemistry 3-3-0
In this course we will look at important total synthesis of natural products, analyze the chemical steps and propose alternative routes.

CHM 471F Scientific Writing and Chemical Literature for Honours Students 3-0-0
This course introduces the Chemistry Honours student to chemical information retrieval and requires two major term papers – one in the Fall semester, one in the Winter semester – each presented also in two short oral presentations. Students will use SciFinder/Chemical Abstracts to perform searching in structure/substructure, reaction, and bibliographic databases. The literature searching will be used in preparing the two term papers, chosen from a list of topics approved by the Chemistry Department, under the direction of a different member of faculty for each.
CHM 471 is a full-year (Fall and Winter), 3-credit course. Honours Chemistry students must enrol in CHM 471 as part of their degree program and may only take this course in their final year. Students receiving credit for CHM 471 cannot also receive credit for CHM 371.

CHM 491 Independent Study 3-0-0

CHM 492 Independent Study 3-0-0

CHM 499 Honours Chemistry Research Project 6-0-12
Under the guidance of a faculty member, the student does an experimental research project requiring approximately 12 hours per week in both the Fall and Winter semesters and presents the results of the project in a seminar and a written dissertation. The project chosen must be approved in advance by the Department and maybe in any field of chemistry plus material science.
Prerequisites: Third Year Honours Chemistry registration or permission of the Department.