Chemistry

This section presents the requirements for programs in:

- M.Sc. Chemistry
- M.Sc. Chemistry with Collaborative Specialization in Biochemistry
- M.Sc. Chemistry with Collaborative Specialization in Chemical and Environmental Toxicology
- M.Sc. in Chemistry with Collaborative Specialization in Data Science
- M.Sc. Chemistry with Concentration in Food Science
- Ph.D. Chemistry
- Ph.D. Chemistry with Collaborative Specialization in Biochemistry
- Ph.D. Chemistry with Collaborative Specialization in Chemical and Environmental Toxicology
- Ph.D. Chemistry with Concentration in Food Science

Program Requirements

M.Sc. Chemistry (5.0 credits)

Requirements:		
1. 0.5 credit in:		0.5
CHEM 5810 [0.5]	Seminar I	
2. 0.5 credit in:		0.5
CHEM 5804 [0.5]	Modern Scientific Communication	
3. 1.0 credit in CHEM at the graduate level, which may include up to 0.5 credit in another discipline, with permission of the department.		1.0
4. 3.0 credits in:		3.0
CHEM 5909 [3.0]	M.Sc. Thesis	
Total Credits		**5.0**

M.Sc. Chemistry with Collaborative Specialization in Biochemistry (5.0 credits)

Requirements:		
1. 1.0 credit in:		1.0
CHEM 5800 [0.5]	Seminar in Biochemistry I	
CHEM 5806 [0.5]	Advances in Applied Biochemistry	
2. 0.5 credit in:		0.5
CHEM 5810 [0.5]	Seminar I	
3. 0.5 credit in:		0.5
CHEM 5804 [0.5]	Modern Scientific Communication	
4. 3.0 credits in:		3.0
CHEM 5909 [3.0]	M.Sc. Thesis (in the Specialization)	
Total Credits		**5.0**

M.Sc. Chemistry with Collaborative Specialization in Chemical and Environmental Toxicology (5.0 credits)

Requirements:		
1. 1.0 credit in:		1.0
CHEM 5708 [0.5]	Principles of Toxicology	
or CHEM 5705 [0.5]	Ecotoxicology	
CHEM 5805 [0.5]	Seminar in Toxicology	
2. 0.5 credit in:		0.5
CHEM 5810 [0.5]	Seminar I	
3. 0.5 credit in:		0.5
CHEM 5804 [0.5]	Modern Scientific Communication	
4. 3.0 credits in:		3.0
CHEM 5909 [3.0]	M.Sc. Thesis (in the specialization)	
Total Credits		**5.0**

M.Sc. in Chemistry with Collaborative Specialization in Data Science (5.0 credits)

Requirements		
1. 0.5 credit in:		0.5
DATA 5000 [0.5]	Data Science Seminar	
2. 0.5 credit in:		0.5
CHEM 5810 [0.5]	Seminar I	
3. 0.5 credit in:		0.5
CHEM 5804 [0.5]	Modern Scientific Communication	
4. 0.5 credit in CHEM at the graduate level, which may include up to 0.5 credit in another discipline, with permission of the department.		0.5
5. 3.0 credits in:		3.0
CHEM 5909 [3.0]	M.Sc. Thesis (in the specialization)	
Total Credits		**5.0**

M.Sc. Chemistry with Concentration in Food Science (5.0 credits)

Requirements:		
1. 0.5 credit in:		0.5
FOOD 5810 [0.5]	Seminar I	
2. 0.5 credit in:		0.5
FOOD 5804 [0.5]	Modern Scientific Communication	
3. 0.5 credit in FOOD at the graduate level.		0.5
4. 0.5 credit in graduate level CHEM or FOOD, or in another discipline, with permission of the department.		0.5
5. 3.0 credits in:		3.0
FOOD 5909 [3.0]	M.Sc. Thesis (in the concentration)	
Total Credits		**5.0**

Ph.D. Chemistry (3.0 credits)

Requirements:		
1. 0.5 credits in:		0.5
CHEM 5810 [0.5]	Seminar I	
2. 0.5 credit in:		0.5
CHEM 5804 [0.5]	Modern Scientific Communication	
3. 2.0 credits in CHEM at the graduate level, which may include up to 0.5 credit in another discipline, with permission of the department.		2.0
4. Comprehensive examination, Part 1 (see Note, below)		
5. Comprehensive examination, Part 2 (see Note, below)		
6. Public lecture, to precede the oral defence		
7. 0.0 credit in:		
CHEM 6909 [0.0]	Ph.D. Thesis	
Total Credits		**3.0**

Ph.D. Chemistry with Collaborative Specialization in Biochemistry (3.0 credits)

Requirements:

1. 0.5 credit in:		0.5
CHEM 6800 [0.5]	Seminar in Biochemistry II	
2. 0.5 credit in:		0.5
CHEM 5806 [0.5]	Advances in Applied Biochemistry	
or, only for students who have already completed CHEM 5806, 0.5 credit from the following:		
CHEM 5001 [0.25]	Analytical Mass Spectrometry	
CHEM 5109 [0.5]	Advanced Applications in Mass Spectrometry	
CHEM 5111 [0.25]	Advanced Topics in Biomolecular Sciences	
CHEM 5900 [0.5]	Directed Special Studies	
3. 0.5 credit in:		0.5
CHEM 5810 [0.5]	Seminar I	
4. 0.5 credit in:		0.5
CHEM 5804 [0.5]	Modern Scientific Communication	
5. 1.0 credits in CHEM at the graduate level, which may include up to 0.5 credit in another discipline, with permission of the department.		1.0
6. Comprehensive examination, Part 1 (see Note below)		**0.0**
7. Comprehensive examination, Part 2 (see Note below)		
8. Public lecture, to precede the oral defence		
9. 0.0 credits in:		
CHEM 6909 [0.0]	Ph.D. Thesis (in the specialization)	
Total Credits		**3.0**

Ph.D. Chemistry with Collaborative Specialization in Chemical and Environmental Toxicology (3.0 credits)

Requirements:

1. 1.5 credits from:		1.5
CHEM 5705 [0.5]	Ecotoxicology	
CHEM 5708 [0.5]	Principles of Toxicology	
CHEM 5805 [0.5]	Seminar in Toxicology (not required for students who have already completed the Seminar in Toxicology for the Master's specialization)	
2. 0.5 credits in:		0.5
CHEM 5810 [0.5]	Seminar I	
3. 0.5 credit in:		0.5
CHEM 5804 [0.5]	Modern Scientific Communication	
4. 0.5 credit in CHEM at the graduate level, which may include up to 0.5 credit in another discipline, with permission of the department.		0.5
5. Comprehensive examination, Part 1 (see Note below)		
6. Comprehensive examination, Part 2 (see Note below)		
7. 0.0 credits in:		0.0
8. Public lecture, to precede the oral defence		
CHEM 6909 [0.0]	Ph.D. Thesis (in the specialization)	
Total Credits		**3.0**

Ph.D. Chemistry with Concentration in Food Science (3.0 credits)

Requirements:

1. 0.5 credits in:		0.5
FOOD 5810 [0.5]	Seminar I	
2. 0.5 credit in:		0.5
FOOD 5804 [0.5]	Modern Scientific Communication	
3. 0.5 credit in FOOD at the graduate level		0.5
4. 1.5 credit in graduate level CHEM or FOOD, graduate level CHEM or FOOD, or in another discipline, with permission of the department.		1.5
5. Comprehensive examination, Part 1 (see Note, below)		
6. Comprehensive examination, Part 2 (see Note, below)		
7. Public lecture, to precede the oral defence		
8. 0.0 credits in:		
FOOD 6909 [0.0]	Ph.D. Thesis (in the concentration)	
Total Credits		**3.0**

Note

Comprehensive examination Part 1 examines the depth and breadth of knowledge in the student's own research area and is normally completed in the third term of registration.

Comprehensive examination Part 2 involves the submission of a research proposal that is both novel and of a sound scientific basis that may be loosely related to the thesis research of the student but not a topic that the student has investigated in any manner. The research proposal will be submitted to a committee for oral defense and is normally completed in the ninth term of registration.

Failure to pass either part of the comprehensive examination will result in deregistration from the graduate program.

Students are required to participate in Thesis Advisory Committee (TAC) meetings in terms 2, 5, 8, and 11. If students are unable to defend their dissertation by term 12, further TAC meetings with a plan for completion must occur in term 14 and, if required term 17. All program requirements must be completed within 18 terms (6 years).

If a student is fast tracking from the M.Sc. program to the PhD program and has previously taken CHEM 5801/ FOOD 5801 [1.0 credit] and obtained a grade of A-, the student will be given credit for CHEM 5804/FOOD 5804 [0.5 credit] and CHEM 5810/FOOD 5810 [0.5 credit]. Additionally, up to 1.0 credit of graduate courses may be transferred from the M.Sc. provided a grade of at least A- was obtained in each of the courses.

Regulations

See the General Regulations section of this Calendar.

Residence Requirement

At least one year of full-time study is required for the M.Sc. program.

Guidelines for Completion of Master's Degree

Full-time students in the master's program will normally complete the degree requirements in two years. Part-time students will normally complete the degree requirements in four years.

Regulations

See the General Regulations section of this Calendar.

Thesis Advisory Committee

Within four months of initial registration in the Ph.D. program, a Thesis Advisory Committee (TAC) will be appointed for each student. The committee will consist of a minimum of three members, including the thesis supervisor and, where practicable, at least one member will be from the other campus of OCCI. Committee membership may include adjunct faculty members of the Faculty of Graduate and Postdoctoral Studies (FGPS) at the University of Ottawa or the Faculty of Graduate Studies and Research at Carleton.

Once a year, the student will prepare a formal Thesis Progress Report. The report is not to exceed one page and will outline the problem, methodology used, results achieved, and aims for future research. The TAC will evaluate the report and indicate whether the student has made satisfactory progress. A meeting to discuss the student's progress may be held at any time at the request of either the student or the committee.

Admission

Honours B.Sc. degree in Chemistry, with a B+ average in the last two years and a B average overall.

Applicants who do not meet this requirement, or whose undergraduate degree is in another, closely related field, may be accepted into the program, but may be assigned extra courses.

Qualifying Year

Applicants who do not qualify for direct admission to the Master's program may be admitted to a qualifying-year program (see 2.3 under General Regulations).

5.0 credits must be completed within two consecutive fall and winter terms, including a 1.0 credit Research Project and Seminar course (CHEM 4908 [1.0]), and 4.0 credits in 0.5- and 0.25-credit courses, as assigned by the Graduate Supervisor. An average grade of A- over these five credits, with a minimum grade of B in each course must be presented to be considered for admission to the M.Sc. program.

Orientation Examinations

Students coming from outside Canada or the United States must write orientation examinations at approximately the third-year university level. Each student will be informed of this requirement upon admission. The examinations will be given in the first week of the term in September and January. Students can choose from any three examination modules in: organic, physical, inorganic/analytical and biochemistry.

In examination areas where the student shows unsatisfactory performance or deficiency, the Graduate Supervisor will assign undergraduate-level remedial courses. To be eligible to continue in the graduate program, the student must achieve a minimum grade of A- in each remedial course.

Admission

The normal requirement for admission to the Ph.D. program is an M.Sc. degree in Chemistry. Direct entrance from a B.Sc. degree in Chemistry will be considered in exceptional cases.

Orientation Examinations

Students coming from outside Canada or the United States must write orientation examinations at approximately the third-year university level. Each student will be informed of this requirement upon admission. The examinations will be given in the first week of the term in September and January. Students can choose from any three examination modules in: organic, physical, inorganic/analytical and biochemistry.

In examination areas where the student shows unsatisfactory performance or deficiency, the Graduate Supervisor will assign undergraduate-level remedial courses. To be eligible to continue in the graduate program, the student must achieve a minimum grade of A- in each remedial course.

Chemistry (CHEM) Courses

CHEM 5001 [0.25 credit] (CHM 8301)
Analytical Mass Spectrometry
The principles of ion sources and mass spectrometers and their applications to problems in chemistry and biochemistry. Introduction to the chemistry of gaseous ions. Ion optics. Special emphasis on interpreting mass spectra.

CHEM 5002 [0.25 credit] (CHM 8301)
Multinuclear Magnetic Resonance Spectroscopy
Principles of Nuclear Magnetic Resonance (NMR). NMR parameters studied: chemical shift, spin-spin coupling, electric quadrupole coupling, spin-spin, spin-lattice relaxation rates. NMR and the periodic table. Dynamic NMR. Applications in chemistry and biochemistry. The Fourier Transform technique. Pulse sequences. Basic principles/applications of two-dimensional NMR.

CHEM 5003 [0.25 credit] (CHM 8325)
Solid State NMR Spectroscopy
Brief introduction to solid state NMR spectroscopy. Topics include dipolar coupling interactions, chemical shielding anisotropy, the quadrupolar interaction and averaging techniques such as magic angle spinning.

CHEM 5004 [0.25 credit] (CHM 8326)
NMR Spectroscopy
Advanced NMR techniques for both proton and carbon spectra, various decoupling and related experiments. Interpretation of NOSY, COSY and related data.

CHEM 5005 [0.25 credit] (CHM 8327)
Physical Organic Chemistry
Hammet functions, transition state energies, stereochemistry of organic compounds, and mechanisms of organic reactions and their determination.

CHEM 5007 [0.25 credit] (CHM 8310)
Introduction to Photochemistry
Basic principles of photochemistry including selection rules, energy transfer processes and the properties of excited state reactions. Lasers and their applications to measurements of the dynamics of elementary reactions.

CHEM 5010 [0.5 credit]
Bio-Organic Chemistry
Chemical and biosynthetic methods applied to the major classes of biomolecules and their derivatives, including: carbohydrates, amino acids, peptides, proteins, nucleic acids, lipids, terpenes, heterocycles and natural products. Reactions and mechanisms that contribute to their biological activities.
Also offered at the undergraduate level, with different requirements, as CHEM 4207, for which additional credit is precluded.

CHEM 5102 [0.25 credit] (CHM 8346)
Supercritical Fluids
Fundamental and practical aspects of the uses of supercritical fluids in the chemistry laboratory. Thermodynamic treatment of high pressure multicomponent phase equilibria, transport properties, solubilities, supercritical fluid extraction and chromatography for analytical purposes, reactions in supercritical fluids, equipment considerations, new developments.
Includes: Experiential Learning Activity

CHEM 5108 [0.5 credit] (CHM 8302)
Surface Chemistry and Nanostructures
Surface structure, thermodynamics and kinetics, specifically regarding adsorption/desorption and high vacuum models. Nanoscale structures and their formation, reactivity and characterization. Thin films, carbon nanotubes, self-assembled monolayers and supramolecular aggregates.
Also offered at the undergraduate level, with different requirements, as CHEM 4103, for which additional credit is precluded.

CHEM 5109 [0.5 credit] (CHM 8302)
Advanced Applications in Mass Spectrometry
Detailed breakdown of the physical, electrical and chemical operation of mass spectrometers. Applications in MS ranging from the analysis of small molecules to large biological macromolecules. Descriptions of the use of mass spectrometry in industry as well as commercial opportunities in the field.
Also offered at the undergraduate level, with different requirements, as CHEM 4304, for which additional credit is precluded.

CHEM 5110 [0.25 credit] (CHM 8176)
Chemistry Education and Chemistry Education Research
Chemistry education including theories of learning, aligning intended outcomes with course activities and assessment, and troublesome areas of learning and teaching in chemistry. Key educational research areas are addressed, including types evidence, research methods, and central publications.

CHEM 5111 [0.25 credit] (CHM 8358)
Advanced Topics in Biomolecular Sciences
Topics of current interest in biomolecular sciences and biological chemistry. Variable content from year to year.

CHEM 5112 [0.25 credit] (CHM 8359)
Advanced Topics in Materials Chemistry
Topics of current interest in materials chemistry. Variable content from year to year.

CHEM 5113 [0.25 credit] (CHM 8165)
Stereoselective Synthesis
Fundamentals of stereoselective synthesis and catalysis, including conformational analysis, substrate and catalyst control. Includes the use of allylic, chiral auxiliaries, directed reactions and chiral catalysts.

CHEM 5114 [0.25 credit] (CHM 8173)
Introduction to Molecular Simulation and Statistical Mechanics (Part A)
Modern molecular simulation techniques including classical molecular dynamics and Monte Carlo simulations with the necessary statistical mechanics required to understand and interpret the results. Introduction to modern scientific computing environments via the Linux operating system.

CHEM 5115 [0.25 credit] (CHM 8175)
Introduction to Molecular Simulation and Statistical Mechanics (Part B)
Modern molecular simulation techniques including classical molecular dynamics and Monte Carlo simulations with the necessary statistical mechanics required to understand and interpret the results. Introduction to modern scientific computing environments via the Linux operating system.
Prerequisite(s): CHEM 5114.

CHEM 5116 [0.25 credit] (CHM 8360)
Characterization Methods and Applications of Advanced Materials
Physico-chemical techniques including thermal analysis, optical spectroscopy, electrochemistry, X-ray and electron diffraction, electron microscopy, electron spectroscopies, magnetic resonance, and general instrumental methods. Applications may include: field affect transistors, photovoltaics, light emitting devices, batteries and fuel cells.

CHEM 5117 [0.25 credit] (CHM 8361)
Chemical Biology (Part A)
Chemical Biology of modern molecular science with applications to understanding biological mechanisms. Chemical and genetically encoded probes for genomics, proteomics, metabolomics as well as biorthogonal chemistry, chemical genetics and expanded genetic codes and alphabets in the context of understanding and engineering living systems.

CHEM 5118 [0.25 credit] (CHM 8363)
Chemical Biology (Part B)
Chemical Biology of modern molecular science with applications to understanding biological mechanisms. Chemical and genetically encoded probes for genomics, proteomics, metabolomics as well as biorthogonal chemistry, chemical genetics and expanded genetic codes and alphabets in the context of understanding and engineering living systems.
Prerequisite(s): CHEM 5117.

CHEM 5119 [0.25 credit] (CHM 8362)
Molecular Magnetism I
Introduction to the principals (Molecular Magnetism I) and advanced characterization of paramagnetic molecules (Molecular Magnetism II). Emphasis will be made on structure-property relationship. This course will contain variable content from year to year by discussing recent progress on molecular magnetism.

CHEM 5120 [0.25 credit] (CHM 8330)
Heterocyclic Chemistry
Properties of heterocycles. Synthesis and reactivity of heterocyclic systems, with examples relevant to the synthesis of pharmaceuticals and natural products. Includes metal-catalyzed reactions.

CHEM 5121 [0.25 credit] (CHM 8364)
Molecular Magnetism II
Introduction to the principals (Molecular Magnetism I) and advanced characterization of paramagnetic molecules (Molecular Magnetism II). Emphasis will be made on structure-property relationship. This course will contain variable content from year to year by discussing recent progress on molecular magnetism.

CHEM 5202 [0.25 credit] (CHM 8323)
Chemistry of the Main Group Elements
Fundamental and applied aspects of main group element chemistry. Topics may include non-metal chemistry, main group organometallic chemistry, application of main group element compounds to solid state synthesis (e.g. CVD and/or sol gel processes), uses of main group element compounds in synthesis.

CHEM 5206 [0.5 credit] (CHM 8302)
Physical Methods of Nanotechnology
An overview of methods used in nanotechnology. Principles of scanning probe techniques ranging from surface physics to biology. State of the art methods to create nanostructures for future applications in areas such as nanolithography, nanoelectronics, nano-optics, data storage and bio-analytical nanosystems.

CHEM 5207 [0.25 credit] (CHM 8302)
Macromolecular Nanotechnology
Fundamentals of synthetic macromolecules related to nanoscale phenomena. Challenges and opportunities associated with polymers on the nanoscale. Topics include molecular recognition, self-assembled nanostructures, functional nanomaterials, amphiphilic architectures, nanocomposites, and nanomachines. Applications to sensing, drug delivery, and polymer based devices.
Also offered at the undergraduate level, with different requirements, as CHEM 4201, for which additional credit is precluded.

CHEM 5208 [0.25 credit] (CHM 8302)
Bio Macromolecular Nanotechnology
Fundamentals of biological macromolecules related to nanoscale phenomena. Challenges and opportunities associated with natural polymers on the nanoscale. Topics include molecular recognition, self-assembled nanostructures, scaffolds and templates, functional nanomaterials, amphiphilic architectures, nanocomposites, and nanomachines. Applications to sensing, biomaterials, drug delivery, and devices.
Also offered at the undergraduate level, with different requirements, as CHEM 4201, for which additional credit is precluded.

CHEM 5300 [0.25 credit] (CHM 8331)
Physical Chemistry of Biological Macromolecules
How the application of physical techniques, normally applied to small molecules, can be used to study macromolecular structure and function of DNA and proteins. Examples of applications to include kinetics, electrochemistry, equilibria phenomena (thermodynamics).

CHEM 5304 [0.25 credit] (CHM 8349)
Free Radicals in Chemistry and Biology
Oxidative stress induced by free radicals plays a significant role in fatal and chronic diseases. The chemistry of bio-radicals will be described and related to pathobiological processes such as lipid peroxidation and atherosclerosis, protein nitration and cross linking, and DNA scission.

CHEM 5306 [0.25 credit] (CHM 8338)
Unimolecular Reaction Dynamics: Experiment and Theory
Theoretical models that have been developed for the understanding of unimolecular reactions; statistical theories such as RRKM theory. Experimental techniques for exploring the kinetics and mechanism of unimolecular reactions, including mass spectrometry, coincidence spectroscopy and ZEKE spectroscopy.

CHEM 5406 [0.5 credit] (CHM 8164)
Organic Polymer Chemistry
Basic principles of industrial and synthetic polymers. Polymerization and polymer characterization. Topics to cover some important polymers with emphasis on synthesis, commodity plastics, engineering thermoplastics and specialty polymers.
Prerequisite(s): CHEM 3201 and CHEM 3202 and/or CHEM 4203 or the equivalent. Students should have a basic knowledge of organic reaction mechanisms and stereochemistry.
Also offered at the undergraduate level, with different requirements, as CHEM 4204, for which additional credit is precluded.

CHEM 5407 [0.5 credit] (CHM 8134)
Spectroscopy for Organic Chemists
Use of NMR spectroscopy in the elucidation of organic structures, interpretation of 1H, 13C and 19F NMR. Use of NMR in determining relative and absolute stereochemistry. Two-dimensional NMR.
Also offered at the undergraduate level, with different requirements, as CHEM 4202, for which additional credit is precluded.

CHEM 5500 [0.25 credit] (CHM 8348)
Analytical Instrumentation
Principles of modern electronics, devices and instruments. Measurement of photonic and electrochemical signals. Conditioning of signals for feedback control and microcomputer interfacing. Computational data analysis techniques such as simplex optimization. Applications in chemical analysis include amperometric detector for capillary electrophoresis, and surface plasmon resonance immunosensor.

CHEM 5501 [0.25 credit] (CHM 8352)
Analytical Approach to Chemical Problems
Case study of analytical approach to various chemical problems in agricultural, biochemical, environmental, food processing, industrial, pharmaceutical and material sciences. Analytical methods include capillary electrophoresis, chemiluminescence, Fourier transform infrared spectroscopy, inductively coupled plasma emission spectroscopy, mass spectrometry, biochemical sensors, and fibre optics for remote sensing.
Includes: Experiential Learning Activity

CHEM 5600 [0.25 credit] (CHM 8323)
Quantum Mechanical Methods - Theory
A course dealing with the theory behind quantum mechanical methods (HF, MP2, CI, DFT).

CHEM 5606 [0.5 credit] (CHM 5606)
Environmental Chemistry and Toxicology
Overview of environmental chemistry and toxicology principles including chemical sources, fate, and effects in the environment. Examining organic reactions occurring in abiotic environments and biological systems, study aspects of toxicant disposition and biotransformation. Emphasis on contemporary problems in human health and the environment.
Also offered at the undergraduate level, with different requirements, as CHEM 4305, for which additional credit is precluded.

CHEM 5607 [0.5 credit]
Advanced Topics in Analytical Chemistry I
Analytical chemistry of trace and ultratrace elements/compounds. Special requirements for quantitative determination by various instrumental methods. Control of contamination and blanks. Analytical method development to improve selectivity, sensitivity and detection limit. Strength and limitations of each instrument in regard to optimization of all operating parameters.
Also offered at the undergraduate level, with different requirements, as CHEM 4301, for which additional credit is precluded.

CHEM 5705 [0.5 credit] (CHM 9109)
Ecotoxicology
Selected topics and advances in ecotoxicology with emphasis on the biological effects of contaminants. The potential for biotic perturbance resulting from chronic and acute exposure of ecosystems to selected toxicants will be covered along with methods of pesticide, herbicide and pollutant residue analysis.
Also listed as BIOL 6403.

CHEM 5708 [0.5 credit] (CHM 8156)
Principles of Toxicology
Basic theorems of toxicology with examples of current research problems. Toxic risk is defined as the product of intensive hazard and research problems. Each factor is assessed in scientific and social contexts and illustrated with many types of experimental material.
Also listed as BIOL 6402 [BIO 9101].

CHEM 5709 [0.5 credit] (CHM 8157)
Chemical Toxicology
Introduction to modeling chemical hazards and exposures at the cellular level. The properties of toxic substances are compared to the responses of enzymatic systems. These interactions are defined as Quantitative Structure-Activity Relationships and used to interpret hazardous materials under regulations such as WHMIS.
Also listed as BIOL 5709 [BIO 8113].
Prerequisite(s): BIOL 6402/CHEM 5708 (BIO 9101/CHM 8156).

CHEM 5800 [0.5 credit]
Seminar in Biochemistry I
A graduate seminar on current topics in the field of Biochemistry. This course introduces the seminar format and involves student, faculty and invited seminar speakers. The student will present a seminar and submit a report on a current topic in Biochemistry.
Includes: Experiential Learning Activity
Also listed as BIOL 5002.

CHEM 5802 [0.0 credit] (CHM 8257S)
Seminar II
Students are required to present a seminar on their Ph.D. research topic in their research program. In addition, students are required to attend the seminars of their fellow classmates and actively participate in the discussion following the seminar.
Includes: Experiential Learning Activity
Also listed as FOOD 5802.

CHEM 5804 [0.5 credit]
Modern Scientific Communication
Communication and other skills useful for chemistry graduates. Effective manuscript writing, creating graphics, CV development, networking, science communication, use of social media, outreach, EDI considerations.
Also listed as FOOD 5804.
Precludes additional credit for CHEM 5801 (no longer offered), FOOD 5801 (no longer offered).

CHEM 5805 [0.5 credit] (CHM 8167)
Seminar in Toxicology
This course introduces the seminar format and involves student, faculty and invited seminar speakers. The student will present a seminar and submit a report on a current topic in toxicology.
Includes: Experiential Learning Activity
Also listed as BIOL 6405.

CHEM 5806 [0.5 credit]
Advances in Applied Biochemistry
A practical hands-on course in the field of Biochemistry. This course is run in a laboratory and will train students in highly specialized technique(s)in Biochemistry. The students will run experiments, gather data, assess and analyze the results and present the findings as a seminar.
Includes: Experiential Learning Activity
Also listed as BIOL 5004.

CHEM 5810 [0.5 credit]
Seminar I
Principles and practice of oral scientific communication for scientific and non-scientific audiences. Students are required to present short seminars geared towards a general audience (in the style of Three-minute thesis (3MT) and/or TedTalk) as well as a research seminar geared towards a scientific audience.
Also listed as FOOD 5810.
Precludes additional credit for CHEM 5801 (no longer offered), FOOD 5801 (no longer offered).

CHEM 5900 [0.5 credit] (CHM 8158)
Directed Special Studies
Under the direction of an approved member of Faculty, the student will undertake advanced study of a field of chemistry unrelated to their thesis topic. Approval of the Associate Chair, Graduate and Postdoctoral Affairs Chemistry is required and will only be granted under unusual conditions.

CHEM 5901 [0.25 credit] (CHM 8304)
Advanced Topics in Organic Chemistry
Topics of current interest in organic chemistry. The content of this course may vary from year to year.

CHEM 5902 [0.25 credit] (CHM 8302)
Advanced Topics in Inorganic Chemistry
Topics of current interest inorganic chemistry. The content of this course may vary from year to year.

CHEM 5903 [0.25 credit] (CHM 8309)
Advanced Topics in Physical/Theoretical Chemistry
Topics of current interest in physical/theoretical chemistry. The content of this course may vary from year to year.

CHEM 5904 [0.5 credit] (CHM 8104)
Scientific Data Processing and Evaluation
Optimization of scientific measurements, calibration, uni-variate and multi-variate analysis of scientific data, “intelligent” spreadsheets for scientific data processing and presentation, noise reduction using spreadsheets, correction for signal drifts; examples from chemistry, spectroscopy and other scientific disciplines.
Prerequisite(s): CHEM 4301, or permission from the Department.
Also offered at the undergraduate level, with different requirements, as CHEM 4303, for which additional credit is precluded.

CHEM 5905 [0.5 credit] (CHM 5105)
Radiochemistry
A study of nuclear stability and decay; chemical studies of nuclear phenomena. Applications of radioactivity.
Prerequisite(s): permission of the Department.
Also offered at the undergraduate level, with different requirements, as CHEM 4502, for which additional credit is precluded.

CHEM 5909 [3.0 credits]
M.Sc. Thesis
Includes: Experiential Learning Activity

CHEM 6800 [0.5 credit]
Seminar in Biochemistry II
A graduate seminar on current topics in the field of Biochemistry. This course introduces the seminar format and involves student, faculty and invited seminar speakers. The student will present a seminar and submit a report on a current topic in Biochemistry.
Includes: Experiential Learning Activity
Also listed as BIOL 6102.
Lecture three hours a week.

CHEM 6909 [0.0 credit]
Ph.D. Thesis
Includes: Experiential Learning Activity

Food Science (FOOD) Courses

FOOD 5100 [0.5 credit]
Advanced Food Processing and Technology
Major techniques used in food processing and preservation of raw agricultural materials. Targeted food groups include dairy, cereal grains and oilseeds.

FOOD 5101 [0.5 credit]
Advanced Nutrition and Metabolism
Metabolism of macronutrients in the human body. Detailed catabolic and anabolic reactions of carbohydrates, lipids and proteins. Regulatory control points in healthy and diseased states. Discussion of the literature pertaining to nutrition, metabolism and disease.
Also offered at the undergraduate level, with different requirements, as FOOD 4201, for which additional credit is precluded.

FOOD 5102 [0.5 credit]
Food Biotechnology
Developments in biotechnology related to food production and quality. Traditional food biotechnology and novel biotechnological methods related to the production of food; the use of traditional food crops in other bio-industries. Aspects of microbiology and genetic engineering.

FOOD 5103 [0.5 credit]
Cellular Redox in Health and Disease
Crucial interactions of free radicals with biomolecules in living organisms. Procedures for detecting cellular and DNA damage, lipid and protein oxidation products; the link between oxidative stress and chronic diseases.

FOOD 5104 [0.5 credit]
Theory and Principles of Food Quality and Control
Sampling plans and statistical methods. Physical, chemical, biological and microbiological tests in quality control as it relates to food safety and regulation.
Also offered at the undergraduate level, with different requirements, as FOOD 4001, for which additional credit is precluded.

FOOD 5105 [0.5 credit]
Functional Foods and Natural Health Products
Bioactive components of functional foods and natural health products, for improvement of health and nutrition. Sources and chemistry of bioactives, mechanisms of actions, process technology, efficacy and safety. Role of research and development in industry in commercialization of new products.
Also offered at the undergraduate level, with different requirements, as FOOD 4203, for which additional credit is precluded.

FOOD 5802 [0.0 credit]
Seminar II
Students are required to present a seminar on their Ph.D. research topic in their research program. In addition, students are required to attend the seminars of their fellow classmates and actively participate in the discussion following the seminar.
Includes: Experiential Learning Activity
Also listed as CHEM 5802.
Prerequisite(s): enrolment in the Ph.D. program.

FOOD 5804 [0.5 credit]
Modern Scientific Communication
A course on communication and other skills useful for chemistry graduates. Effective manuscript writing, creating graphics, CV development, networking, science communication, use of social media, outreach, EDI considerations.
Also listed as CHEM 5804.
Precludes additional credit for CHEM 5801 (no longer offered), FOOD 5801 (no longer offered).

FOOD 5810 [0.5 credit]
Seminar I
Explore the principles and practice of oral scientific communication for scientific and non-scientific audiences.Students are required to present short seminars geared towards a general audience (in the style of Three-minute thesis(3MT)and/or TedTalk) as well as a research seminar geared towards a scientific audience.
Also listed as CHEM 5810.
Precludes additional credit for CHEM 5801 (no longer offered), FOOD 5801 (no longer offered).
Seminar

FOOD 5909 [3.0 credits]
M.Sc. Thesis
Includes: Experiential Learning Activity

FOOD 6909 [0.0 credit]
Ph.D. Thesis
Includes: Experiential Learning Activity