Chemistry

2011-12 Undergraduate Handbook

for students joining in Fall 2009 or thereafter

Courses Programs Degree Requirements Resources Information

www.chem.yorku.ca 416-736-5246

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A Message from the Chair

The field of Chemistry continues to flourish, and to grow into new areas. Our Department continues to respond with innovative degree programs — programs that are relevant, interesting and challenging — to enable you to take advantage of the increasing opportunities after graduation. Two of the newer degrees, the stream in *Pharmaceutical and Biological Chemistry* and the degree in *Biochemistry*, have become tremendously popular. Our biological side is just one of our areas of development: We also offer optional course sequences focusing on *Materials Chemistry* or *Analytical Chemistry*, both industrially important areas, as well as several other degrees. Whatever your choice may be, our degree programs are a great preparation for a variety of careers in education, government and industry, for graduate studies and research, or for entry into medical, dental, law, business and other professional schools.

Our ambition is to provide you with an education which reaches beyond the classroom. One example is our very popular fourth-year Research Project course, where students interact personally with their supervisors and participate in their forefront research in their labs. You can peruse the profiles of our faculty members and their research activities on our website. Many of our students also experience summer or part-time employment in our research laboratories, while others enjoy internships in industries or participate in student-exchange or international internship programs.

As Chair of this Department, let me offer you my help in making yours the most rewarding and enriching undergraduate experience you can get anywhere. The staff of the Chemistry Office and the Chemistry faculty members are available for advice and help.

Chemistry continues to captivate students and faculty alike. I invite you to make full use of what we offer!

J. Rudolph, *Chair*

A Message from the Undergraduate Program Director

As part of the Chemistry Department's commitment to offering useful and high-quality degrees, our programs are continually evolving. This year is the last year of a three-year transition begun in 2009-10. The changes to the teaching of Theoretical Chemistry continue as CHEM 2030 now incorporates some of the CHEM 2010 topics and CHEM 3010 has taken on the majority of the material. CHEM 2010 will be offered one last time this year for those whose degrees require it. The lab-only courses CHEM 3000 and 3001 will have their second cohort of students. At the same time, the 4-credit lecture-plus-lab courses (CHEM 3010, 3011, 3020, 3021, 3030 and 3031) will continue to run one last time for those whose degrees demand them. This transition may see a few bumps on the road, but we are committed to delivering a quality experience for all students.

There are two major innovations from the Biology Department this year, affecting those needing BIOL or BCHM courses. Summer 2011 will have the last offerings of the 4-credit versions of BCHM/BIOL 2020, 2021 or 2040, after which only the 3-credit versions will be available. The laboratory components have been combined into the new BIOL 2070. New students in Biochemistry or in the Biological and Pharmaceutical Chemistry stream will need to take this new lab course, without any overall increase or decrease in credits required, but there are provisions for students caught in the transition.

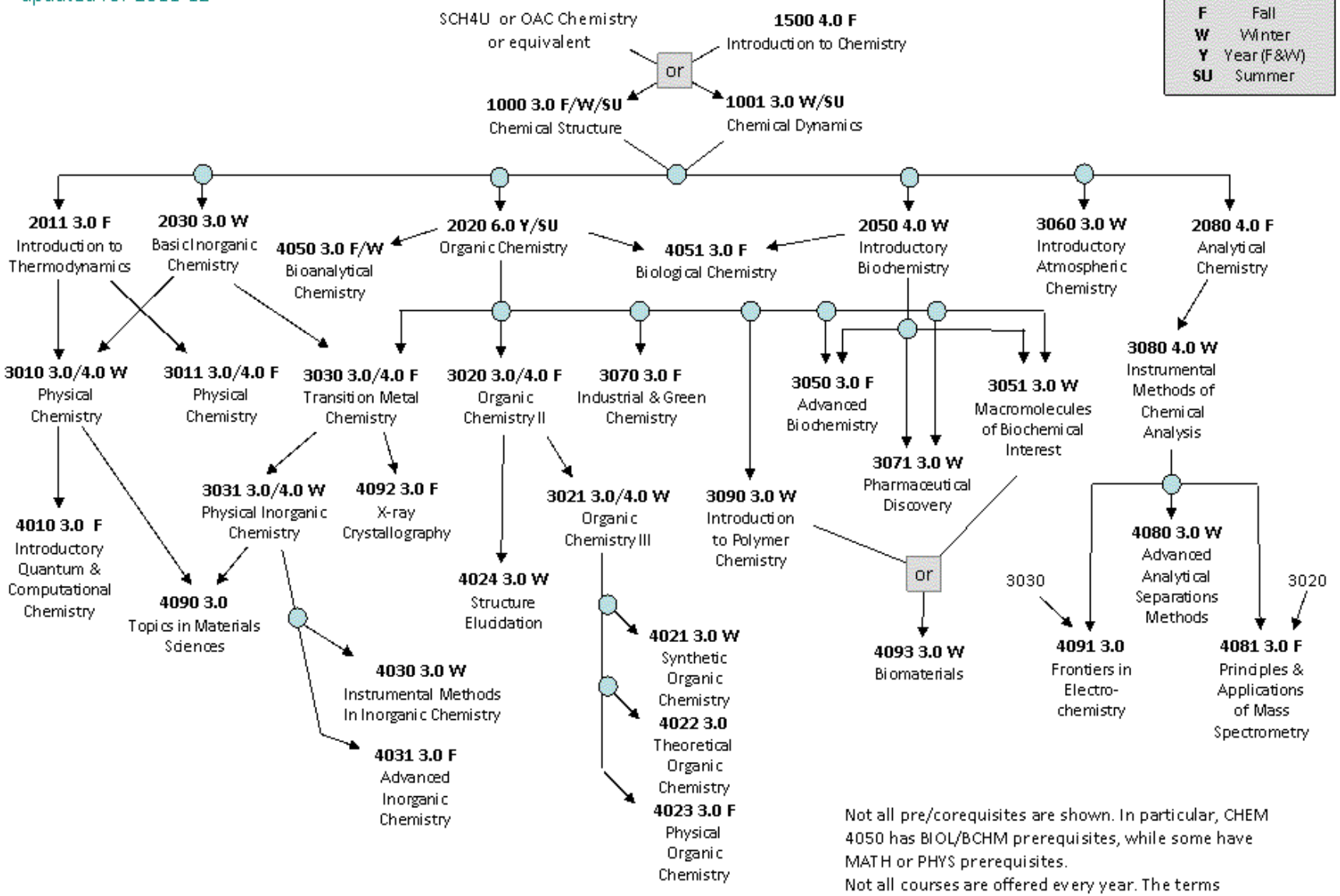
Part of my job is to provide you with the most complete information on our programs and offerings, through the web site and this Handbook. To facilitate the task, the undergraduate area of the web site has been redesigned this past spring with ease-of-use in mind, but also with a better look. The quaint alchemical symbols decorating the undergraduate web pages serve to remind us of the long history of our science, that what we think we know can be very incomplete and that our science is not eternal but ever-evolving.

I welcome constructive criticisms and suggestions on how we can improve any aspect of the undergraduate experience, so feel free to visit or to email me at *pgpotvin@yorku.ca* with your ideas or concerns. Have a successful and productive year in 2011-2012!

P. G. Potvin, *Undergraduate Program Director*

CHEM courses: Scheduling & Prerequisite Structure

updated for 2011-12



Not all pre/corequisites are shown. In particular, CHEM 4050 has BIOL/BCHM prerequisites, while some have MATH or PHYS prerequisites.

Not all courses are offered every year. The terms indicated apply to 2011-2012. Courses with no term indication are not offered in 2011-2012.

Course Offerings 2011-2012

Courses Offered Every Year:

Number	*Term*	*Daytime/Evening*
1000 3.00	F,W,SU	day/eve
1001 3.00	W,SU	day/eve
1500 4.00	F	day
1509 0.00	F	day
1550 3.00	F	day
2011 3.00	F	day
2020 6.00	Y,SU	day
2030 3.00	W	day
2050 4.00	W	day
2080 4.00	F	day
2550 3.00	W	day
3000 3.00	F	day/eve
3001 3.00	W	day/eve
3010 3.00/4.00	W	day
3011 3.00/4.00	F	day
3020 3.00/4.00	F	day
3021 3.00/4.00	W	day
3030 3.00/4.00	F	day
3031 3.00/4.00	W	day
3050 3.00	W	day
3051 3.00	F	day
3080 4.00	W	day
4000 4.00/8.00	Y, F,W,SU	day
4300 3.00	F,W,SU	day

Courses Not Necessarily Offered Every Year:

Number	*Term*	*Daytime/Evening*
2010 3.00	W	day
3060 3.00	W	day
3070 3.00	F	day
3090 3.00	W	day
4010 3.00	F	day
4021 3.00	F	eve
4023 3.00	F	eve
4024 3.00	W	day
4030 3.00	W	eve
4031 3.00	F	day
4050 3.00	F,W	day
4051 3.00	F	day
4080 3.00	W	eve
4081 3.00	W	day
4092 3.00	F	day
4093 3.00	W	day

Courses Not Offered This Year:

Number
3071 3.00
4022 3.00
4032 3.00
4090 3.00
4091 3.00

SC/CHEM 1000 3.0 'Chemical Structure'

An introduction to chemistry with emphasis on the physical and electronic structure of matter, including gases, liquids and solids. Topics include the behaviour of gases, thermochemistry, atomic structure and the periodic table, chemical bonding and architecture, the structure of liquids and solids, and frontiers in chemistry.

Offered every year. This year in **Fall** or **Winter** terms. Available in **Summer** term.
Summer - Three lecture hours per week, one tutorial hour per week, 1 three-hour laboratory session on alternate weeks. One term. Three credits.
Fall/Winter - Two and one-half lecture hours per week, one tutorial hour per week, six three-hour laboratory sessions. One term. Three credits.

Prerequisites: OAC Chemistry, 12U chemistry or SC/CHEM 1500 4.00 or equivalent.
Course Credit Exclusion(s): SC/CHEM 1000 6.0, SC/CHEM 1010 6.0, AK/CHEM 2000 6.0

Text(s) & Other Materials: "General Chemistry", 10th Ed., R. H. Petrucci, F. G. Herring, J. D. Madura and C. Bissonnette (Pearson, 2011).

Course Content

1. Gases: The behaviour of gases, equations of state, kinetic theory and speed distribution law, intermolecular forces and real gas compressibilities.
2. Thermochemistry: Thermodynamic quantities (heat, work, internal energy), the first law of thermodynamics, enthalpy of formation and reaction, calorimetry and thermochemistry.
3. Atomic Theory and the Periodic Table: An introduction to the wave theory of the atom, quantum theory, quantum numbers, spdf orbitals, electron configurations, the Periodic Table, periodicity of atomic properties and the relationship to the properties of the elements.
4. Chemical Bonding: Chemical bonding (ionic and covalent), relationships to electronegativities, Lewis structures, resonance, molecular shape determination, bond energies, valence bond theory, hydrogen bonding, and van der Waals forces.
5. Solids and Liquids: Properties of liquids (surface tension, viscosity, vapourization) and solids (melting, sublimation, intermolecular forces, crystal structures).

Please note that the Chemical Society at York distributes **tutorial packages** for SC/CHEM 1000.

SC/CHEM 1001 3.0 'Chemical Dynamics'

A complement to SC/CHEM 1000 3.00 with emphasis on chemical change and equilibrium. Topics include chemical kinetics, chemical equilibrium, entropy and free energy as driving forces for chemical change, electrochemistry and frontiers in chemistry.

Offered every year. This year in **Winter** term. Available in **Summer** term.
Summer - Three lecture hours per week, one tutorial hour per week, 1 three-hour laboratory session on alternate weeks. One term. Three credits.
Winter - Two and one-half lecture hours per week, one tutorial hour per week, six three-hour laboratory sessions. One term. Three credits.

Prerequisites: OAC Chemistry, 12U chemistry or SC/CHEM 1500 4.00 or equivalent.
Course Credit Exclusion(s): SC/CHEM 1000 6.0, SC/CHEM 1010 6.0, AK/CHEM 2000 6.0.

Text(s) & Other Materials: "General Chemistry", 10th Ed., R. H. Petrucci, F. G. Herring, J. D. Madura and C. Bissonnette (Pearson, 2011).

Course Content

1. Chemical Kinetics: The rates of chemical reactions in homogeneous gas and liquid phases, rate laws, reaction mechanisms, temperature dependence, and catalysis.
2. Chemical Equilibria: Principles of chemical equilibria, equilibrium constants, Le Châtelier's Principle, acids and bases, titrations, buffers, solubility, common ion effect and pH-effects on solubility.
3. Entropy and Free Energy: Entropy, Second Law of Thermodynamics, spontaneous change, free energy change and equilibrium, temperature dependence of equilibrium, Clasius-Clapeyron and related equations.
4. Electrochemistry: Oxidation states, balancing redox reactions, electrochemical cells and potentials, electrochemical work, the Nernst equation, batteries and corrosion.

Please note that the Chemical Society at York distributes **tutorial packages** for SC/CHEM 1001.

SC/CHEM 1500 4.00 'Introduction to Chemistry'

An introductory course in chemistry for students needing an adequate preparation for SC/CHEM 1000 3.0 and SC/CHEM 1001 3.0. Topics include basic atomic theory, stoichiometry, the periodic table, chemical bonding, equilibria, acids and bases, oxidation-reduction and organic chemistry.

Offered every year. This year in **Fall** term.
Three lecture hours per week, three laboratory hours and mandatory enrolment in the SC/CHEM 1509 0.00 tutorial (two tutorial hours in alternate weeks). One term. Four credits.

Prerequisites: Students will be counseled to enrol either in this course or in SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00, depending on their previous chemistry experience.
Course Credit Exclusion(s): SC/CHEM 1520 4.0. May not be taken by any student who has taken or is currently taking another university course in chemistry.

Text(s) & Other Materials: "General Chemistry", Petrucci, Harwood and Herring, 8th Ed., (Prentice Hall, 2002).

Course Content

1. Review of measurement, significant figures, metric system and dimensional analysis.
2. Elements and compounds, states of matter.
3. Molecular formulas, chemical equations, reaction stoichiometry.
4. The atom, electrons, electron configurations, orbital diagrams, periodicity.
5. Chemical bonding, Lewis structures, molecular geometry of simple molecules, oxidation numbers.
6. Oxidation reduction reactions, electrochemical cells.
7. Chemical equilibrium, ions in aqueous solution, acid-base equilibria, titrations, buffers.
8. Organic chemistry, isomerism, functional groups.
9. Simultaneous enrolment in CHEM 1509 0.00 is compulsory.

SC/CHEM 1550 3.00 'Introductory Biochemistry for Nurses'

An introductory course in Chemistry as applied to the Nursing Profession. Provides an overview of the basic chemical and biochemical concepts relevant to the understanding and promotion of human health and wellness.Offered every year.

This year in **Fall** term. Two lecture hours per week, one tutorial hour per week where dosage calculations and assignments will be discussed. One term. Three credits.

Prerequisites: Only open to students in the Second Entry Nursing Program.

Text(s) & Other Materials:

- Bettelheim, F.A., Brown, W.H., & March, J. (2004) Introduction to organic and biochemistry (5th Ed.) Brooks/Cole: Toronto, ON
- Osis, M. (2003) Dosage calculations in SI units (4th Ed). Mosby: Toronto, ON
- Kee, J.L. & Paulanka, B.J. (2000) Handbook of fluid, electrolyte and acid-base imbalances. Delmar Publishers: Toronto, ON
- Fischbach, F. (2002) Nurses' quick reference to common laboratory and diagnostic tests (3rd Ed.) Lippincott, Williams and Wilkins: Philadelphia, PA.

Course Content

- The course teaches the fundamentals of: nutrition, metabolism, gene expression as well as fluid, electrolyte and acid-base balance in the body. Topics to be covered include:
- The chemical level of human organization
- Nutrition, vitamins and minerals
- Carbohydrates
- Lipids
- Proteins
- Bioenergetics: The conversion of food to energy
- Chemical communications
- Nucleotides, nucleic acid and heredity
- Gene expression and protein synthesis
- Body fluids and electrolyte balance
- Acid and base balance in the body

The pedagogical components of the course include lectures; tutorial sessions; assignments; tests; and examinations. A special emphasis will be placed on drug dosage calculations in the tutorial sessions.

SC/CHEM 2010 3.00 'Symmetry, Electronic Structure and Bonding'

Note: *This course will be offered for the last time in 2011-12.*

An introduction to elementary group theory and wavefunctions for atoms and molecules. Topics include descriptions of bonding and the use of symmetry in the construction of molecular orbitals and in the derivation of selection rules for electronic and vibrational spectroscopy.

Offered this year in **Winter** term. Three lecture hours, one tutorial hour per week. One term. Three credits.

Prerequisites: Both SC/CHEM 1000 3.00 and SC/CHEM 1001 3.00, or SC/CHEM 1000 6.0; SC/MATH 1013 3.00, SC/MATH 1014 3.00
Prerequisite or Corequisite: SC/PHYS 1010 6.00 or SC/PHYS 1410 6.00 or SC/PHYS 1420 6.00, pending approval

Text(s) & Other Materials: There is no required text but appropriate books will be placed on reserve in the Steacie Science Library. These may include:

- "Introduction to Crystallography", D.M. Sands.
- "Chemical Bonds: An Introduction to Atomic and Molecular Structure", H.B. Gray.
- "University Chemistry", B. Mahan.
- "The Structures of Molecules", G.M. Barrow.

The more important material will be available in a Course Reader.

Course Content

- Symmetry operations, group multiplication and character tables for simple point groups.
- The Schrödinger equation and introduction to quantised systems.
- Atomic orbitals.

- Many-electron atoms, Slater determinants.
- Selection rules for atomic spectroscopy.
- Valence bond theory, resonance and hybrid orbitals.
- Molecular Orbital Theory: Linear combination of atomic orbitals (LCAO).
- Molecular orbitals for homonuclear and heteronuclear diatomics and for small polyatomic molecules (e.g. water and butadiene).
- Vibration-rotation spectra of diatomic molecules.
- Molecular vibrations and a brief introduction to normal coordinate analysis.

SC/CHEM 2011 3.00 'Introduction to Thermodynamics'

This course is an introduction to equilibrium thermodynamics. The three laws of thermodynamics and the thermodynamic state functions are described. Many applications are considered including the operation of heat engines, phase transformations, thermochemistry. and chemical reaction equilibria.

Offered every year. This year in Fall term. Three lecture hours, one tutorial hour per week. One term. Three credits.

Prerequisites: SC/CHEM 1000 3.00 or SC/CHEM 1001 3.00; SC/MATH 1013 3.00 and SC/MATH 1014 3.00

Text(s) & Other Materials: TBA

Course Content

- Temperature, heat, and work: Introduction and review of ideal gas. Temperature, energy, and the motion of gas molecules. Internal energy, heat, and work. The First Law of Thermodynamics, reversible processes. Expansion and compression of ideal gases. Heat capacities, enthalpy, and latent heat. Standard enthalpy changes and standard states. Thermochemistry. The meaning of equilibrium. State and path functions, total differentials and partial derivatives.
- Entropy and the Second Law of Thermodynamics: Definition of entropy and statements of the Second Law. Entropy is a state function; the Clausius inequality. Calculating entropy changes in reversible processes. Entropy production in irreversible processes. Absolute entropies and the Third Law of Thermodynamics. Helmholtz and Gibbs free energies.
- Applying Thermodynamics: Phase Equilibria: The Fundamental Equation of Thermodynamics. Partial derivatives: the mathematical machinery of Thermodynamics. Temperature and pressure dependence of ΔG. Temperature and pressure dependence of phase equilibria. The phase rule and phase diagrams.
- Applying Thermodynamics: Chemical Equilibria and Electrochemistry: Partial molar quantities and chemical potential. Gibbs free energy changes and the equilibrium constant. The activity; equilibrium constants in terms of activity. Temperature dependence of chemical equilibria. Electrochemical cells; the Nernst equation.
- Deviations from Ideal Behaviour: Solutions. The Gibbs-Duhem equation; thermodynamics of mixing. Enthapies of mixing and activities. Chemical potentials, activities and standard states. Ideal and non-ideal solutions. Dilute solutions, Henry's Law. Colligative properties. Electrolyte solutions.

SC/CHEM 2020 6.00 'Organic Chemistry'

Current description: Structure including stereochemistry, physical and chemical properties of simple organic compounds; methods in structure determination; introductory concepts of reaction mechanisms and methods for determination of mechanisms.
Pending approval, new description: Structure including stereochemistry, physical and chemical properties of simple organic compounds; methods in structure determination; Interchanges between all major functional

groups and major types of reaction mechanism.

Offered every year. This year in Fall & Winter terms (full-year course). Available in Summer term (see Summer Offerings).

Summer: Five lecture hours, one tutorial hour and three laboratory hours per week. One term. Six credits.
Fall/Winter: Two and one half lecture hours and one tutorial hour per week, three laboratory hours every second week. Two terms. Six credits.

Prerequisites: Both SC/CHEM 1000 3.00 and SC/CHEM 1001 3.00, or SC/CHEM 1000 6.00
Course Credit Exclusion(s): SC/CHEM 2020 5.0

Text(s) & Other Materials:
- Organic Chemistry, L.G. Wade, Jr., 6th or 7th Ed. or 2010 York Custom Ed. (Prentice Hall)
- Recommended: Solutions Manual for L.G. Wade, Jr., Organic Chemistry, J. W. Simek (Prentice Hall)
- Recommended: Molecular Model Set for Organic Chemistry (Allyn and Bacon, 1984)

Course Content

- Review of electronic structure and properties of main group elements (first two rows), chemical bonding. orbital hybridization, molecular orbital theory, conjugation and resonance. Bond moments, dipole moments, intermolecular interactions.
- Stereochemistry: conformations of acyclic and cycloalkanes, alkenes, alkynes, chiral carbon, and asymmetry of molecules. Optical activity, absolute configuration. Systems with more than one chiral center.
- Functionality: Alkanes, Haloalkanes, alkenes, alkynes, arenes, alcohols, amines, ethers, ketones, aldehydes, carboxylic acids (discussion of Bronsted acid-base theory) and derivatives. Some characteristic reactions of each class, including interconversions. Multi-step synthetic sequences.
- Mechanisms of chemical reactions: photochemical halogenation, S_N1, S_N2, E1, E2, S_EAr and several others.
- Structure determination: elemental analysis and mass spectrometry, nuclear magnetic resonance (NMR) and infrared (IR) spectroscopy.

SC/CHEM 2030 3.00 'Basic Inorganic Chemistry'

Current description: The descriptive chemistry of the more common elements is discussed within the context of qualitative inorganic analysis. Principles of ionic equilibria in aqueous solution, elementary coordination chemistry and electrochemical potentials are presented.

Pending approval, new description: An introduction to symmetry, structure and bonding. Descriptive chemistry of common elements. Coordination chemistry.

Offered every year. This year in Winter term. Three lecture hours, one tutorial hour. One term. Three credits.

Prerequisites: Both SC/CHEM 1000 3.00 and SC/CHEM 1001 3.00, or SC/CHEM 1000 6.00
Course Credit Exclusion(s): SC/CHEM 2030 4.00.

Text(s) & Other Materials: "General Chemistry", 10th Ed., R. H. Petrucci, F. G. Herring, J. D. Madura and C. Bissonnette (Pearson, 2011) as well as a course kit on molecular symmetry.

Course Content

- Introduction to symmetry.
- Ionic equilibria in aqueous solutions.
- Elementary coordination chemistry.
- Redox potentials and electrochemistry.
- Descriptive chemistry of the common elements.

SC/CHEM 2050 4.00 'Introductory Biochemistry'

An introduction to biochemistry primarily for chemistry students. Course material includes cellular functions, biomolecules and metabolism.

Offered every year. This year in Winter term. Three lecture hours, three laboratory hours, one tutorial hour. One term. Four credits.
Prerequisite or correquisite: SC/CHEM 2020 6.00
Course Credit Exclusion(s): SC/BIOL 2020 3.00 (or 4.00), SC/BCHM 2020 3.00 (or 4.00)

Text(s) & Other Materials: TBA

Course Content

A course introducing students to biochemical topics.

A. Lecture Material
1. Cells, tissues, organs, organelles and their roles.
2. Macromolecules, their roles and their building blocks: amino acids and proteins, nucleotides and nucleic acids, lipids, sugars and polysaccharides.
3. Enzymes and their properties: structures and active site, introductory enzyme kinetics, coenzymes and cofactors.
4. Metabolism: glycolysis, tricarboxylic acid cycle, electron transport and respiration, photosynthesis, fatty acid metabolism

B. Laboratory Material: Ten weekly laboratory experiments will be conducted to provide practical experience that demonstrates and supplements the material presented in the lectures, and which teaches students the basic experimental techniques used by biochemists. The laboratory experience may be a combination of dry and wet experiments teaching observation, data collection and appropriate data treatment, with formal, graded written reports. The topics covered may be rotated from year to year and may include isolation of cell components, staining for microscopy, buffer preparations, spectrometric quantitation of nucleic acids, protein isolation & purification, protein crystallization, chemical modification of proteins, electrophoresis, ion exchange chromatography, size-exclusion chromatography, micelles, fermentation, amylase kinetics, enzyme dosing, use of lipases and esterases in stereoselective reactions, nucleic acid structure.

SC/CHEM 2080 4.00 'Analytical Chemistry'

Introduction to quantitative chemical analysis and the analytical method; errors and statistical analysis of data; gravimetric and volumetric methods of analysis including acid-base, precipitation, complexation and redox titrimetry, the effect of equilibria on chemical analysis; introduction to potentiometry and spectrophotometry.

Offered every year. This year in Fall term. Three lecture hours and three laboratory hours per week. One term. Four credits.

Prerequisites: Both SC/CHEM 1000 3.00 and SC/CHEM 1001 3.00, or SC/CHEM 1000 6.00
Course Credit Exclusion(s): SC/CHEM 2110 5.0, SC/CHEM 2110 4.0

Text(s) & Other Materials: "Quantitative Chemical Analysis", D. C. Harris, Freeman (any recent edition).

Course Content

- Introduction to analytical chemistry.
- Errors and statistical analysis.
- Gravimetric methods of analysis.
- Equilibrium in solution.
- Titrimetric methods of analysis.

- Potentiometry.
- Introduction to spectrophotometry.

Grading: 70% lecture, 30% lab. Students must pass the laboratory in order to pass the course. Students will be expected to be familiar with the use of a spreadsheet, or other software, to produce graphs and to perform simple statistical analyses.

SC/CHEM 2550 3.00 'Pharmacology for Health Sciences'

An introduction to the general principles of pharmacotherapeutics, pharmacokinetics and pharmacodynamics.

Offered every year. This year in Winter term. Two lecture hours per week, one tutorial hour per week where assignments will be discussed and student presentations will take place. One term. Three credits.

Prerequisites: SC/CHEM 1550 3.00 or SC/BIOL 2020 3.00 (or 4.00) or SC/BCHM 2020 3.00 (or 4.00)
Note: Preference in enrolment will be given to students in the Second Entry Nursing Program.

Text(s) & Other Materials:

- Pharmacology for Nurses: A Pathophysiologic Approach, 2005. By Michael Adams, Dianne Josephson and Leland Holland Jr. Pearson Prentice Hall Publishing
- Medical dictionary of choice
- Drug handbook of choice

Course Content:

The course teaches the fundamentals of pharmacotherapeutics. Topics to be covered include:

1. Absorption and distribution of drugs
2. Metabolism, excretion and administration of drugs
3. Drug receptor relationships
4. Adverse drug reactions; drug-drug interactions
5. Key receptor systems in the body
6. Drugs of the autonomic nervous system
7. Central nervous system pharmacology
8. Ritalin for treatment of ADHD
9. Drugs for the treatment of pain
10. Chemotherapy of infectious diseases
11. Cancer chemotherapy
12. Drugs to treat inflammation
13. Drugs for the treatment of congestive heart failure
14. Drugs for the treatment of hypertension
15. Drugs to prevent clotting
16. Drugs used to treat diabetes mellitus
17. Drugs to prevent conception
18. Drugs for the treatment of male reproductive disorders
19. Drugs of the immune system - immunizations
20. Substance abuse

The pedagogical components of the course include lectures, tutorial sessions, assignments, tests and examinations.

SC/CHEM 3000 3.00 'Experimental Chemistry I'

A laboratory course in organic, inorganic and physical chemistry, including basic instruction in data-handling, use of the literature and formal report-writing.

Offered every year. This year in Fall term. Six laboratory hours and one one-hour tutorial per week for 10 weeks. One Term. Three credits.

Prerequisites: CHEM 2020 6.00, CHEM 2030 3.00. Not open to students entering Chemistry programs before Fall 2009.
Course Credit Exclusion(s): CHEM 3011 4.0, CHEM 3020 4.0, CHEM 3030 4.0

SC/CHEM 3001 3.00 'Experimental Chemistry II'

A second, advanced laboratory course in organic, inorganic and physical chemistry, building on CHEM 3000.

Offered every year. This year in Winter term. Six laboratory hours per week for 10 weeks. One Term. Three credits.

Prerequisites: CHEM 3000 3.00. Not open to students entering Chemistry programs before Fall 2009.
Course Credit Exclusion(s): CHEM 3010 4.0, CHEM 3021 4.0, CHEM 3031 4.0

SC/CHEM 3010 3.00 'Physical Chemistry'

Note: This course is also available in a 4-credit version, but it may not be appropriate for students whose degree requirements include SC/CHEM 3001 3.0. See the web site (www.chem.ca/ugrad) for details.

Current description: An introduction to spectroscopy and statistical thermodynamics for atoms and small molecules. Determination and applications of enthalpies of formation, reaction and solution for different systems.
Pending approval, new description: An introduction to quantum chemistry, atomic and molecular structures, spectroscopy and statistical thermodynamics for atoms and small molecules.

Offered every year. This year in Winter term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2011 3.00
Course Credit Exclusion(s): SC/CHEM 3010 4.00

Text(s) & Other Materials: Any recent edition of "Physical Chemistry", by P. W. Atkins & J. de Paula. The 9th edition is available in the Bookstore. Any recently published textbook with the title, "Physical Chemistry" would be acceptable but Atkins is recommended.

Course Content

- The principles of quantum mechanics and its applications to simple systems.
- Atomic structure and atomic spectra. Term symbols and selection rules. The structures of simple molecules.
- Rotational, vibrational and electronic spectra of molecules. The fates of excited states and the principles of lasers.
- The relationship between the quantum states of atoms and molecules and thermodynamic properties of matter. Statistical thermodynamics as the link between microscopic properties of matter and its bulk properties. Calculation of thermodynamic properties.

SC/CHEM 3011 3.00 'Physical Chemistry'

Note: This course is also available in a 4-credit version, but it may not be appropriate for students whose degree requirements include SC/CHEM 3000 3.0. See the web site (www.chem.ca/ugrad) for details.

Current description: This is an introductory course in chemical kinetics as applied primarily to reactions in the gas phase but also in solution and at electrode surfaces.
Pending approval, new description: This is an introductory course in chemical kinetics as applied primarily to reactions in the gas phase but also in solution and at surfaces.

Offered every year. This year in Fall term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2011 3.00
Course Credit Exclusion(s): SC/CHEM 3011 4.00, SC/CHEM 3210 4.0

Text(s) & Other Materials: Any recent edition of "Physical Chemistry", by P. W. Atkins & J. de Paula. The 9th

edition is available in the Bookstore. Any recently published textbook with the title, "Physical Chemistry" would be acceptable but Atkins is recommended.

Course Content

- Empirical Kinetics (rates, rate laws, order, molecularity, integrated rate laws, rate constants, half lives).
- Reaction Mechanism (elementary reversible, consecutive, and rate-determining reactions, steady-state approximation, catalysis, pressure-dependent rate constants in unimolecular reactions).
- Complex Processes (chain reactions and explosions, hydrocarbon combustion, reactions in solution, polymerization kinetics, oscillating reactions, photochemical processes).
- Elementary Reaction Rate Theory (collision theory, transition state theory, isotope effects).
- Reactions on surfaces. Gas-solid and liquid-solid reactions.

SC/CHEM 3020 3.00 'Organic Chemistry II'

Note: This course is also available in a 4-credit version, but it may not be appropriate for students whose degree requirements include SC/CHEM 3000 3.0. See the web site (www.chem.ca/ugrad) for details.

A course organizing structural organic chemistry on a mechanistic basis and applying these mechanisms to synthesis and degradation. The application of spectroscopic methods will also be incorporated where appropriate.

Offered every year. This year in Fall term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2020 6.00 or 5.00
Course Credit Exclusion(s): SC/CHEM 3020 4.00

Text(s) & Other Materials: Background: "Organic Chemistry", L.G. Wade Jr., 6th or 7th Ed. (Pearson). A two-volume course kit is available in the bookstore containing lecture notes, problem sets and readings.

Course Content

- Advanced topics in mass spectrometry: isotopic clusters, secondary fragmentations, rearrangements, softer ionization methods.
- Advanced topics in nuclear magnetic resonance (NMR) spectroscopy: chemical shift contributors, complex splitting, magnetic inequivalence, exchange phenomena, diastereotopicity, coupling constants. Introduction to multi-dimensional spectra.
- Carbanion chemistry: enols/enolates, their alkylations and acylations, aldol-type condensations, β-elimination, Michael addition.
- Heterocyclic chemistry: syntheses of common heterocycles, reactivity.
- Biochemically relevant examples are used throughout.
- Laboratory Section: Approximately 7 experiments involving a variety of synthetic and analytical techniques.

SC/CHEM 3021 3.00 'Organic Chemistry III'

Note: This course is also available in a 4-credit version, but it may not be appropriate for students whose degree requirements include SC/CHEM 3001 3.0. See the web site (www.chem.ca/ugrad) for details.

A course building on SC/CHEM 3020 4.0 and introducing methods for probing mechanisms, base-catalyzed reactions, rearrangements, cyclization, strain, pericylic reactions and other topics.

Offered every year. This year in Winter term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 3020 3.00 or 4.00
Course Credit Exclusion(s): SC/CHEM 3021 4.00

Text(s) & Other Materials: Background: "Organic Chemistry", L. G. Wade, Jr., 6th or 7th Ed. (Pearson). Additional material will be made available.

Course Content

- Kinetics and Mechanisms: methods for probing mechanisms.
- Base-catalyzed reactions involving carbanions and synthetic applications.
- Carbanionic intermediates: acid-base involvements. Condensations and reactions. Nucleophilic addition mechanisms.
- Skeletal rearrangements and 1,2-shifts.
- Further molecular rearrangements.
- Pericyclic reactions, especially cycloadditions.
- Design of organic syntheses: the disconnection approach.
- Selected multistage synthetic examples.
- Laboratory Section: Approximately 4 experiments involving a variety of synthetic and spectroscopic techniques and chemical identification of a mixture of two unknowns.

SC/CHEM 3030 3.00 'Transition Metal Chemistry'

Note: This course is also available in a 4-credit version, but it may not be appropriate for students whose degree requirements include SC/CHEM 3000 3.0. See the web site (www.chem.ca/ugrad) for details.

The chemistry of the transition metals is discussed from a historical perspective and within the context of modern theories of bonding, structure, and spectroscopy. Topics will include classical coordination compounds, organometallics, metallocenes, metal carbonyls, and bioinorganic chemistry.

Offered every year. This year in Fall term. Three lecture hours per week. One Term. Three credits.

Prerequisites:
Current: SC/CHEM 2010 3.0; SC/CHEM 2020 6.0; SC/CHEM 2030 3.00 or 4.00
Pending approval: SC/CHEM 2020 6.0; SC/CHEM 2030 3.00 or 4.00
Course Credit Exclusion(s): SC/CHEM 3030 4.00

Text(s) & Other Materials: Text: Cotton, Wilkinson and Gaus, Basic Inorganic Chemistry (Wiley).

Course Content

- Review of elementary bonding theory and principles. Crystal field and molecular orbital theory of octahedral, square planar and tetrahedral structures.
- Coordination Numbers and Geometries of metal complexes: common ligands, chelates, and macrocyclic systems.
- Mechanisms of ligand substitution reactions in octahedral and square planar complexes. Mechanisms of electron transfer reactions. Inner and outer sphere mechanisms. Marcus theory. Electron transfer proteins.
- Introduction to crystal structure determination, Bravais lattices, space groups, bond lengths, van der Waals radii. (Atkins, Physical Chemistry, 4th Ed., Ch. 21)
- Organometallics and complexes of π acid ligands. Metal carbonyl, olefin and phosphine complexes. Metallocenes. 18 NVE rule, stereochemical nonrigidity (NMR).
- Basic organometallic reaction types and catalysis by metal complexes. Olefin hydrogenation, isomerisation, and oligomerization, oxo, Wacker, Fischer Tropsch, and Ziegler-Natta catalysts.
- Introduction to bioinorganic chemistry- heme and nonheme metalloproteins, dioxygen carriers.

SC/CHEM 3031 3.00 'Physical Inorganic Chemistry'

Note: This course is also available in a 4-credit version, but it may not be appropriate for students whose degree requirements include SC/CHEM 3001 3.0. See the web site (www.chem.ca/ugrad) for details.

An introduction to physical and theoretical methods in inorganic chemistry. Topics selected from the following: Atomic structure and spectra, molecular orbital and ligand field theory, bonding, electronic spectroscopy, and magnetism of metal complexes, photochemistry, electrochemistry, solid state chemistry, metal metal bonding.

Offered every year. This year in Winter term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 3030 3.00 or 4.00
Course Credit Exclusion(s): SC/CHEM 3031 4.00

Text(s) & Other Materials: Same as for SC/CHEM 3030 3.00, plus:
- Schlafer and Gliemann: "Ligand Field Theory"
- DeKock and Gray: "Chemical Structure and Bonding"
- Kettle: "Coordination Compounds"
- Gerloch and Constable: "Transition Metal Chemistry"

Course Content

- Atomic structure and atomic spectra. Term symbols, Slater orbitals.
- Ligand Field Spectra. Tanabe Sugano diagrams.
- Charge Transfer Spectra.
- Molecular Orbital Methods. Ligand Field Theory. Angular Overlap Model. Application to simple hydrides, diatomics, polyatomics, clusters, metallocenes.
- Magnetic properties of transition metal compounds.
- Band Theory. Metals. Semiconductors. Solid state devices.
- Electrochemistry of transition metal complexes.
- Inorganic Photochemistry.

SC/CHEM 3050 3.00 'Advanced Biochemistry'

A detailed discussion of enzyme structure and function as well as the chemistry and metabolism of biological molecules including amino acids, nucleotides, lipids and polysaccharides. Control of metabolism at the level of enzyme activity. Knowledge of general concepts of metabolism, details of the major pathways of energy metabolism and of basic aspects of enzyme structure and function is assumed. (Same as SC/BIOL 3010 3.00.)

Offered every year. This year in Winter term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2050 4.00 or SC/BIOL 2020 3.00 (or 4.00) or SC/BCHM 2020 3.00 (or 4.00); SC/CHEM 2020 6.00
Course Credit Exclusion(s): SC/BIOL 3010 3.00, SC/BCHM 3010 3.00

Text(s) & Other Materials: No required text. Any recent edition of Voet & Voet (Wiley) is recommended.

Course Content

- Enzymes: structure, function, regulation.
- Metabolism: degradation and biosynthesis of carbohydrates, lipids, amino acid, nucleotides.

A discussion of enzyme structure and function and metabolic processes with emphasis on control and regulation of metabolic pathways. The course will concentrate on the biosynthesis and degradation of small molecules. The approach to the course is quantitative rather than purely descriptive and problem solving will be an integral part of the course.

SC/CHEM 3051 3.00 'Macromolecules of Biochemical Interest'

A discussion of the structures and functions of naturally occurring macromolecules including nucleic acids, proteins, polysaccharides and related macromolecular conjugates.

Offered every year. This year in Fall term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2020 6.00 and SC/CHEM 2050 4.00 or equivalent
Course Credit Exclusion(s): SC/CHEM 3150 3.0, SC/BIOL 3051 3.00, SC/BCHM 3051 3.00

Text(s) & Other Materials: No overall reference texts are available, but a selection of books covering the major topics will be available in Steacie Science Library. Students should possess a standard textbook of organic chemistry. In addition, access to a good general textbook on biochemistry such as 'Lehninger and Cox', 'Stryer', or 'Moran, Scrimgeour, Horton, Ochs and Rawn' will be useful.

Course Content

- Building units in natural macromolecules: Structural and stereochemical features of monomer units; the nature of inter-residue linkages and their stereochemical consequences; activation of monomers for biosynthesis.
- Polymers: Distinction between addition and condensation polymers; contrasts between synthetic and natural polymers; homogeneity and heterogeneity in polymers; distinction between covalent and non-covalent bonding with respect to hydrogen bonding and hydrophobic interactions; size and shape of macromolecules.
- Proteins: Primary structure of proteins. Sequence determination in proteins, including the use of mass spectrometry; disulfide bridges; protein sub-units.
- Proteins: Secondary, tertiary and quaternary structures in proteins. Definition; pleated sheets and a-helices; conformational information from X-ray diffraction and polarized infra-red spectroscopy.
- Polysaccharides: Primary structure of polysaccharides. Sugar composition; ring size and anomeric configuration of glycosides; determination of sugar sequences and linkage types by methylation, periodate oxidation (including the Smith degradation), and controlled depolymerization; NMR spectroscopy.
- Polysaccharides: Some representative polysaccharides. Starch, cellulose, glycosaminoglycans, some bacterial polysaccharides.
- Nucleic Acids: Chemistry of nucleotides and nucleic acids. Nucleosides and nucleotides; phosphodiester bonds in nucleic acids; reactivities of nucleic acids towards base and enzymes; sequence determinations in DNA and RNA.
- Nucleic Acids: Nucleic acid and protein biosynthesis. The genetic code: replication, transcription and translation. The role of transfer RNA in Protein synthesis.

Structure of Macromolecular Complexes: All students will select a single essay assignment which will comprise 30% of the final grade. A typical list of topics would include:

- The Ribosome - strucure and function
- NMR Spectroscopy - applications in protein and nucleic acid structure determination
- Mass spectrometry applications to proteins
- Carbohydrate degrading enzymes (lysozyme, cellulases, amylases) structure and enzymatic mechanism
- Protein-carbohydrate interactions
- Ribozymes - mechanisms and structures
- In vitro evolution (selection) of functional nucleic acids (aptamers, DNA enzymes)
- Inhibitors of HIV enzymes (protease, RT)
- Protein structure prediction

SC/CHEM 3060 3.00 'Introductory Atmospheric Chemistry'

An introductory course linking chemistry and atmospheric science. Topics include atmospheric evolution; biogeochemical cycles; sources, transformations and sinks of atmospheric species; human impacts such as acid rain, photochemical smog, and depletion of the ozone layer. (Same as SC/EATS 3130 3.00.)

Offered every year. This year in Winter term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 1001 3.00; one of AS/SC/MATH 1010 3.00, AS/SC/MATH 1014 3.00, AK/AS/SC/MATH 1310 3.00, AS/SC/MATH 1505 6.00
Course Credit Exclusion(s): SC/CHEM 3160 3.0, SC/EATS 3130 3.00

Text(s) & Other Materials: "Introduction to Atmospheric Chemistry", D.J. Jacob (Princeton University Press).

Course Content

- Basic concepts: a. Composition and mass of the atmosphere. b. Hydrostatic equilibrium, uniformity of major atmospheric constituents. c. Vertical temperature structure of the atmosphere.
- Mass balance, steady state, and atmospheric change: a. Review of chemical kinetics. b. Mass balance, steady state, and lifetimes in chemical reactions. c. Sources of atmospheric components. d. Sinks of atmospheric components. e. Mass balance and simple models. f. Transport in simple atmospheric models. g. Atmospheric mixing.
- Biogeochemical cycles: a. The carbon cycle. b. The oxygen cycle. c. Coupling between the carbon and oxygen cycles. d. The nitrogen and sulphur cycles.
- Greenhouse effect: a. Absorption and emission of radiation. b. Radiative balance of the Earth. c. Modelling the greenhouse effect. d. Climate change and global warming. e. Atmospheric particles.
- Stratospheric chemistry: a. Basics of photochemical processes. b. Pressure dependence of reaction rates. c. The ozone layer and the Chapman mechanism. d. Basics of stratospheric chemistry. e. Catalytic cycles for ozone destruction. f. The Antarctic ozone hole.
- Tropospheric chemistry: a. Sources and reactions of free radicals. b. Chain oxidation of hydrocarbons; production of ozone. c. Comparison of tropospheric and stratospheric ozone chemistry. d. Chain termination reactions. e. Formation of photochemical smog. f. Ozone control strategies. g. Acid deposition.

SC/CHEM 3070 3.00 'Industrial and Green Chemistry'

An in-depth look at various topics on the evolution of chemistry in the petrochemical, pharmaceutical, dye, agrochemical, food, personal care, cosmetic and detergent industries, including recent environmentally friendly approaches (green chemistry).

Offered this year in Fall term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2020 6.00

Text(s) & Other Materials: No fixed text will be required. A course kit, containing selected readings, is available. Other readings will be selected from library materials.

Course Content

This course is a study of the chemistry of some of the major processes of the chemical industry together with an examination of some representative problems that have emerged, and some solutions that have been developed. There will also be a discussion of standards and regulatory issues.

SC/CHEM 3071 3.00 'Pharmaceutical Discovery'

A practical look into the pharmaceutical industry will be covered, providing an overview of the drug discovery process. Topics include: choosing disease states to study, pharmacological assays, rational drug design, synthetic and analytical chemistry, toxicology, drug metabolism, and clinical trials.

Offered this year in Winter term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2020 6.00, SC/CHEM 2050 4.00 or equivalent

Course Credit Exclusion(s): SC/BIOL 3071 3.00

Text(s) & Other Materials: No fixed text will be required. A course kit, containing selected readings, is contemplated. Other readings will be selected from library materials.

Course Content

A. Historical Evolution of Medicines
- A.1 natural products, extracts, herbal medicines, etc.
- A.2 chemical synthesis, chromatographic separation, structural identification, molecular biology, molecular modeling, high throughput screens (HTS), combinatorial chemistry, genomics.

B. The Drug Discovery Team (what and who forms the modern day pharmaceutical 'team')
C. What Disease Areas Are Under Investigation By Pharmaceutical Firms and What Products Are On the Market
D. Legal Issues: Patenting, Regulatory Aspects (FDA, EPA and Canadian equivalents)
E. The Process of Drug Discovery
- E.1 Pharmacological Assays: How To Assay Against Biological Targets (Enzymes, Receptors, etc.) and How Potential Drug Candidates Are Discovered
- E.2 Synthetic Chemistry: How Diverse Collections of Compounds are Prepared (Combinatorial Chemistry)
- E.3 Rational Drug Design (modeling, crystal structures, QSAR, etc.)
- E.4 Animal Testing
- E.5 Toxicology
- E.6 Pharmacokinetics (Drug Metabolism, Secondary Drug By-products, Drug Movement in the Body, Delivery, etc.)
- E.7 Clinical Trials

F. Case Studies (in-depth examinations of the development of individual drugs, from conception, synthetic evolution and scale-up issues, to proofing and clinical trials)

SC/CHEM 3080 4.00 'Instrumental Methods of Chemical Analysis'

The theory and application of a variety of modern instrumental methods. Topics include basic electronics, signal processing, electroanalytical methods, optical spectroscopy, atomic absorption and emission spectroscopy, chromatography and mass spectrometry. This course covers applications relevant to modern chemical analysis.

Offered every year. This year in Winter term. Three lecture hours, three laboratory hours per week. One Term. Four credits.

Prerequisites: SC/CHEM 2080 4.0; SC/PHYS 1010 6.00 or SC/PHYS 1410 6.00 (or SC/PHYS 1420 6.00, pending approval)
Course Credit Exclusion(s): SC/CHEM 3110 4.0

Text(s) & Other Materials: "Principles of Instrumental Analysis", Skoog & Leary, 6th Ed. (Saunders College Publishers, 2007).

Course Content

- Aims of course - generalized instrument - statistics review.

- Basic Electronics.
- Semiconductor Electronics.
- Computers and interfaces.
- Noise - Averaging etc.
- Chromatography.
- Basic absorption: spectrometer, components, monochromators.
- Atomic absorption and atomic emission.
- Infrared Spectroscopy and Fourier Transform spectrometers.
- Electrochemistry - Advanced applications.
- Mass spectroscopy.

SC/CHEM 3090 3.00 'Introduction to Polymer Chemistry'

This course deals with fundamental aspects of polymer science with special focus on polymer synthesis, polymerization mechanism, kinetics and the key factors which govern molecular weight, polymer architecture and properties. Applications of polymeric materials, including electronic polymers and functionalized polymers, will also be discussed.

Offered this year in Winter term. Three lecture hours per week. One Term. Three credits.

Prerequisites: SC/CHEM 2020 6.00
Course Credit Exclusion(s): SC/CHEM 3200A 3.0

Text(s) & Other Materials:
- Recommended: "Introduction to Polymers", R. J. Young and P. A. Lovell, 2nd Ed. (Chapman and Hall, London, 1991); QD 381 Y6 1991
- Additional reading: "Polymers: Chemistry and Physics of Modern Materials", J. M. G. Cowie, 2nd Ed. (Chapman and Hall, London, 1991) QD 381 C68 1991
- Handouts on specific subjects will be given during the course.

Course Content

This course provides an introduction to the chemistry and properties of polymers and polymeric materials, and will focus on synthesis, mechanisms, kinetics, physical properties, and applications. A detailed outline of the topics expected to be covered follows.
- Review of polymer structural classification. Solubility and miscibility of polymers. Crystalline phases and melting points. Amorphous phases and glass-transition temperatures.
- Fundamental aspects of polymer synthesis. Free radical polymerization, chemistry and kinetics. Ionic polymerization, chemistry and kinetics. Stepwise polymerization, chemistry, kinetics and products. Metathesis and ring-opening polymerization. Catalysis: transition metal-catalyzed polymers and processes.
- Copolymerization, block and graft copolymers, polymer blends, alloys and polymer compatibilization.
- Polymer characterization, principles and practices involved in determination of properties, structural morphology and molecular weights, with particular focus in molecular weight determinations: osmometry, viscosimetry, size-exclusion chromatography (GPC). Thermal analysis of polymers: Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA).
- Polymer reactions: polymer functionalization, degradation of polymers. Auto-oxidation/effects of temperature and light, stabilizing of polymers.
- Overview of polymers of industrial application, commodity polymers and of polymers of specific applications (optical/electronic/biomedical).

SC/CHEM 4000 4.00/8.00 'Research Project'

An original laboratory or theoretical project, supported by studies of the relevant scientific literature.

Offered every year. This year in Fall or Winter terms (half-course) or Fall & Winter terms (full course). Available in Summer term (see Summer Offerings).
Four credits: One term. Six hours of tutorials.
Eight credits: Two terms or equivalent. Twelve hours of tutorials.

Prerequisites: Only open to an Honours student with at least 84 credits, with permission of the Department.
Course Content

- **Proposal**: At the beginning of the project, a proposal approximately one page in length must be submitted jointly by the student and supervisor to the Course Director for approval. This proposal should include short statements concerning motivation (the student's interest and background in the project), scientific merit, plan of the project, likelihood of success and relation to the supervisor's other research (the degree to which the research project is self-contained).
- **Written Report on Thesis**: Towards the end of the research period, the work should be written up as a small thesis (20-25 double-space typed pages is suggested) which should delineate clearly and concentrate heavily on the student's own contribution. Lengthy introductions, description of existing apparati, etc. should be avoided, but there should be a brief discussion of the scientific motivation and importance of the project. The student should prepare at least three copies of the thesis, and submit two copies to the Course Director two weeks prior to the examination. One copy of the thesis will be retained by each of the student, the supervisor and the Department.
- **Examination**: The thesis will be examined by not fewer than two members of the Department of Chemistry (selected by the Course Director) in addition to the supervisor. The student will be asked to give an oral report on the research on which the student will also be examined.
- **Grading**: A final letter grade for a student in the course will be arrived at by the course director, examiners and supervisor. The final grade will be based on the performance in the oral presentation and examination, on the quality of the thesis, on the supervisor's evaluation of the student's overall performance in conducting the research project, and the course director's evaluation. All five components of the grade shall be based on evidence of the student's approach, dedication and technical ability towards research.
- **Public Presentation**: The student is encouraged to present an illustrated lecture of approximately 15 minutes duration at the annual Southwestern Ontario Student Chemistry Conference. The program at this Conference, usually held in mid-March, is comprised of papers presented by undergraduate students from universities in the southwestern Ontario area. It provides an excellent opportunity to participate in a conference setting, and to meet with colleagues from other universities. The event is concluded with a banquet.
- **Tutorials**: The tutorials are geared to help students in the preparation of the written thesis and the oral presentation. They will include sessions on the use of library resources, word processing and computer graphics. Also, students will be encouraged to present their work orally to their colleagues in order to develop skills required for an effective public presentation.

Advice on how to find a supervisor is available on the Chemistry website at
www.chem.yorku.ca/ugrad/Choices/FindingASupervisor.htm.

SC/CHEM 4010 3.00 'Quantum and Computational Chemistry'

Introduction to quantum mechanics; solutions of the Schroedinger equation describing molecular vibrations and rotations; electronic structure; molecular orbitals; computational methods.

Offered this coming year in Fall term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3010 3.0

Text(s) & Other Materials:

- Quantum Chemistry 3rd Edition (2006) John P. Lowe and Kirk A. Peterson, Elsevier Academic Press.
- Supplementary reading material (handouts, articles)

Course Content

- Experiments that show failures of classical mechanics — photoelectric effect, electron diffraction
- The DeBroglie wavelength and the Schrodinger equation
- The free particle and the particle in a box
- Energy quantization, the correspondence principle
- Energies and eigenfunctions for a few systems: particle in a 3D box, harmonic oscillator, rigid rotor, hydrogen atom
- Linear algebra, eigenvalue equations, matrix/operator analogy
- Postulates, theorems, and measurements in quantum mechanics
- Electron spin and the Pauli principle and many-electron atoms
- The Born-Oppenheimer approximation and the orbital approximation
- Hückel molecular orbital theory
- Density Functional Theory
- An introduction to software packages and what they can do: molecular structure; thermochemistry; reaction paths; spectroscopy (IR, UV-visible, NMR)
- Elements of computational chemistry: basis sets; electron correlation; optimization of wavefunctions and molecular geometries
- Comparisons of computational chemistry to experimental results: the good, the bad, and the ugly.

SC/CHEM 4021 3.00 'Synthetic Organic Chemistry'

A course concentrating on strategies of synthesizing complex molecules, with emphasis on carbon-carbon bond-forming reactions, blocking groups, regioselectivity and stereochemical methods.

Offered this year in Winter term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3021 3.00 or 4.00

Text(s) & Other Materials: Organic Chemistry by Clayden, Greeves, Warren and Wothers, Oxford University Press, 2001, ISBN 0-19-850346-6.

Course Content

- Introduction (life problems & solutions, discovery & synthesis, scale up, commercialisation)
- Retrosynthesis (synthons, disconnections, chemoselectivity, group disconnnections, donor and acceptor synthons, umpolung)
- Chemoselectivity and protecting groups
- More retrosynthesis & synthesis case studies
- C=C double bond stereochemistry & synthesis
- Stereoselectivity and asymmetric synthesis
- Rearrangement chemistry
- Fragmentation & stereochemical control
- Heterocycles
- Organometallics in synthesis e.g. cross-couplings
- Scale-up for commercial manufacture and regulatory context

SC/CHEM 4022 3.00 'Theoretical Organic Chemistry'

The basic theoretical techniques for synthesizing many-electron wave functions both from atoms and molecules from one electron functions (orbitals) are described. The approximations and methods of constructing molecular orbitals by the linear combination of atomic orbitals are critically reviewed. Hückel molecular orbitals for the p-systems are used to predict physical properties and reactivities of large organic molecules. Orbital symmetry and correlation diagrams are used to predict whether reactions are photochemically or thermally allowed.

Not offered this coming year. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3010 3.00 or 4.00, SC/CHEM 2020 6.0
Pre- or Corequisite: SC/CHEM 3021 3.00 or 4.00
Course Credit Exclusion(s): SC/CHEM 4040 3.0

Text(s) & Other Materials: "Molecular Orbital Theory for Organic Chemistry", A. Streitwieser (Wiley). "Quantum Chemistry", J.P. Lowe (Academic Press).

Course Content:

- Schrödinger equation.
- Atomic orbitals and Slater orbitals.
- Many-electron atoms, Pauli principles and Slater determinants.
- Variation principal; Born-Oppenheimer approximation and molecular orbitals.
- Self-consistent field (SCF) method of obtaining near Hartree-Fock molecular orbitals.
- Hückel theory for π-systems.
- Use of symmetry in Hückel theory.
- Localisation energies, free valence indices.
- Hückel (4n+2) rule of aromaticity.
- Woodward-Hoffman rules.

SC/CHEM 4023 3.00 'Physical Organic Chemistry'

Advanced topics, including methods for determining mechanisms, the study of reactive intermediates (carbocations, carbanions, carbenes, carbon radicals), acid catalysis and other aspects of mechanistic organic chemistry.

Offered this year in Fall term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3021 3.00 or 4.00

Text(s) & Other Materials: Any mechanistic organic chemistry text such as J. March, "Advanced Organic Chemistry" or T. H. Lowry and K. S. Richardson, "Mechanism and Theory in Organic Chemistry", would be suitable.

Course Content

- Experimental methods for studying reaction mechanisms.
- Study of organic intermediates: Carbocations, Carbanions, Neutrals (free radicals, carbenes, nitrenes).
- Acid-base reactions.
- Strain in chemical reactions.

SC/CHEM 4024 3.00 'Structure Elucidation of Organic and Organometallic Compounds'

Spectroscopic methods for the identification of organic reaction products and other organic and organometallic unknowns, primarily for chemistry students. The main focus is on solving molecular structure using NMR techniques.

Offered this year in Winter term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3020 3.00 or 4.00

Text(s) & Other Materials: A suggested reading list could consist of:

- Modern NMR Spectroscopy – A Guide for Chemists, 2nd Ed., Jeremy K.M. Sanders, Brian K. Hunter, Oxford, 1993; ISBN 0-19-855567-9, QD 96.N8S25 1993.
- UV-Vis Spectroscopy and Its Applications, H.-H. Perkampus, Springer-Verlag, 1992; ISBN 3-540-55421-1, QD96U4P4713 1992.
- Mass Spectrometry – A Textbook, Jurgen H. Gross, Springer-Verlag, 2004; ISBN 3-540-40739-1, QD96M3G76 2004.
- Infrared Spectroscopy: Fundamentals and Applications, Barbara Scott, Wiley, 2004; ISBN 0-470-85428-6, QD96I5S76 2004.
- IR Spectroscopy: An Introduction, Helmut Gunzler, Hans-Ulrich Gremlich, Wiley-VCH, 2002; ISBN 3-527-28896-1 QD 96I5G86 2002.
- Two-Dimensional NMR Spectroscopy – Applications for Chemists and Biochemists, Eds. William R. Croasmun, Robert M.K. Carlson, VCH, 1994; ISBN 1-56081-664-3 QD96N8T87 1994.

Course Content

A course combining spectroscopy and mass spectrometry with the goal of determining structure of various types of organic and organo-metallic compounds.

- Spectroscopy overview.
- In depth presentation of key molecular and spectroscopic properties used in structural determination by NMR.
- Specific strategies will be addressed which impact on the success of these techniques.
- Description of computer programs available for spectral database searches and spectral simulation.
- Spectral properties and structural identification of sugars (and polysaccharides), natural products, aromatic hydrocarbons and organo-metallic compounds.

SC/CHEM 4030 3.00 'Instrumental Methods in Inorganic Chemistry'

Theory and applications of instrumental methods for investigating the structure and properties of inorganic and organometallic compounds. Magnetic resonance techniques (NQR and ESR) UV-Visible, Infrared, Raman and resonance Raman spectroscopy will be introduced and discussed.

Offered this year in Winter term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3031 3.00 or 4.00

Text(s) & Other Materials: No specific text is required. A reading list will be made available and key texts will be placed on reserve in the Steacie Science Library.

Course Content

- Magnetic resonance spectroscopies.
- Electronic spectroscopy, d-d and charge transfer spectra of transition metals.
- Infrared spectroscopy.

- Raman spectroscopy.
- Other techniques.

SC/CHEM 4031 3.00 'Advanced Inorganic Chemistry'

Advanced topics in inorganic chemistry, including organometallic, synthesis, reaction types, fluxionality and analysis.

Offered this year in Fall term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3030 3.00 or 4.00; SC/CHEM 3031 3.00 or 4.00 is recommended
Course Credit Exclusion(s): SC/CHEM 4130 3.0

Text(s) & Other Materials: "Structural Methods in Inorganic Chemistry", Ebsworth, Rankin and Cradock, (Blackwell Scientific Publishers).

Course Content

This course builds upon concepts learned in lower level (SC/CHEM 1000-3000) inorganic courses. The course emphasizes the use of this knowledge to address issues and solve problems related to synthetic organometallic chemistry. Reaction types encountered in organometallic chemistry are presented in great details. Particular attention is paid to the synthetic aspects of transition metal complexes and to their reactivity.

SC/CHEM 4050 3.00 'Bioanalytical Chemistry'

Note: There are special recommendations regarding the pre-requisites and timing for this course.

This course describes modern methods of bioanalytical chemistry in their application to the analysis of biological polymers: proteins, nucleic acids, carbohydrates and lipids. Analytical aspects of genomics and proteomics are considered.

Offered this year in Fall or Winter terms. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 2020 6.00, SC/BIOL 2020 4.00 (or 3.00) and SC/BIOL 2021 4.00 (or 3.00)

Text(s) & Other Materials: No fixed text. Students will be given comprehensive handouts and lecture notes.

Course Content

- Introduction. Biological molecules. Equilibrium and activity. Aqueous acid-base chemistry.
- Sequencing of proteins. Electrophoresis of proteins gel, isoelectric focusing, and capillary. Mass spectrometry of proteins. Optical detection of proteins - absorption, fluorescence. Time-resolved fluorescence detection. Energy transfer.
- Protein databases/proteomics.
- Antibody as reagent; complexation chemistry; affinity chromatography. Analytical aspects of immunoassay.
- Analysis of carbohydrates.
- Analysis of lipids.
- Electrophoresis of DNA. DNA sequencing. Genomics.
- Cytometry flow, image, chemical.
- Data analysis.
- Good laboratory practice.

SC/CHEM 4051 3.00 'Biological Chemistry'

Bio-organic and bio-inorganic topics: the structure and mode of action of active sites in enzymes and other proteins, especially including the roles of coenzymes and metals. Abiotic models. Secondary metabolic formation of aromatic natural products, terpenoids and some alkaloid classes.

Offered this year in Fall term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 2020 6.00 and SC/CHEM 2050 4.00 or equivalent (SC/CHEM 2030 3.00 (or 4.00) strongly recommended)

Text(s) & Other Materials: No fixed text. Students will be given comprehensive handouts and lecture notes.

Course Content

- Some active sites and their mode of action: hemoglobin/myoglobin, cytochromes and heme-containing oxidases, Carboxypeptidase, Carbonic Anhydrase, serine proteases, purple acid phosphatase, hemerythrin, etc.
- Coenzymes and their chemistry: coenzyme B12, thiamine (vitamin B1), pyridoxal/pyridoxamine (vitamin B6), NAD(P)H/NAD(P)+, etc.
- Small-molecule structural and functional models: O2-binding heme and non-heme models, artificial esterases and phosphoesterases, etc.
- Secondary metabolism: in vivo assembly of aromatic compounds, terpenoids, isoquinoline alkaloids, tropane alkaloids, etc.; use of isotope tracing by ^{13}C-NMR.

SC/CHEM 4080 3.00 'Advanced Analytical Separation Methods'

Advanced theory and practice of high–resolution separation techniques, especially high–resolution chromatography and capillary electrophoresis, with emphasis on the practical application of advanced theories and the problem of optimizing separation procedures. Analytical procedures as integrated methods. Possibilities and limitations of interfacing sample injection, separation method and detection.

Offered this year in Winter term. Three lecture hours per week. One term. Three credits. The course will be offered in alternate years.

Prerequisites: SC/CHEM 3080 4.00
Course Credit Exclusion(s): SC/CHEM 4050D 3.0, CHEM 4200D 3.0

Text(s) & Other Materials:

- "Principles of Instrumental Analysis", D.A. Skoog and J.J. Leary, 6th Ed.; Harcourt Brace College Publishers, 2007.
- "Capillary Electrophoresis", D.R. Baker, Wiley and Sons, 1995.

Course Content

- Short review of the principles of chromatographic techniques with emphasis on high resolution GC and HPLC.
- Capillary electrophoresis and related techniques.
- Multidimensional separation techniques.
- Ion chromatography.
- Sample preparation for advanced separation techniques.
- Coupling of high resolution separation methods with advanced detection techniques.

SC/CHEM 4081 3.00 'Principles and Applications of Mass Spectrometry'

This course will develop Mass Spectrometry as an analytical tool in chemistry and biochemistry, at an advanced level. The course will be delivered in three sections: instrumentation, theory and applications. Topics will include ionization, mass analyzers, ion dissociation, ion mobility, qualitative and quantitative analysis with various applications, including in the health and medical sciences.

Offered this year in Winter term. Three lecture hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3020 3.00 or 4.00; SC/CHEM 3080 4.00

Text(s) & Other Materials: No fixed text. Readings will be selected from library materials.

Course Content

Mass Spectrometry is rapidly growing in importance as an analytical tool in the health and medical sciences. This course will provide a detailed introduction to mass spectrometry, covering all major topics in instrumentation, theory and applications, and building upon the fundamentals in fragmentation patterns and isotopic diversity acquired in the prerequisite coursework.

Topics:

1. Instrumentation
   * 1.1 The history of MS
   * 1.2 Ionization
   * 1.3 Mass Analyzers
   * 1.4 Ion Mobility
   * 1.5 Detectors
2. Theory
   * 2.1 Quadrupole Mass Selection
   * 2.2 Ion traps
   * 2.3 Fourier Transform Ion Cyclotron Resonance
   * 2.4 Ion Dissociation
3. Applications

   A variety of areas of application will be presented, for instance in the measurement of drugs, explosives and environmental contaminants, studies of protein function and complex assembly and proteomics.

Learning Objectives:

By the end of the course, students will:

- Be familiar will all common MS instrumentation, their parts and their function.
- Understand the theory underlying common MS techniques, their individual capabilities and limitations, including but not limited to issues of sampling, resolution and purity.
- Be familiar with current applications of mass spectrometry in academic research and industry, and be able to derive structural information from mass spectrometric data of various types.
- Understand the techniques and limitations of sample preparation and of sampling methodology, artefacts, data handling, storage and retrieval.
- Be able to design experiments and experimental sequences aimed at solving complex analytical problems and answering complex structural questions, with particular application to proteins and proteomics.
- Be able to critically read, understand and summarize in writing the findings in current literature reports on mass spectrometry methods and applications.

SC/CHEM 4090 3.00 'Topics in Material Sciences'

Several aspects of the structure/property relationship in materials are discussed using examples from various fields (electronics, alternative energy sources, life sciences and polymer sciences). The main objective is to enable the student to understand the theory behind selected properties and to rationalize a material's behaviour in term of its structure.

Not offered this coming year. Three lecture hours per week that will include demonstration when appropriate (no laboratory required). One term. Three credits.

Prerequisites: SC/CHEM 3010 3.00 or 4.00; SC/CHEM 3031 3.00 or 4.00

Text(s) & Other Materials: No single text is suitable. Sets of notes will be distributed in class. A list for supplementary reading books and articles will be available in the Steacie Library.

Course Content

This course shows how various material structures and properties can be understood and explained using an extension of the student's knowledge in physical, inorganic and organic chemistry. Emphasis is on selected topics in various areas of current interest in materials science.

- Review knowledge of crystal structure and x-ray diffraction.
- Introduction to solid-state synthesis methods.
- Electronic properties of materials: insulators, semiconductors and metals are defined in terms of their band structures.
- Superconductivity and magnetic properties and their relation to a material's structure and composition.
- Thermal properties of materials: heat capacity, thermal conductivity and thermal expansion.
- Mechanical properties & surface and interface phenomena.

SC/CHEM 4091 3.00 'Frontiers in Electrochemistry'

This course will present selected aspects of modern surface electrochemistry, electrocatalysis and electroanalysis. It will introduce new methods and instrumentation employed to understand electrochemical processes at the molecular and atomic levels. This will include scanning probe methods (STM and AFM), IR spectroscopy and X-ray diffraction.

Not offered this coming year. Three lecture hours per week that will include demonstrations when appropriate. One term. Three credits.

Prerequisites: SC/CHEM 3030 3.00 or 4.00, SC/CHEM 3080 4.00. SC/CHEM 3011 3.00 or 4.00 and SC/CHEM 3031 3.00 or 4.00 are strongly recommended.

Text(s) & Other Materials: No fixed text is required. A list of supplementary references will be provided for books available in the Steacie Library that are relevant to this course. Sets of notes will be distributed in class. This course requires demonstration materials that will be used to introduce certain topics of the lectures.

Course Content

The scope of electrochemistry is to study phenomena related to the measurement of potential, current or conductivity. This course will concentrate on issues relevant to various electroanalytical methods and the development of sensors and devices, electrocatalysis and the understanding of electrochemical processes at the atomic and molecular level. A common theme in these areas are the presence of multiple interfaces: liquid/solid, solid/solid, liquid/liquid etc. In most cases, one wishes to control or characterize the chemistry occurring at one of these interfaces without the influence of the others. This requires the use of new methods. This course will be divided in four sections:

- Structure of the electrode/solution interface.
- Introduction to potentiometric and amperometric methods, application to sensors.
- Introduction to electrocatalysis, applications to fuel cells.
- Understanding of electrochemical processes at the atomic and molecular levels, methods and instrumentation.

SC/CHEM 4092 3.00 'X-ray Crystallography'

The principles and practical details of X-Ray crystallography are presented. Computational methods of solving

structures using the SHELX based software will be emphasized. Each student carries out an original structure determination from supplied reflection data.

Offered this year in Fall term. Three lecture hours + unscheduled laboratory hours per week. One term. Three credits.

Prerequisites: SC/CHEM 3031 3.00 or 4.00

Text(s) & Other Materials:
- "X-Ray structure Determination", Stout and Jensen, 2nd Ed. (Wiley, 1989).
- "Crystal Structure Analysis for Chemists and Biologists", Glusker, Lewis, and Rossi (VCH Publishing, 1994)
- References:
  - "X-Ray Crystallography", Ladd and Palmer (1976).
  - "Physical Chemistry", Chapter 21 of 4th Ed., Atkins.
  - "SHELX 97" - a manual for crystal structure determination.

Course Content

- Lattices, Planes, Reciprocal Space, X-Ray Diffraction
- Bravais Lattices, Symmetry, Space Groups
- Practical Matters - crystal growth, mounting, geometric and intensity data collection, hardware and software.
- Structure Factors and Fourier Synthesis.
- The Phase problem. Direct Methods, Patterson Methods.
- Least Squares Refinement.
- Crystallography Literature / Manuscript preparation.

SC/CHEM 4093 3.00 'Biomaterials Chemistry'

This course serves as an introduction of materials used for biomedical applications to students with background in chemistry, physics and biology. Emphasis is on biological and biomimetic surfaces, interactions at the biomaterial/tissue interfaces, and mechanisms involved with biologically driven materials self-assembly.

Offered this year in Winter term. Three lecture hours. One term. Three credits.

Prerequisites: SC/CHEM 3051 3.00 or SC/CHEM 3090 3.00

Text(s) & Other Materials: No fixed text. Readings will be selected from library materials.

Course Content

The course covers a range of natural and synthetic biomaterials, general aspects of their structure, properties, behavior in contact with biological systems, and selected applications. It highlights latest advancements in biomaterials research and technology including approaches to surface modification for enhanced biocompatibility of materials, development of materials with controlled properties for drug delivery and biologically inspired materials that mimic natural systems and processes as well as design of sophisticated three-dimensional architectures for tissue engineering.
- Review of major classes of biomaterials.
- Bulk properties of biomaterials.
- Surface properties of biomaterials, interactions with biological systems and biocompatibility. Methods of surface characterization.
- Surface modification strategies for enhanced biocompatibility.
- Principles of molecular self-assembly. Biomimetic materials.
- Immunoisolation strategies and drug delivery.
- Approaches to tissue engineering.

SC/CHEM 4300 3.00/6.00 'Selected Topics in Chemistry'

By special arrangement through the Chair of the Chemistry Department, a student may enrol in a reading course under the direction of a member of the chemistry faculty to study in a special area of chemistry.

Offered every year. This year in Fall or Winter terms. Available in Summer term (see Summer Offerings).
Regular meetings. One term. Three credits.
Regular meetings. Two terms. Six credits.

200-series 'Research Experience Term' courses

Course Numbers

SC/CHEM 2200 0.0, SC/CHEM 2201 0.0, SC/CHEM 2202 0.0
SC/CHEM 3200 0.0, SC/CHEM 3201 0.0, SC/CHEM 3202 0.0
SC/CHEM 4200 0.0, SC/CHEM 4201 0.0, SC/CHEM 4202 0.0

What these courses are

A sequence of non-credit, pass/fail courses providing part-time supervised research and supplementary laboratory experience. Open only to Chemistry and Biochemistry majors, by permission and subject to availability. Pre-requisites apply. Minimum time commitment: 5 hours per week. One term each, and each available in Fall, Winter and Summer terms.

These non-credit courses provide the structure by which Chemistry and Biochemistry majors can seek and obtain enrichment in terms of professionalism, research experience and practical, specialized laboratory training supplementing that provided by credit courses, to be conducted on a part-time basis under the supervision of one or more participating faculty members. Regular on-campus attendance, face-to-face communication with the supervisor(s) and/or laboratory personnel and active participation in group meetings may be expected.

There are to be three instantiations of the courses at the 2000, 3000 and 4000 levels, allowing students to enrol in up to three terms at each level. The prerequisites are sequential and the pass/fail grading will prevent students having failed one instance from continuing at that year level. The course and grade will appear on the student's transcript.

Potential supervisors are identified by the student or by the Course Director. A written Student-Supervisor Agreement listing the student's course load and other obligations, outlining the tasks and other expectations, and detailing the hours involved will be filed with the Course Director before permission to enrol is given. At the end of the term, the supervisor(s) will provide the student and the Course Director with a pass/fail grade and an assessment of the degree to which the student will have met the agreed-upon expectations and the learning objectives.

Learning Objectives

Laboratory-based work will provide opportunities for practical instruction and experience in some aspect of experimental and analytical chemistry. Alone or in combination with laboratory work, computational work will provide opportunities for data mining, software use and/or programming in simulation or modeling tasks. In all cases, the opportunities are meant to enrich and stretch beyond what is available in other courses. While remaining consistent with the student's past experience, the specifics will vary with the type of work and the level of the student. Unlike the Research Project course, there will be no need to achieve specific research goals, and there is considerable freedom in the definition of the tasks and in the expected contribution of the student. Participation in many individual tasks or projects, especially in collaborative groups, will expose the student to a wide variety of experiences. In general, the objectives are to:

- increase useful experience, versatility and breadth in the student's practical skill set
- promote team work
- promote ethical practice
- promote rigour and meticulousness
- train in literature awareness
- train in experimental design, in implementing the scientific method and in research planning, as appropriate to the type of work chosen
- train in laboratory management
- practice scientific communication, both written and oral
- promote time-management strategies
- enhance professionalism and marketability

The actual objectives achieved will depend on the student's prior experience, the time commitment and the nature of the assigned tasks.

Pre-requisites

The normal sequence is to start with a 200 course in your year level, then progress as desired to a 201 and 202 course. These courses can be taken in any term.

- For SC/CHEM 2200 0.0: Open to year 2 students in a Chemistry or Biochemistry program having completed SC/CHEM 1000 3.0 and SC/CHEM 1001 3.0.
- For SC/CHEM 2201 0.0: SC/CHEM 2200 0.0.
- For SC/CHEM 2202 0.0: SC/CHEM 2201 0.0.
- For SC/CHEM 3200 0.0: Open to year 3 students in a Chemistry or Biochemistry program having completed at least 22 credits in CHEM and BCHM courses.
- For SC/CHEM 3201 0.0: SC/CHEM 3200 0.0.
- For SC/CHEM 3202 0.0: SC/CHEM 3201 0.0.
- For SC/CHEM 4200 0.0: Open to year 4 students in an Honours Chemistry program having completed SC/CHEM 3001 3.0, or to year 4 students in the Specialized Honours program in Biochemistry having completed SC/BIOL 3140 4.0, or with permission of the Course Director. May not overlap with SC/CHEM 4000 4.0 or 8.0, nor with SC/BCHM 4000 8.0.
- For SC/CHEM 4201 0.0: SC/CHEM 4200 0.0. May not overlap with SC/CHEM 4000 4.0 or 8.0, nor with SC/BCHM 4000 8.0.
- For SC/CHEM 4202 0.0: SC/CHEM 4201 0.0. May not overlap with SC/CHEM 4000 4.0 or 8.0, nor with SC/BCHM 4000 8.0.

Note that the university's definitions of year level apply.

How it works

1. There are two ways in which you can find a supervisor for a Research Experience Term course:
   - Identify one or more supervisors yourself, perhaps by first searching the Faculty Research web pages at *www.chem.yorku.ca* for people working on research topics of interest to you, or by contacting the professors you already know, either in person or by email after consulting the Departmental Directory for their email addresses.
   - Fill out the on-line position request form and submit it by email. Once submitted, this will be sent to all professors in the Department. Since professors generally experience much email traffic, this may not have much success in eliciting a response and you may need to follow up with individual contact. There will be no need to fill out the form again, since the Course Director will have a copy, unless there is some detail that you wish to change.
2. Once you have identified a professor (or more than one professor), you will together fill out and sign a Student-Supervisor Agreement form (available on-line) to which both parties shall be held. This will list the general tasks, the expectations and the time commitment. You will detail your academic (course load) and

non-academic obligations for the term in which you wish to enroll. You can only engage in one Agreement and register in only one Research Experience course each term.
3. Submit the Agreement form to the Course Director (for the moment, this is the Undergraduate Program Director) prior to the enrolment deadline for the term in which you wish to volunteer.
4. If the terms of the Agreement are satisfactory (they serve to meet the Learning Objectives) and realistic in view of your other obligations, you will be issued permission to enrol and notified by email. Enrol yourself before the permission expires. There will be no tuition and no fees due.
5. Carry out your assigned duties, as per your Student-Supervisor Agreement.
6. If it appears that you will not be able to fulfill the terms of your Student-Supervisor Agreement, you would be well advised to either seek an amendment to the Student-Supervisor Agreement and submit it for approval by the Course Director, or to drop the course prior to the drop deadline.
7. At the end of the term, the supervisor(s) will report on your participation in the course and issue a Pass or Fail grade that will appear on your transcript. A copy of the report will be available to you.
8. Assuming that you pass and that your course load allows it, permission to continue into the next term by enrolling in the next course in the sequence, with the same supervisor(s) and under the same conditions, will be issued upon request, without additional paperwork. This will result in a new entry in the transcript.
9. Assuming that you pass, you should be able to secure a recommendation letter from your supervisor, should you need one, on the basis of his/her experience with you.

To access the forms, go to *www.chem.yorku.ca*, click on 'Undergraduate Program', choose 'Courses' then '200-series Research Experience Term courses'.

Writing Course

SC/BC 3030 3.0 'Technical and Professional Writing'

This writing-intensive course is for upper-year Science students and others in related fields. Students develop confidence and competence in professional and technical writing. Focus is on communication of complex information in a clear, sensible style.

Three hours per week. One term. Three credits.

Prerequisite: At least 6 non-science General Education credits.
Corequisite: Concurrent enrolment in at least one 3000- or 4000-level Science course (or course which is cross-listed with a Science course), or permission of the instructor.
Degree credit exclusions: SC/BC 3050 3.0, AS/SC/COSC 3530 3.0.

This course may be taken using the Pass/Fail grading option. Science students who wish to take it on a Pass/Fail basis must have completed at least 24 credits and have taken no more than 9 previous Pass/Fail credits for an Honours Degree, or no more than 3 previous Pass/Fail credits for a Bachelor of Science Degree.

Summer Courses

Summer courses are convenient for all kinds of students

- students home for the summer
- visa students
- students with no room in their Fall-Winter schedules
- students who want a lighter load

Our summer courses in General and Organic Chemistry are in preparing to enter a medical, dental or other professional program. Our summer courses are recognized by other universities and can be taken for credit elsewhere. Usually, the home university requires a Letter of Permission (or similar document) in order to credit an on-going degree program with a course taken outside the home university. The home university may require

a minimum grade for the course to be credited. If you are interested in taking a York course for credit at your home university, please enquire from your home department as to the procedure to follow to ensure that the course is credited to your degree.

Summer 2010 Courses

- SC/CHEM 1000 3.00 Chemical Structure
- SC/CHEM 1001 3.00 Chemical Dynamics
- SC/CHEM 2020 6.00 Organic Chemistry
- In addition, students can elect to carry out their Research Projects (SC/CHEM 4000 8.00/4.00) in the Summer.

Of interest to students in the Biochemistry and the Pharmaceutical & Biological programs, the Department of Biology often offers the following courses in the summer: BIOL 1000 3.0, BIOL 1001 3.0, BCHM/BIOL 2020 3.0, BCHM/BIOL 2021 3.0, BIOL 2040 3.0, BCHM/BIOL 3140 4.0 and BCHM/BIOL 4290 4.0.
Summer offerings can vary from year to year. Check the Registrar's website for current summer offerings.

Grading

The FSE-approved correlation of percentage grades to letter grades is as follows:

Letter Grade	Grade-Point Value	Grade-Point Range	Percentage Range
A+	9	8.5+	90-100
A	8	7.5-8.4	80-89
B+	7	6.5-7.4	75-79
B	6	5.5-6.4	70-74
C+	5	4.5-5.4	65-69
C	4	3.5-4.4	60-64
D+	3	2.5-3.4	55-59
D	2	1.5-2.4	50-54
E	1	0.1-1.4	40-49
F	0	0	0-39

How to use this Table:

1. For the purposes of assigning letter grades in a course, the letter in the 1st column which corresponds to the % range in the 4th column is normally used. Thus, a grade of 76% is a B+. However, this correspondence is only a guideline, as Course Directors are free to deviate from this.
2. For the purposes of calculating a grade-point average (gpa) over many courses, the value in the 2nd column corresponding to the letter in the 1st column is multiplied by the number of credits. Thus, a B+ in a 6-credit course contributes 42 points. This product is summed for all courses and the sum is divided by the total credits. In case of repeated courses, only the second grade counts unless a petition to make a later grade count is granted.
3. For the purposes of evaluating an average letter grade, use the letter from the 1st column which corresponds to the gpa range in the 3rd column. Thus, a B average means a gpa between 5.50 and 6.49.

Writing Centre

Bethune College's Writing Centre offers workshops and individualized instruction in academic writing to students affiliated with Norman Bethune College. If you are enrolled in a Bethune course, in Science & Engineering, in Environmental Studies, or in the Science & Technology in Society program (STS), you may request an appointment with a Bethune writing instructor.

Bethune Writing Centre instructors are faculty members who specialize in rhetoric and composition. They have interdisciplinary backgrounds in science, environmental studies, media, literature, social science, planning, case writing, and government.

Typical assignments include lab reports, short essays, research papers, Honours Theses, Plans of Study, technical reports, and feasibility reports. Writing instructors work on actual assignments, to help you:

- Identify audience and purpose
- Understand the assignment
- Discover and organize ideas
- Present evidence in your discipline
- Document sources in your discipline
- Revise

You may see a writing instructor at any stage of your writing process - from writer's block to final revisions. Be sure to bring your notes and a copy of the assignment with you to your meeting. Writing instructors do not proofread or correct grammar, but they will show you patterns of error for your attention.

Group instruction (2-4 students) is recommended, and available during regular appointment times. We encourage you to set up a writing group: students with writing partners are known to achieve better results in academic writing. For more than 4 students, please ask your course instructor to request a workshop.

To book an appointment, please speak to the Academic Secretary, 205 Bethune College, 736-2100 ext. 22035 or visit *www.yorku.ca/bethune*.

Downloads

Available on the Undergraduate website (www.chem.yorku.ca/ugrad):

- **Descriptive Brochures** on: *Analytical Chemistry*, *Biochemistry*, *Materials Chemistry*, *Pharmaceutical & Biological Chemistry Stream*, *Seneca@chem.yorku.ca* (for Seneca CHT & CLP graduates)
- **Useful documents**: (1) *2009 Program Changes & You*: A Summary of changes to the Chemistry degree programs effective Fall 2009, & how they affect you; (2) *2006 Program Changes & You*: A Summary of changes to the BSc and Spec Hon BSc programs effective Fall 2006, & how they affect current students; (3) *Chart of Degrees involving Chemistry*; (4) *Undergraduate Course Offerings: Scheduling and Prerequisite Chart*; (5) *Changes to BIOL/BCHM 2020, 2021 & 2040*: A Summary of changes effective Fall 2011, and how they affect you; (6) *Brief overview of Careers for Chemists & Biochemists*.

Laboratory Safety & Safety Resources

Chemists commonly live to a grand old age, in spite of dealing regularly with hazardous equipment and dangerous substances. What's their secret? They keep alert, they know about the hazards involved, and they think SAFETY in the laboratory.

Safety is not just about you living a long life. It's also about everyone else around you being safe, it's about not getting injured, it's about protecting your clothes, your books, your experiments.

Available on the Undergraduate website (www.chem.yorku.ca/ugrad):

- Guidelines for Laboratory Safety
- Links to online Safety Resources

Academic Advising

Advising helps students pick their courses, survey and plot their academic progress, and can be used to obtain advice of all kinds.

New Students

Advising for new, incoming students is conducted by the Faculty of Science & Engineering during the summer and in early September. To book an appointment for incoming advising, call 416.736.5790.

Continuing & Transfer Students

Advising is usually conducted during the summer months in preparation for course selection, but is available all year.

Who needs advising?

* 4th-year students in Chemistry and Biochemistry degree programs preparing to graduate
* students transfering from other universities (Admissions Transfer Credit statement needed)
* students transfering from other degree programs (Change in Major form needed)
* students needing help in selecting courses
* students experiencing difficulties with enrolments
* students with special needs or circumstances

To get advising, go to *www.chem.yorku.ca/ugrad*, click on 'Help & Advice' and 'Advising Sessions'.

On-line Advising

At any time, you can monitor your progress toward your chosen degree and also see what a change in degree program will mean for you. Go to *www.chem.yorku.ca/ugrad*, choose 'Help & Advice' then 'On-line Advising'.

Help & Advice

University life is full of challenges. There are so many things to know, so many rules and procedures, and even your friends might not give you the right answer. How to do this? What is that? What if...? How to deal with a personal problem? Where to get career advice? How to get better grades?
The on-line FAQ answers all kinds of questions: "What do I do if...?" or "How do I...?" or "What is...?" or "How can I get help to...?". Simply visit *www.chem.yorku.ca/ugrad*, and choose 'Help & Advice'.

York-Seneca Articulation Agreement

An articulation agreement is now in effect between our Department of Chemistry and the School of Biological Sciences and Applied Chemistry at Seneca, specifically in the Chemical Technology (CHT) and Chemical Laboratory Technology - Pharmaceutical (CLP) Diploma Programs.

It allows for York Chemistry graduates who are intending to follow a career in industry (rather than proceeding towards post-graduates studies) to enter one of the above Seneca programs with advanced standing credits for York courses. York graduates should be able to complete the requirements for a Seneca diploma in a minimum of 3 Seneca semesters.

Details at *www.chem.yorku.ca/ugrad* (choose 'Good Things To Know' then 'York-Seneca Articulation').

Chemical Society at York

The Chemical Society is a student-run club for Chemistry students and students taking Chemistry courses. They organize social and instructional events, sell lab-coats and safety glasses and offer packages of old tests and exams. Visit them at 317 CB or at *www.yorku.ca/csy*.

Work/Study and RAY Programs

Each year, the Chemistry Department offers a number of part-time jobs as lab assistants and researchers within the department. Certain professors also offer part-time or summer positions in their laboratories. These programs are open to full-time students who are Ontario citizens or landed immigrants, and who demonstrate a financial need. Positions are offered in Fall/Winter and Summer terms and the hiring is done shortly beforehand. For more information, visit the Office of Student Financial Services (Bennett Centre) or the program web pages at *www.yorku.ca/osfs/employ/ray.htm* (RAY) and *www.yorku.ca/osfs/employ/wrkstdy.htm* (WS).

Course Materials (Lab) Fees

CHEM 1000 or 1001	$ 10.00	**others**	$ 5.00

Important Dates for 2011-2012

Fall classes: Sept. 7 to Dec. 6
Fall Reading Week: Oct. 8-14
Fall Exams: Dec. 8-22
Fall drop deadline: Nov. 11

Winter classes: Jan. 3 to Apr. 2
Winter Reading Week: Feb. 18-24
Winter Exams: Apr. 4-20
Winter drop deadline: Mar. 9

Please also take note of enrollment deadlines.
For the full list of important dates: *www.registrar.yorku.ca/enrol/dates/index.htm*.

Drop deadline for full-year courses: Feb. 10

Departmental Administration Contacts

Chair (J. Rudolph)	chrchem@yorku.ca	124 CB	416-736-5246
Administrative Assistant (M. Mamais)	mmamais@yorku.ca	124 CB	416-736-5246
Undergraduate Program Director (P. G. Potvin)	pgpotvin@yorku.ca	124 CB	416-736-5246
Undergraduate Program Assistant (N. Bissoon)	chemasst@yorku.ca	124 CB	416-736-5246
CHEM 1000/1001 Director (M. Hempstead)	mikey@yorku.ca	206 CB	416-736-5312
CHEM 1000/1001 Assistant		206 CB	416-736-5312
Graduate Program Director (P. Johnson)	pjohnson@yorku.ca	414 CB	416-736-2100 x 55896
Graduate Program Assistant (M. Baket)	mbaket@yorku.ca	124 CB	416-736-2100 x 77724

Faculty Members

Off-campus telephone callers: dial 416-736-2100 before the 5-digit telephone extension.

Audette, Gerald	audette@yorku.ca	456 CB	33318
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Hastie, Donald R.	hastie@yorku.ca	305 PSE	55388
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Morin, Sylvie	smorin@yorku.ca	346 PSE	22303
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Organ, Michael	organ@yorku.ca	460 CB	55313
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Tsoukanova, Valeria	valeriat@yorku.ca	349 PSE	20015
Wilson, Derek J.	dkwilson@yorku.ca	318 CB	20786

Individual website addresses are listed at *www.chem.yorku.ca* (click on 'Faculty Research').

Undergraduate Degree Programs Involving Chemistry

Honours Major BSc

- Chemistry

Honours Major-Minor BSc

- Chemistry Major and Science Minor in:
  - Applied Mathematics
  - Biology
  - Computer Science & Engineering
  - Earth & Atmospheric Science
  - Kinesiology & Health Science
  - Mathematics
  - Statistics
  - Physics **or** Astronomy
  - Psychology
- Chemistry Minor and Science Major in:
  - Applied Mathematics
  - Biology
  - Computer Science & Engineering
  - Earth **or** Atmospheric Science
  - Kinesiology & Health Science
  - Mathematics
  - Statistics
  - Physics **or** Astronomy
  - Psychology
- Chemistry Major and Arts Minor (21 possible subjects)
- Chemistry Major and Fine Arts Minor (8 possible subjects)
- Chemistry Major and Minor in Environmental Studies

Bachelor of Science (3-year)

- Chemistry
- Chemistry *with optional focus on Analytical Chemistry*

Specialized Honours BSc

- Chemistry
- Pharmaceutical & Biological Chemistry
- Biochemistry
- Chemistry *with optional focus on Analytical Chemistry*
- Chemistry *with optional focus on Materials Chemistry*

Honours Double Major BSc

in Chemistry and one of

- Applied Mathematics
- Kinesiology & Health Science
- Computer Science & Engineering
- Earth & Atmospheric Science
- Biology
- Mathematics
- Statistics
- Physics and Astronomy
- Psychology

Degrees offered by other Faculties

involving a Chemistry Minor

Honours (4-year) Bachelor of Arts (BA)

Arts Major and *Minor in Chemistry*

Honours (4-year) Bachelor of Fine Arts (BFA)

Fine Arts Major and *Minor in Chemistry*

Honours (4-year) Bachelor of Environmental Studies (BES)

Major in Environmental Studies and *Minor in Chemistry*

Bachelor of Education (BEd)

Concurrent or consecutive enrolment with:
Bachelor of Science Degree in *Chemistry* or
Honours Bachelor of Science Degree in *Chemistry*

What program should you follow? What courses should you choose?

There are a number of choices for students, so it is important to make a good choice with your future in mind. To learn about the various programs, here are some resources:

- a chart that summarizes the possibilities [see previous page],
- the **Table of Credit Requirements** below, which lists the different amounts of Chemistry and other subjects required by each degree program,
- brief descriptions of the programs and detailed listings of their requirements on the pages that follow.

When deciding on a program, the following should be kept in mind:

- For easy transferability between programs, the first two years of the *Specialized Honours BSc in Chemistry* degree are identical to those of the *Materials Chemistry* option, the *4-year Analytical Chemistry* option, the *Honours Major BSc* degree, and almost the same as for the *Honours Major-Minor BSc degree*, the *Honours Double Major BSc* degree, the *3-year BSc* degree and the *3-year Analytical Chemistry* option.
- Similarly, the first two years of the *Pharmaceutical & Biological Chemistry Stream* are very similar to those of the *Specialized Honours BSc in Biochemistry* degree.
- Different academic standards are required for continuation in Honours and non-Honours degree programs.
- The Specialized Honours programs are accredited by the **Canadian Society for Chemistry** (CSC).
- Only Honours programs are suitable for post-graduate studies in chemistry.

See pages 51-52 for information on academic standards, accreditation and preparation for graduate studies.

As detailed on our Help & Advice web pages, there is an on-line tool available to help you track your progress, and one-on-one advice on program and course selections is always available. We also offer links to career advice. The Help & Advice pages also answer numerous common questions about policies and procedures. They also point you to resources to help you become a more effective student, to deal with personal issues or to deal with coursework, and provide advice on your options.

Credit Requirements By Type (effective Fall 2009)

	Science (minima)			other	
degree	**CHEM**	**other SC**	**electives**	**Gen Ed**	**free electives**
Spec Hon BSc Chemistry *with optional Materials Chemistry focus*	71	24	0	12	13
Spec Hon BSc Chemistry *with or without optional Analytical Chemistry focus*	68	18	4	12	18
Spec Hon BSc Chemistry - Pharmaceutical & Biological Chemistry stream	64	33	0	12	8
Hon Major-Minor BSc with Major in Chemistry and Minor in another Science	52	18++	20--	12	18--
Hon Major BSc in Chemistry	47	18	25	12	18
Three-year BSc Chemistry *with or without optional Analytical Chemistry focus*	43	18	5	12	12
Hon Double Major BSc in Chemistry & another Science	40	18++	32--	12	18--
Spec Hon BSc Biochemistry	30	55	0	12	12

Notes

- Elective credits in Science serve to fulfill minimum Faculty requirements. A second Major (in Double Major programs) or a Minor (in Major-Minor programs) will reduce the number of credits available for electives.
- A second Major (in Double Major programs) will require at minimum 36 credits in that Major, while a Minor (in Major-Minor programs) will require a minimum 30 credits in the Minor. A second Major or a Minor in another Science may have requirements that overlap those for Chemistry, such that many of the credits required by Chemistry will serve to satisfy the requirements in the other Science subject. A Minor in another Faculty may likewise serve the General Education requirements.

To whom do the following degree requirements apply?

The following degree requirements are those that have been in place since Fall 2009 and apply to students joining in Fall 2009 or thereafter. Students joining earlier are subject to different requirements, which are detailed at *www.chem.yorku.ca/ugrad*. There are also downloadable documents explaining the differences and their options (from *www.chem.yorku.ca/ugrad*, click on 'Resources').

Core Program Requirements

Common to all programs except where noted. Consists of 49 credits, including 37 SC credits and 22 CHEM credits.

Year 1

(21 credits)

- SC/CHEM 1000 3.00 'Chemical Structure' [F, W, S]
- SC/CHEM 1001 3.00 'Chemical Dynamics' [W, S]
- SC/PHYS 1010 6.00 'Physics' [Y] (pre/co-requisite: SC/MATH 1025 3.00)
  or SC/PHYS 1410 6.00 'Physical Science' [Y]
  or SC/PHYS 1420 6.00 'Physics with Applications to Life Sciences' [Y]
- SC/CSE 1540 3.00 (formerly SC/COSC 1540 3.00) 'Computer Use for the Natural Sciences' [F,W]
  or SC/CSE 1020 3.00 (formerly SC/COSC 1020 3.00) 'Introduction to Computer Science' [F,W]
  or SC/CSE 1520 3.00 (formerly SC/COSC 1520 3.00) 'Computer Use: Fundamentals' [F,W]
  or SC/CSE 1530 3.00 (formerly SC/COSC 1530 3.00) 'Computer Use: Programming' [F,W]
- SC/MATH 1013 3.00 'Applied Calculus I' [F,W] – see Note below
- SC/MATH 1014 3.00 'Applied Calculus II' [W] – see Note below

Year 2

(16 credits)

- SC/CHEM 2011 3.00 'Introduction to Thermodynamics' [F]
- SC/CHEM 2020 6.00 'Organic Chemistry' [Y, S]
- SC/CHEM 2030 3.00 'Basic Inorganic Chemistry' [W] (or SC/CHEM 2030 4.0 before Fall 2006)
- SC/CHEM 2080 4.00 'Analytical Chemistry' [F]

In Addition

(12 credits)

General Education -- 12 credits -- Normally taken during the first two years of study but may be delayed to subsequent years or taken during Summer terms [F,W,S]

Important Note Concerning the MATH Requirement

Courses that are *Course Credit Exclusions* for SC/MATH 1013 3.00 or 1014 3.00 are not acceptable substitutes for SC/MATH 1013 3.00 or 1014 3.00. This includes SC/MATH 1505 6.00, SC/MATH 1300 3.00 and SC/MATH 1310 3.00. Students transferring into a Chemistry program from a non-Chemistry program may be allowed an exemption by the Undergraduate Program Director provided that their previous program of study had a different Calculus requirement and that they achieved a high level of competence in meeting that requirement. The same applies to students transferring into Biochemistry. Students transferring *between* Chemistry programs or into a Chemistry program from Biochemistry or into Biochemistry from Chemistry are not eligible for that exemption. Students in a Chemistry or Biochemistry degree program without SC/MATH 1013 3.00 and SC/MATH 1014 3.00 and without that exemption will not be able to graduate.

Specialized Honours BSc in Chemistry

The *Specialized Honours* Degree is the premier program in Chemistry offered at York University and the program into which most students will enter. It is a four-year honours program specializing in chemistry (with at least 68 CHEM credits) with emphasis on education in the five sub-fields of chemistry (analytical, biochemistry, inorganic, organic, and physical/theoretical chemistry) at the 1000-4000 levels. The program also includes cognate requirements, some with options. This program provides an ideal preparation for graduate studies in Chemistry and is fully accredited by the Canadian Society for Chemistry (CSC).

Minimum GPA required: 5.50 (effective Fall 2009)

For easy transferability between programs, the first two years of this program are identical to those of the *Materials Chemistry* option, the *4-year Analytical Chemistry* option and the *Honours Major BSc* degree, and virtually identical to those of the *Honours Major-Minor BSc* degree, the *Honours Double Major BSc* degree, the *3-year BSc* degree and the *3-year Analytical Chemistry* option.

Years 1 & 2

(53 credits)

- Chemistry Program Core
- SC/CHEM 2050 4.00 'Introductory Biochemistry' [W]

Year 3

(19 credits)

- SC/CHEM 3000 3.00 'Experimental Chemistry I' [F]
- SC/CHEM 3001 3.00 'Experimental Chemistry II' [W]
- SC/CHEM 3010 3.00 'Physical Chemistry' [W]
- SC/CHEM 3020 3.00 'Organic Chemistry II' [F]
- SC/CHEM 3030 3.00 'Transition Metal Chemistry' [F]
- SC/CHEM 3080 4.00 'Instrumental Methods of Chemical Analysis' [W]

Year 4

(8 credits)

- SC/CHEM 4000 8.00 'Research Project' [Y,S]

In Addition

- Additional 1000-level SC credits are required for a minimum total of 24 1000-level SC credits. BIOL 1000 3.0 and BIOL 1001 3.0 (or BIOL 1010 6.0) are strongly recommended if lacking 12U Biology (see Note), but CHEM 1500 4.0, CHEM 1550 3.0, MATH 1510 6.0, MATH 1515 3.0 and all NATS courses are ineligible for this requirement.
- 15 additional CHEM credits at the 3000 or 4000 levels, of which at least 9 must be at the 4000 level.
- Additional SC courses as needed for a minimum total of 90 SC credits.
- Additional courses as needed for a minimum overall total of 120 credits.

Notes

1. BIOL 1010 3.0 and BIOL 1001 3.0 (or BIOL 1010 6.0) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.0/4.0 as prerequisite) or to transfer to the *Specialized Honours program in Biochemistry* or into the *Pharmaceutical and Biological Chemistry* stream.
2. SC/CHEM 2050 4.0 can be substituted by BCHM/BIOL 2020 4.0 or by the combination of BCHM/BIOL 2020 3.0 and BIOL 2070 3.0. Note that BIOL 1001 3.0 and BIOL 1001 3.0 (or BIOL 1010 6.0) are prerequisite to these substitutes but not to CHEM 2050 4.0. Students having completed CHEM 2050 4.0 will be exempted from BCHM/BIOL 2020 3.0 if transferring to a program that requires it.

Pharmaceutical and Biological Chemistry Stream

This program leads to a Specialized Honours BSc degree with specific mention of the stream on the transcript.

This is a program of study designed for students interested in biologically related chemistry but who don't want to major in biochemistry; it is for students interested in pharmaceutical development, or in the unique chemistry in Nature (bio-organic and/or bio-inorganic chemistry, enzyme mechanisms, biomimetics, bioanalytical chemistry or other aspects of biologically related chemistry). The program provides a solid grounding in Chemistry plus a specialized exploration of the chemistry of biologically and pharmaceutically relevant substances and processes. Thus, it provides a broader, more chemical focus than is available in other degree programs dealing with these subjects (Spec. Hon. BSc in Biochemistry, Hon. CHEM/BIOL Double Major degree, or Hon. CHEM Major/BIOL Minor degree).

This degree program is fully accredited by the Canadian Society for Chemistry (CSC) and is suitable for pursuits at the graduate level as well as for employment in the pharmaceutical industry, government or research & development laboratories in areas of Medicinal or Biological Chemistry.

Minimum GPA required: 5.50 (effective Fall 2009)

A descriptive brochure is available in the *Downloads* section of the website.

For easy transferability between programs, the first two years of this degree stream are almost identical to those of the Specialized Honours BSc degree in Biochemistry.

Years 1 & 2

(67 credits)

- Chemistry Program Core
- SC/BIOL 1010 6.0 'Biological Science' [Y, S] or both SC/BIOL 1000 3.00 'Biology I' [F, W, S] and SC/BIOL 1001 3.00 'Biology II' [W S]
- 12 credits of 2000-level Biochemistry and Genetics (see Note):
  - SC/BCHM/BIOL 2020 4.00 'Biochemistry' (or SC/CHEM 2050 4.00 'Introductory Biochemistry' [W]) and SC/BCHM/BIOL 2021 4.00 'Cell Biology' and SC/BIOL 2040 4.00 'Genetics'
  - or SC/BCHM/BIOL 2020 3.00 'Biochemistry' [F, W, S] (or SC/CHEM 2050 4.00 'Introductory Biochemistry' [W]) and SC/BCHM/BIOL 2021 3.00 'Cell Biology' [W] and SC/BIOL 2040 3.00 'Genetics' [F, W, S] and SC/BIOL 2070 3.00 'Research Methods in Cell and Molecular Biology' [F, W, S]

Years 3 & 4

(45-46 credits)

- SC/CHEM 3000 3.00 'Experimental Chemistry I' [F]
- SC/CHEM 3001 3.00 'Experimental Chemistry II' [W]
- SC/CHEM 3011 3.00 'Physical Chemistry' [F]
- SC/CHEM 3020 3.00 'Organic Chemistry II' [F]
- SC/CHEM 3030 3.00 'Transition Metal Chemistry' [F]
- SC/CHEM 3050 3.00 = SC/BIOL/BCHM 3010 3.00 'Advanced Biochemistry' [W]
- SC/CHEM 3051 3.00 = SC/BIOL/BCHM 3051 3.00 'Macromolecules of Biochemical Interest' [F]
- SC/CHEM 3071 3.00 = SC/BIOL 3071 3.00 'Pharmaceutical Discovery' [W]
- SC/CHEM 3080 4.00 'Instrumental Methods of Chemical Analysis' [W]
- SC/CHEM 4000 8.00 'Research Project' [Y,S]
- SC/BCHM/CHEM 4050 3.00 (= SC/BIOL 4051 3.00) 'Bioanalytical Chemistry' [F, W]
- the combination of SC/CHEM 3021 3.00 'Organic Chemistry III' [W] and SC/CHEM 4021 3.00 'Synthetic Organic Chemistry' [W]
  or SC/CHEM 4051 3.00 (= SC/BCHM 4051 3.00) 'Biological Chemistry' [F] and either
  SC/CHEM 3021 3.00 'Organic Chemistry III' [W]
  or SC/BCHM/BIOL 3110 3.00 'Molecular Biology I: Nucleic Acid Metabolism' [F]
  or SC/BCHM/BIOL 4151 3.00 'Membrane Transport' [F]

In Addition

Additional courses as needed for a minimum overall total of 120 credits.

Notes

- General Education courses may safely be delayed. Some program-mandated courses may be delayed, but this may give rise to scheduling conflicts.
- SC/CHEM 4050 3.00 and SC/CHEM 4051 3.00 may be taken in year 3.
- As of this writing, the 4-credit versions of SC/BCHM/BIOL 2020, SC/BCHM/BIOL 2021 and SC/BIOL 2040 were to be offered for the last time in Summer 2011. Students unable to finish their requirements with 4-credit courses should consult the document titled *Changes to BIOL/BCHM 2020, 2021 & 2040*, available at *www.chem.yorku.ca/ugrad* (select 'Resources' and 'Downloads').

Materials Chemistry Study Plan

This study plan is not yet a special degree stream. It leads to a fully accredited Specialized Honours BSc degree in Chemistry suitable for pursuits at the graduate level in all areas of Chemistry, including Material Sciences. The degree and transcript will not specifically mention the Materials Chemistry focus, but students having completed this study plan can obtain a statement from the department Chair attesting to that fact.

This is a study plan designed for students interested in polymers, electronic materials, optical materials, magnetic materials, surface chemistry, biosensors and/or biomaterials, crystallography and other aspects of chemistry related to the preparation, characterization and use of specialized solid-state materials. It provides a solid grounding in Chemistry plus a specialized exploration of the chemistry of solid-state substances, their preparations and properties. Students having completed 2 or 3 full years of study with a minimum B average will be offered summer placements in University and industrial laboratories. Beyond providing training in Materials Chemistry, these placements are opportunities to carry out original research and to gain experimental skills of value in the job market.

Minimum GPA required: 5.50 (effective Fall 2009)
A descriptive brochure is available in the *Downloads* section of the website.

Years 1-4

(107 credits)

- the requirements for the Specialized Honours BSc program in Chemistry except that, besides the courses listed below, only 6 additional CHEM credits are required at the 4000 levels
- SC/BIOL 1010 6.0 'Biological Science' [Y, S] (or both SC/BIOL 1000 3.00 'Biology I' [F, W, S] and SC/BIOL 1001 3.00 'Biology II' [W S]) or SC/EATS 1010 3.00 'The Dynamic Earth and Space Geodesy' [F] and SC/EATS 1011 3.00 'Introduction to Atmospheric Science' [W]
- SC/MATH 2015 3.00 'Applied Multivariate and Vector Calculus' [F]
  or SC/MATH 2270 3.00 'Differential Equations' [W]
- SC/CHEM 3011 3.00 'Physical Chemistry' [F]
- SC/CHEM 3031 3.00 'Physical Inorganic Chemistry' [W]
- SC/CHEM 3090 3.00 'Introduction to Polymer Chemistry' [W]
- SC/CHEM 4090 3.00 'Topics in Material Sciences' [W]

In Addition

Additional courses as needed for a minimum overall total of 120 credits

Notes

- One or more courses from the Chemistry Program Core may need to be delayed. Consult with an advisor

about course selection and timing.
- BIOL 1010 3.0 and BIOL 1001 3.0 (or BIOL 1010 6.0) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.0/4.0 as prerequisite) or to transfer to the *Specialized Honours program in Biochemistry* or into the *Pharmaceutical and Biological Chemistry* stream.

Four-year Analytical Chemistry Study Plan

This study plan is not yet a special degree stream. It leads to a fully accredited Specialized Honours BSc degree in Chemistry suitable for pursuits at the graduate level in all areas of Chemistry, including Analytical Chemistry. The degree and transcript will not specifically mention the Analytical Chemistry focus, but students having completed this study plan can obtain a statement from the department Chair attesting to that fact.

Analytical Chemistry is a cornerstone of our Science. Students trained in the fundamentals of chemical analysis and separation, and in modern instrumentation, are highly desirable candidates for positions in Industry and government agencies. As well, the field evolves through research and students can pursue graduate studies in this area.

Minimum GPA required: 5.50 (effective Fall 2009)

There is also a three-year program available.

A descriptive brochure is available in the Downloads section of the website.

Years 1-4

- the requirements for the Specialized Honours BSc program in Chemistry except that, besides the two courses listed below, only 9 additional CHEM credits are required at the 3000 or 4000 levels, of which at least 6 must be at the 4000 level.
- SC/CHEM 3070 3.00 'Industrial and Green Chemistry' [F]
- SC/CHEM 4080 3.00 'Advanced Analytical Separation Methods' [W]

Note

BIOL 1000 3.00 and BIOL 1001 3.00 (or BIOL 1010 6.0) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.00/4.00 as prerequisite) or to transfer to the *Specialized Honours* program in *Biochemistry* or into the *Pharmaceutical and Biological Chemistry* stream.

Honours Major BSc in Chemistry

This four-year program is ideal for those students interested in an Honours (120-credit) degree and wishing to develop a Major in Chemistry but with less specialization than in the Specialized Honours program, and without needing to match it with a Major or a Minor in another subject. This provides a student with the opportunity to take Chemistry with the flexibility to add several courses from another discipline or from a combination of disciplines, for instance to prepare for medicine and other health professions or to develop several subjects for a teaching career. This degree program may be suitable for graduate studies in Chemistry or in an interdisciplinary area, depending on course selections.

Minimum GPA required: 5.00

Years 1 & 2

(53 credits)
- Chemistry Program Core
- SC/CHEM 2050 4.00 'Introductory Biochemistry' [W] (see Note 1)

Years 3 & 4

(21 credits)

- SC/CHEM 3000 3.00 'Experimental Chemistry I' [F]
- SC/CHEM 3001 3.00 'Experimental Chemistry II' [W]
- 15 additional CHEM credits at the 3000 or 4000 levels, to include:
  - SC/CHEM 3030 3.00 'Transition Metal Chemistry' [F]

  or SC/CHEM 3050 3.00 = SC/BIOL 3010 3.00 = SC/BCHM 3010 3.00 'Advanced Biochemistry' [W]
  or SC/CHEM 3080 4.00 'Instrumental Methods of Chemical Analysis' [W] (see Note 2)
  - at least 6 credits at the 4000-level (see Note 3) exclusive of SC/CHEM 4000 4.00/8.00 'Research Project' (see Note 4)

In Addition

- Additional 1000-level SC credits as needed for a minimum total of 24 1000-level SC credits (see Notes 5 and 6).
- Additional courses as needed for a minimum total of 42 credits at the 3000 and 4000 levels.
- Additional SC courses as needed for a minimum total of 90 SC credits.
- Additional courses as needed for a minimum overall total of 120 credits.

Notes

1. SC/CHEM 2050 4.0 can be substituted by BCHM/BIOL 2020 4.0 or by the combination of BCHM/BIOL 2020 3.0 and BIOL 2070 3.0. Note that BIOL 1001 3.0 and BIOL 1001 3.0 are prerequisite to these substitutes but not to CHEM 2050 4.0. Students having completed CHEM 2050 4.0 will be exempted from BCHM/BIOL 2020 3.0 if transferring to a program that requires it.
2. CHEM 3080 4.0 is recommended to facilitate employment in industry.
3. Be mindful of 3000-level pre-requisites for 4000-level courses. As well, some 4000-level courses can be taken in year 3.
4. Students in this degree program may undertake SC/CHEM 4000 4.0/8.0, with permission and according to availability, but are not required to do so. If SC/CHEM 4000 4.0/8.0 is taken, at least 6 other 4000-level CHEM credits will still be needed.
5. Excluding CHEM 1500 4.0, CHEM 1550 3.0, MATH 1510 6.0, MATH 1515 3.0 and all NATS courses.
6. BIOL 1000 3.00 and BIOL 1001 3.00 (or BIOL 1010 6.0) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.00/4.00 as prerequisite) or to transfer to the *Specialized Honours* program in *Biochemistry* or into the *Pharmaceutical and Biological Chemistry* stream.

Combined Degrees

These are degrees that combine a Major subject with another Major or a Minor subject.

Honours Double Major BSc in Chemistry

The Department of Chemistry offers several Double Major Degrees combining Chemistry and a second science (see choices below). These are integrated programs giving you an advanced education in two fields of science. They can be demanding programs, and they are only recommended for very good students who can handle the challenge and the workload.

These degree programs are suitable for graduate studies in either Major area or in an interdisciplinary area overlapping the two Major subject areas.

Minimum GPA required: 5.0 (6.0 for the CHEM/BIOL Double Major program)

Possible combinations: Major CHEM with second Major in

• Applied Mathematics (APMA) • Biology (BIOL) • Computer Science (CSE) • Earth & Atmospheric Science (Earth Science Stream) (EATS) • Kinesiology & Health Science (KINE) • Mathematics (MATH) • Psychology (PSYC) • Physics (Physics Stream) (PHYS) • Statistics (STAT)

Listed below are the requirements for the Chemistry portion. The requirements for the second Major can be obtained from the Department offering the second Major, from the University Calendar or from the FSE Office of Academic Services (355 Lumbers). Some requirements here, particularly in the first two years may overlap those of the second Major and need not be retaken or substituted.

Years 1 & 2

(52 credits)

- Chemistry Program Core
- at least three credits from:
  - SC/BIOL 1000 3.00 'Biology I' [F, W, S] (or SC/BIOL 1010 6.0 'Biological Science' [Y, S])
  - SC/EATS 1010 3.00 'The Dynamic Earth and Space Geodesy' [F]
  - SC/EATS 1011 3.00 'Introduction to Atmospheric Science' [W]
  - SC/MATH 1025 3.00 'Applied Linear Algebra' [F,W]
  - or from other 1000-level science courses required for the second major (see Notes)

Years 3 & 4

(22-26 credits)

- SC/CHEM 3000 3.00 'Experimental Chemistry I' [F]
- 15 additional CHEM credits at the 3000 or 4000 levels, including at least 6 credits at the 4000 level
- SC/CHEM 4000 8.00 'Research Project' [Y,S] or SC/CHEM 4000 4.00 'Research Project' [F,W,S] or equivalent Research Project course in the second major

In Addition

(12+ credits)

- General Education -- 12 credits -- Normally taken during the first two years of study but may be delayed to subsequent years or taken during Summer terms [F,W,S]
- The course requirements for the second major.
- Additional courses as needed for a minimum total of 42 credits at the 3000 and 4000 levels.
- Additional SC courses as needed for a minimum total of 90 SC credits.
- Additional courses as needed for a minimum overall total of 120 credits.

Note

- SC/CHEM 1500 4.0, SC/CHEM 1550 3.0, SC/MATH 1510 6.0, SC/MATH 1515 3.0 and all NATS courses are ineligible.
- BIOL 1000 3.00 and BIOL 1001 3.00 (or BIOL 1010 6.00) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.00/4.00 as prerequisite) or to transfer to the *Specialized Honours* program in *Biochemistry* or into the *Pharmaceutical and Biological Chemistry* stream.

Honours Major-Minor BSc (with Major in Chemistry)

The Department of Chemistry offers a Major in Chemistry that can be combined with various Minors in another Science, in Arts, Fine Arts, or in Environmental Studies. If your Major is in Chemistry, the degree is classified as an Honours BSc regardless of the Minor. This degree is for students looking for less specialization in chemistry (more than or equal to 57 credits) than offered in the Specialized Honours Degree, and who wish to add some breadth to their education in a second subject. Options in the program are dictated by the choice of

the Minor (see below for available choices). These degree programs are suitable for graduate studies in Chemistry or in an interdisciplinary area overlapping the Major and Minor subject areas.

There are ten available Minor subject areas in Science and thirty subject areas outside of Science. Possible combinations: Major CHEM with

- a Science Minor in ♢ Applied Mathematics ♢ Biology ♢ Computer Science ♢ Earth & Atmospheric Science ♢ Geography ♢ Kinesiology & Health Science ♢ Mathematics ♢ Physics (Astronomy Stream) ♢ Physics (Physics Stream) ♢ Psychology ♢ Statistics
- a Minor in ♢ Environmental Studies
- an Arts Minor such as in ♢ Anthropology ♢ Classical Studies ♢ Classics ♢ East Asian Studies ♢ Economics ♢ English ♢ French Studies ♢ German ♢ Greek ♢ History ♢ Humanities ♢ Italian ♢ Latin ♢ Linguistics ♢ Philosophy ♢ Political Science ♢ Religious Studies ♢ Russian ♢ Sociology ♢ Spanish ♢ Women's Studies
- a Fine Arts Minor in ♢ Dance ♢ Film & Video ♢ Cultural Studies ♢ Music ♢ Theatre (Production) ♢ Theatre (Theatrical Studies) ♢ Visual Arts (Art History) ♢ Visual Arts (Studio)

Students interested in combining an Arts minor with a Chemistry major should consult the FSE Office of Academic Services (355 Lumbers) for the complete and most current list of available choices.

Minimum GPA required: 5.00

Listed below are the requirements for the Chemistry portion. The requirements for the Minor can be obtained from the Department offering the Minor, from the University Calendar or from the FSE Office of Academic Services (355 Lumbers).

Years 1 & 2

(52 credits)

- Chemistry Program Core
- at least three credits from
  - SC/BIOL 1000 3.00 'Biology I' [F, W, S] (or SC/BIOL 1010 6.0 'Biological Science' [Y, S])
  - SC/EATS 1010 3.00 'The Dynamic Earth and Space Geodesy' [F]
  - SC/EATS 1011 3.00 'Introduction to Atmospheric Science' [W]
  - SC/MATH 1025 3.00 'Applied Linear Algebra' [F,W]
  - or from other 1000-level science courses required for the minor (see Notes)

Years 3 & 4

(30 credits)

- SC/CHEM 3000 3.00 'Experimental Chemistry I' [F]
- SC/CHEM 3001 3.00 'Experimental Chemistry II' [W]
- 15 additional CHEM credits at the 3000 or 4000 levels; SC/CHEM 3080 4.00 'Instrumental Methods of Chemical Analysis' [W] is highly recommended
- at least 9 additional CHEM credits at the 4000 level

In Addition

- The course requirements for the minor.
- Additional courses as needed for a minimum total of 42 credits at the 3000 and 4000 levels.
- Additional SC courses as needed for a minimum total of 90 SC credits.
- Additional courses as needed for a minimum overall total of 120 credits.

Notes

- BIOL 1000 3.00 and BIOL 1001 3.00 (or BIOL 1010 6.00) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.00/4.00 as prerequisite) or to transfer to the *Specialized Honours* program in *Biochemistry* or into the *Pharmaceutical and Biological*

Chemistry stream.

- Some 2000-level CHEM courses have MATH and/or PHYS pre-requisites; careful planning of course sequences is required.
- Courses (in other departments) that are cross-listed with Chemistry may be used to satisfy the 3000- and 4000-level CHEM elective requirements.
- With careful choice of courses in Arts minor subject areas, students may satisfy some or all of the FSE General Education requirements.
- Students taking a minor in Environmental Studies are exempted from 6 FSE General Education credits for taking ES/ENVS 1000 6.00.

Honours Major-Minor degree (with Minor in Chemistry)

Students can combine a Minor in Chemistry with a Major in another Science (BSc), in Arts (BA), in Environmental Studies (BES) or in Fine Arts (BFA) in the same subject areas as above. Students interested in combining an Arts major with a Chemistry minor should consult the FSE Office of Academic Services (355 Lumbers) for the complete and most current list of available choices.

The completion of a Chemistry Minor would give you a very basic education in chemistry but would not be recommended for those wishing to pursue a professional career in chemistry, nor for those intending to pursue graduate studies in Chemistry.

Minimum GPA required: 5.00 (6.00 for the Major BIOL/Minor CHEM program)

Listed below are the requirements for the Chemistry portion. Students must consult the Department of their intended Major for the other requirements.

(30 credits)

- SC/CHEM 1000 3.00 'Chemical Structure' [F, W, S]
- SC/CHEM 1001 3.00 'Chemical Dynamics' [W, S]
- 24 additional credits of 2000- or higher-level CHEM courses, plus any needed prerequisites or corequisites

BSc in Chemistry

The three-year BSc degree in Chemistry is composed of 1000-3000 level courses, predominantly in Chemistry (at least 47 credits) but also including requirements in computer science, mathematics and physics, as well as general education requirements in Humanities and/or Social Sciences. The first two years of this program are identical to those of the 4-year Specialized Honours degree, for easy transferability. The degree offers considerable freedom in the choice of upper-year courses. The program is not suitable for those wishing to enter into a post-graduate degree program in Chemistry. With a sufficient gpa, students graduating with this degree may be able to enter the Honours program.

Minimum GPA required: 4.00

Years 1-3

(70 credits)

- Chemistry Program Core
- 21 CHEM credits at the 3000 level (see Notes)

In Addition

- Additional 1000-level SC credits for a minimum total of 24 1000-level SC credits. SC/CHEM 1500 4.0, SC/CHEM 1550 3.0, SC/MATH 1510 6.0, SC/MATH 1515 3.0 and all NATS courses are ineligible.
- Additional SC courses as needed for a minimum total of 66 SC credits.
- Additional courses as needed for a minimum overall total of 90 credits.

Note

- BIOL 1000 3.00 and BIOL 1001 3.00 (or BIOL 1010 6.0) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.00/4.00 as prerequisite) or to transfer to the *Specialized Honours* program in *Biochemistry* or into the *Pharmaceutical and Biological Chemistry* stream.
- SC/CHEM 2050 4.00 'Introductory Biochemistry' [W] or equivalent is strongly advised. This is especially recommended if contemplating a transfer to a *Specialized Honours* degree.
- SC/CHEM 3080 4.00 'Instrumental Methods of Chemical Analysis' [W] is strongly recommended as preparation for many careers in Industry.
- If prerequisites allow, courses at the 4000 level may be used to meet the 3000-level requirement.

Three-year Analytical Chemistry Study Plan

This study plan leads to a BSc degree in Chemistry. The degree and transcript will not specifically mention the Analytical Chemistry focus, but students having completed this study plan can obtain a statement from the department Chair attesting to that fact.

Analytical Chemistry is a cornerstone of our Science. Students trained in the fundamentals of chemical analysis and separation, and in modern instrumentation, are highly desirable candidates for positions in Industry and government agencies.

Minimum GPA required: 4.00

A descriptive brochure is available in the *Downloads* section of the website.

Years 1-3

- the applicable requirements for the BSc program in Chemistry except that, besides the two courses listed below, only 14 additional CHEM credits are required at the 3000 level (see Notes)
- SC/CHEM 3070 3.00 'Industrial and Green Chemistry' [F]
- SC/CHEM 3080 4.00 'Instrumental Methods of Chemical Analysis' [W]

Notes

- BIOL 1000 3.00 and BIOL 1001 3.00 (or BIOL 1010 6.00) are required for those wishing to take advanced courses in the biological areas (especially courses with BCHM/BIOL 2021 3.00/4.00 as prerequisite) or to transfer to the *Specialized Honours* program in *Biochemistry* or into the *Pharmaceutical and Biological Chemistry* stream.
- SC/CHEM 2050 4.00 'Introductory Biochemistry' [W] or equivalent is strongly advised. This is especially recommended if contemplating a transfer to a *Specialized Honours* degree.
- If prerequisites allow, courses at the 4000 level may be used to meet the 3000-level requirement.

General Education Requirement for all BSc degrees

Students earning other degrees (BA, BES, BFA) with a Minor in Chemistry need to fulfill the General Education requirement appropriate to their degree, information on which will be provided by the home Faculty.

A minimum of twelve (12) credits of General Education courses are required within all B.Sc. programs. These non-science courses provide a broad perspective on current scholarship and the diversity of human experience. The courses are also expected to enhance students' critical skills in reading, writing, and thinking and contribute to their preparation for post-university life. All BSc candidates must choose from two different areas of study, including at least 3 credits from each area, subject to the restrictions noted below. For the purposes of this regulation, "different area" means offered by different academic units such as divisions, departments or

Faculties and excluding courses offered by similar departments in different Faculties.

General Education requirements are normally taken 6 credits at a time in your first and second years. For certain degree programs, however, especially those in an Honours Double Major program, some adjustment in timing of these courses may be desirable, either by enrolment in a summer session or by deferment until your third year.

Many General Education courses are available in the summer, for instance to achieve a lighter course load during the regular academic year. Check the Registrar's web site for each year's summer offerings.

General education courses are normally taken at the 1000 or 2000 level, but higher-level courses are acceptable, subject only to prerequisites and course access specifications for enrolment.

Eligible Courses

The Faculty of Science and Engineering maintains a list of some courses eligible for General Education credit (*http://science.yorku.ca/images/sribeiroyorkuca/geneds2009-1.pdf*). The list is not exhaustive, and other courses can be used if they meet the eligibility guidelines and restrictions set out below. The courses in this list are not offered every year nor every term. Enrolment restrictions may be in place for some courses. In all cases, the University's lecture schedule must be consulted to identify candidate courses that interest you.

Qualified courses may be taken in (with restrictions on areas identified by *):

- the Faculty of Liberal Arts and Professional Studies (FLAPS) in: ♢ Anthropology ♢ English ♢ History ♢ Humanities ♢ Philosophy ♢ Political Science ♢ Social Science ♢ Sociology ♢ Women's Studies;
- Arabic 2700 6.0; Economics 1000 3.0, 1010 3.0, 1900 3.0; French 2200 6.0; Chinese 2200 6.0 (previously AS/CH 2700 6.0); Geography 1000 6.0, 1410 6.0, 2050 6.0, 2060 3.0, 2065 3.0 (courses cannot be used to satisfy general education requirements for BSc or BSc Honours candidates majoring in geography); Hindi 2700 6.0; Italian 2751 9.0, 2761 9.0, 2791 9.0; Japanese 2700 6.0; Linguistics 1000 6.0, 2400 3.0, 2410 3.0, 2430 3.0, 2450 3.0; Modes of Reasoning 1730 6.0, 1760 6.0, 1770 6.0
- the Faculty of Environmental Studies: ENVS 1000 6.0, 2150 3.0
- the Faculty of Fine Arts (FA): Dance 1340 3.0, 2340 3.0; Film 1401 6.0, 1410 6.0, 1701 3.0, 2401 6.0; Fine Arts Cultural Studies 1900 6.0; Music 1510 6.0, 1520 6.0, 1530 6.0, 1540 6.0, 1550 6.0; Theatre 1500 6.0; Visual Arts 1110 6.0, 2110 6.0, 2540 6.0, 2550 6.0, 2620 6.0

Permission may be granted by the Office of Science Academic Services, on an individual basis, for a student to take a course outside the areas and Faculties listed above for general education credit, subject to the course fulfilling the Faculty of Pure and Applied Science breadth and critical skills requirements for general education courses, the student having the appropriate prerequisites and the course access specifications permitting enrolment.

A student who is in doubt regarding whether or not any specific course will fulfill the Faculty of Pure and Applied Science general education requirements should consult the Office of Science Academic Services (355 Lumbers).

Restrictions

- Courses which are cross-listed as SC courses or which are eligible for SC credit, including courses cross-listed as STS courses.
- Courses whose major focus is increased facility in the use of a language.
- Quantitative courses focussing on techniques of mathematics or statistics. For example, this applies to some Economics courses.
- Geography courses for BSc candidates majoring in Geography.
- Women's Studies courses which are cross-listed with Natural Science courses.

Note: General Education courses may not be taken on a pass/fail basis (see "Pass/Fail Grading Option" in Science section III in the Undergraduate Calendar).

Credits and Timing

The Faculty of Science and Engineering operates on a credit system which gives flexibility to the timing of an individual student's program. However, there is a sequence to Chemistry instruction, such that the order in which courses are taken is an important consideration. Thus, most CHEM courses have prerequisites which must be successfully completed first and/or corequisites which must be taken either at the same time or successfully completed earlier. In all cases, pre- and corequisites to program-mandated courses are also program-mandated.

Prerequisites and corequisites are listed with the course descriptions. Course directors have the prerogative of their enforcement.

The prescribed selections of courses in any program are based on a 3-year (for the BSc degree) or 4-year program duration (for Honours BSc degrees), at an average 30-credit-per-year course load in the normal (8-month) academic year (Fall and Winter terms).

Some students will be constrained by circumstances to a lighter load and may take longer to complete the degree requirements but may also take advantage of Summer term offerings in Chemistry and in cognate courses (CSE, MATH, PHYS, etc.) and in those that fulfil the General Education requirement.

The programming of course offerings assumes that the year of study is recognizable (as first, second, third or fourth year) and the course numbering reflects the normal progression. However, it is possible to take some 4000-level courses in year 3, or any 3000-level course in year 4, and so on. Importantly, the timetabling of lectures, tutorials and laboratory periods has been carried out accordingly, so as to avoid conflicts between courses in the same year of study. Students should bear in mind that it may not be possible to avoid timetable conflicts with "out-of-year" courses.

Honours and Your GPA

A student interested in Chemistry will usually derive much more from an Honours BSc degree program than from a 3-year BSc degree program, but entrance and continuation in all Honours programs is dependent on meeting the academic standards set out by the Faculty of Science & Engineering (FSE).

The cumulative grade-point average (gpa) is the credit-weighted average of the grade points corresponding to the letter grades that you earn. York University operates on a 9-point scale. See the Grading Table (p. 32) for the grade point values of the letter grades and the numerical % range to which they correspond.

- To enter a *Specialized Honours program in Chemistry* requires successful completion of at least 24 credits with a minimum cumulative credit-weighted grade-point average (gpa) of 5.50 over all courses completed.
- For students enrolled in Fall 2009 and thereafter, continuation in each year of a *Specialized Honours BSc Chemistry* program requires a minimum cumulative credit-weighted gpa of 5.50 over all courses completed. To graduate in a *Specialized Honours BSc program in Chemistry* requires successful completion of all Faculty requirements, and Department-required courses, and a minimum cumulative credit-weighted gpa of 5.50 over all courses completed.
- For the Specialized Honours Biochemistry program, that minimum is 5.50 over all SC courses and 5.00 overall.
- For the Honours Major program, that minimum is 5.00 over all courses.
- For the Chemistry-Biology Double Major degree or for the Major Biology/Minor Chemistry program, the minimum gpa is 6.00 over all BIOL courses and 5.00 overall, to declare, proceed and graduate.
- For other Double Major or Major-Minor programs with Chemistry as a Major, the minimum gpa is 5.00 over all, in order to declare, proceed and graduate.
- For students enrolled in FW 2001 and thereafter, graduation in the 3-year BSc degree is dependent on achieving an overall cumulative grade-point average of 4.00 (C).

Refer to the York Undergraduate Calendar for a full description of the academic standards for these degree programs.

You may be required to transfer to another degree program if your gpa falls below the required minimum.

Students in Honours programs falling just under the minimum may seek permission to proceed on an Honours Waiver. Details and advice on this situation are available on the website.

Accreditation

The Specialized Honours degrees in Chemistry are fully accredited by the Canadian Society for Chemistry (CSC). As of this writing, these are being considered for re-accreditation for another 10-year period, and the Specialized Honours degree in Biochemistry is being considered for accreditation for the first time.

Accreditation by the CSC implies to other professional chemists that the program meets certain minimum educational criteria and has the potential to prepare graduates to practice their profession in a competent scientific manner. Thus, the CSC requires a minimum number of courses in each sub-discipline, a number of cognate courses and a minimum number of instructional laboratory hours.

In Alberta and Quebec, practicing chemists are licensed by professional bodies under provincial government mandates, and obtaining a license requires an adequate academic preparation, a requirement that a CSC-accredited program satisfies. The Association of Professional Chemists of Ontario is seeking similar licensing for chemists practicing in Ontario.

Accreditations are reviewed every five years by external examiners. Only some of our degree programs are meant to be CSC-accreditable.

Preparation for Graduate Studies

Students completing an Honours degree are eligible for entry into a Graduate Studies program (MSc or PhD), here at York or elsewhere, provided they meet the admission requirements of their university of choice. Currently, a minimum B average (gpa of 5.50 or more on York's 9-point scale) in the 3rd and 4th years of study is required at York University, and a B+ average is preferred for research-based post-graduate programs. However, meeting this minimum implies with no guarantee of acceptance, as space, funding and other limitations restrict the number of new graduate students admitted each year. Students accepted into the York Chemistry graduate program most frequently have higher incoming averages.

Honours Major, Major/Minor or Double Major graduates are in principle admissible to graduate programs in interdisciplinary fields or in their Major(s). In some cases, additional courses in the chosen field may be necessary to better prepare the candidate, depending on course selection in the BSc program and the graduate program area of specialization. Frequently, however, such courses can be used to fulfill part of the graduate degree requirements.

Disclaimer: *Although all information contained herein is intended to be accurate, this document is not intended to be authoritative and we cannot be held responsible for unfortunate errors. The authoritative sources are the University Calendar and the Degree Checklists.*