Chemistry

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Chemistry is the central discipline of science, with interdisciplinary links to all other physical and life science disciplines. The Chemistry Department offers a comprehensive range of courses in the fundamentals of analytical, biochemical, environmental, inorganic, organic, and physical chemistry. Upper-level courses include study in advanced fundamentals, as well as computational, bio-inorganic, and materials chemistry. Chemistry education at Trent involves working closely with faculty and staff in formal lecture and informal laboratory and tutorial/workshop settings. Students enrol in either a General or an Honours program. Many students in the Honours program choose to do a research project in which they obtain first-hand experience in modern chemical research design and methods.

Notes

- A 4U Chemistry or equivalent is a prerequisite for CHEM 1000H and 1010H. Students without this prerequisite should contact the departmental office for advice prior to the opening of registration in the spring.
- All students taking Chemistry courses that have a laboratory component will be expected to pay for breakage of equipment and/or glassware on a per-item basis, billed monthly to their student account.
- The single-major Honours degree program in Chemistry is accredited by the Canadian Society for Chemistry.
- For the Biochemistry & Molecular Biology, Environmental Chemistry, and Chemical Physics programs, see the relevant sections of the Calendar.

Bachelor of Science Program in Chemistry

- In addition to the program requirements listed below, students must satisfy the University degree requirements (see p. 14).
- The same course may not simultaneously satisfy the requirements of both programs in a joint-major degree.
- A maximum of 2.0 credits may be taken in Chemistry project courses (CHEM 4010Y, 4011H, 4012H, 4020D, 4030Y, 4031H, 4032H, 4040D).
- No more than 2.0 credits from thesis or project courses may be counted toward any degree offered wholly or jointly by the Chemistry Department.

The single-major Honours program. 20.0 credits including the following 14.0 credits:

- 5.0 CHEM credits consisting of CHEM 1000H, 1010H, 2100H, 2110H, 2200H, 2300H, 2400H, 2500H, 3200H, and 3520H
- 0.5 CHEM credit from CHEM 3400H or 3410H
- 2.0 CHEM credits at the 3000 level in addition to the above
- 3.0 CHEM credits at the 4000 level, including at least 1.5 credits in lecture courses
- 1.0 science credit at the 4000 level or 1.0 CHEM credit at the 3000 level or beyond in addition to the above
- 1.0 PHYS credit consisting of PHYS 1001H and 1002H
- 1.0 MATH credit from MATH 1110H and 1120H; or from MATH 1005H and one of MATH 1350H or 1550H
- 0.5 MATH or COIS credit in addition to the above (excluding MATH 1001H and 1080H)

The joint-major Honours program. 20.0 credits including the following 8.5 credits:

- 2.5 CHEM credits consisting of CHEM 1000H, 1010H, 2100H, 2400H, and 2500H
- 0.5 CHEM credit at the 2000 level in addition to the above
- 2.0 CHEM credits at the 3000 level
- 2.0 CHEM credits at the 4000 level
- 1.0 MATH credit from MATH 1110H and 1120H; or from MATH 1005H and one of MATH 1350H or 1550H
- 0.5 MATH or COIS credit in addition to the above (excluding MATH 1001H and 1080H)
- 14.0 science credits are required for the Honours degree

The single-major General program. 15.0 credits including the following 7.0 credits:

- 3.5 CHEM credits consisting of CHEM 1000H, 1010H, 2100H, 2110H, 2400H, 2500H, and 3520H
- 2.0 CHEM credits at the 3000 level in addition to the above
- 0.5 CHEM credit in addition to the above
- 1.0 MATH credit from MATH 1110H and 1120H; or from MATH 1005H and one of MATH 1350H or 1550H
- 11.0 science credits are required for the General degree

The joint-major General program. 15.0 credits including the following 6.0 credits:

- 2.5 CHEM credits consisting of CHEM 1000H, 1010H, 2100H, 2400H, and 2500H
- 0.5 CHEM credit at the 2000 level in addition to the above
- 2.0 CHEM credits at the 3000 level
- 1.0 MATH credit from MATH 1110H and 1120H; or from MATH 1005H and one of MATH 1350H or 1550H
- 11.0 science credits are required for the General degree

The minor in Chemistry consists of the following 5.0 credits:

- 1.0 CHEM credit consisting of CHEM 1000H and 1010H
- 2.0 CHEM credits at the 2000 level
- 2.0 CHEM credits at the 3000 level

Please consult the academic timetable for information on courses that will be offered in 2019–2020, including when they will be scheduled.

» **CHEM 1000H: Introductory Chemistry I (Sc)**
Essential aspects of general, molecular, and intermolecular chemistry. Topics include atomic structure, bonding, equilibrium, acids-bases, gases, liquids, solutions, and the solid state. Emphasis is on the relation between molecular and physical properties. Prerequisite: 4U Chemistry or equivalent or permission of instructor (see notes).

» **CHEM 1010H: Introductory Chemistry II (Sc)**
Essential aspects of physical, inorganic, organic, and biological chemistry. Topics include redox chemistry, kinetics, thermodynamics, and an introduction to inorganic, environmental, organic, and biological chemistry. Prerequisite: CHEM 1000H or equivalent, or permission of instructor (see notes).

» **CHEM 2100H: Introductory Organic Chemistry I (Sc)**
An introduction and overview of organic compounds and reactions within synthetic methodology are presented for alkanes, alkenes, alkynes, and alkyl halides. The concepts of stereochemistry are introduced. The driving force behind reactions is examined. Prerequisite: CHEM 1000H and 1010H.

» **CHEM 2110H: Introductory Organic Chemistry II (Sc)**
The thermodynamics and kinetics pertaining to mechanistic organic chemistry are investigated with case example classes of compounds. The application and theory of MS, IR, UV, and NMR spectroscopy in the structural determination of organic compounds are introduced. Prerequisite: CHEM 2100H.

» **CHEM 2200H: Transition Metal Chemistry (Sc)**
The bonding and structure of coordination compounds of the d-block transition metals; mechanisms of ligand exchange and redox reactions; physical and chemical properties of d-block elements. Prerequisite: CHEM 2500H.

» **CHEM-BIOL 2300H: Biochemical Concepts (Sc)**
Introduces key molecules and concepts in biochemistry. Topics include the properties of water, the thermodynamics of biological systems, and the behaviour of biomolecules in water. Focuses on each of the four major classes of biomolecules—proteins, nucleic acids, carbohydrates, and lipids—as they apply to biological systems. Prerequisite: CHEM 1000H and 1010H.

» **CHEM 2400H: Analytical Chemistry (Sc)**
The theory and practice of chemical analysis including dealing with chemical data, wet chemical techniques, electrochemistry, instrumental methods, and separations. Prerequisite: CHEM 1000H and 1010H.

» **CHEM 2500H: Elements of Physical Chemistry: Quantum Mechanics and Reaction Kinetics (Sc)**
An introduction to the properties of atoms and molecules, and the theory and practice of chemical reaction kinetics. Prerequisite: Both CHEM 1000H and 1010H and one of MATH 1120H or 1005H.

» **CHEM-ERSC 2610H: Atmospheric Environmental Chemistry (Sc)**
Designed for students who have taken general chemistry, this course explores and discusses topics such as the greenhouse effect, chemistry of the ozone layer, air pollution, photochemical smog, and acid rain. Prerequisite: CHEM 1000H and 1010H. Excludes CHEM-ERSC 2600Y.

» **CHEM-ERSC 2620H: Aquatic Environmental Chemistry (Sc)**
Exposes the main chemical principles that govern environmental processes in natural waters such as rivers, lakes, estuaries, and oceans. Includes the chemical composition of aquatic systems and the behaviour of aqueous pollutants such as metals and pesticides. Prerequisite: CHEM 1000H and 1010H. Recommended: CHEM-ERSC 2610H. Excludes CHEM-ERSC 2600Y.

» **CHEM 3102H: Advanced Synthetic Organic Chemistry (Sc)**
The structure, reactivity, and synthesis of biologically and industrially important organic molecules are considered. Particular emphasis is placed upon oxygen, sulfur, and nitrogen organic functional group chemistry. The thermodynamics and kinetics of reaction mechanisms of these functional groups are considered. Prerequisite: CHEM 2100H and 2110H. Excludes CHEM 3100Y.

» **CHEM 3110H: Advanced Synthetic Organic Chemistry: Biological Applications (Sc)**
Biologically important reaction pathways that are employed in the synthesis of organic molecules are considered. Particular emphasis is placed upon the chemistry of carbonyl compounds and amines. An introduction to the organic chemistry of metabolic pathways, including pericyclic reactions, is provided. Prerequisite: CHEM 3102H. Excludes CHEM 3100Y.

» **CHEM 3120H: Computational Chemistry (Sc)**
Theory and application of molecular mechanics, semi-empirical and ab initio methods in the investigation of molecular structure, properties, and reactivity. Includes a computer lab component using modern research-level software. Prerequisite: CHEM 2500H, 2100H, and 2110H. Excludes CHEM 4120H.

» **CHEM 3200H: Chemistry of the Main-Group Elements (Sc)**
Structure and bonding in compounds of the main group elements, including symmetry, correlation of physical and chemical properties with electronic structure, crystalline solids, and band theory. Qualitative comparison of the second-row elements with the heavier elements in the group. Prerequisite: CHEM 2200H and 2500H.

» **CHEM-BIOL 3310H: Protein Chemistry and Enzymology (Sc)**
The structure and function or proteins, key protein biophysical methods, and enzyme mechanisms are treated in detail. Students use web-based resources such as ExPASy and the Protein Data Bank, and gain practical laboratory experience in bioseparations and the determination of enzyme rate parameters. Prerequisite: CHEM-BIOL 2300H and one of CHEM 2100H or 2110H.

» **CHEM-BIOL 3320H: Metabolism (Sc)**
The key topics are biological processes that produce and use high-energy biomolecules. These include membrane transport, multienzyme pathways, and their regulation. With their skills acquired in CHEM-BIOL 3310H, students are given more freedom for independent laboratory work in devising and executing their own enzyme purification scheme. Prerequisite: CHEM-BIOL 3310H. Excludes CHEM-BIOL 3300H.

» **CHEM-ERSC-FRSC 3400H: Chromatography (Sc)**
Theory and practice of chromatography, sampling, and quality control. Particular emphasis is placed on applications in environmental analysis. Prerequisite: CHEM 2400H.

» **CHEM-ERSC-FRSC 3410H: Methods of Spectral Analysis (Sc)**
Modern analytical spectroscopic instrumentation, techniques, and application to the analysis of organic, inorganic, and biochemical contaminants with a particular focus on the forensic and environmental fields are addressed. Prerequisite: CHEM 2400H. Strongly recommended: CHEM 2100H and 2110H.

» **CHEM 3520H: Elements of Physical Chemistry: Thermodynamics (Sc)**
An introduction to thermodynamics: the First and Second Laws. The properties of gases, thermochemistry, and principles of chemical equilibrium. Phase diagrams of typical materials. Prerequisite: Both CHEM 1000H and 1010H and one of MATH 1120H or 1005H. Excludes CHEM 2510H.

» **CHEM-ERSC 3600H: Aqueous Environmental Geochemistry (Sc)**
Focuses on the inorganic processes and on the chemistry at the terrestrial-aquatic interface. The principles and applications of chemical weathering, adsorption-desorption, and redox reactions are particularly emphasized. Combines theory and environmental applications. Prerequisite: Both CHEM-ERSC 2610H and 2620H; and either CHEM 2400H or both ERSC 2220H and 2230H.

» **CHEM-ERSC 3610H: Ocean and River Chemistry (Sc)**
Focuses on the parameters controlling the natural water chemistry in surface and subsurface systems. These key processes involve chemical reactions and kinetics, pH control of equilibria, chemical speciation, and photochemical processes. Combines theory and environmental applications. Prerequisite: CHEM-ERSC 2620H; and either CHEM 2400H or both ERSC 2220H and 2230H. Recommended: CHEM-ERSC 3600H.

» **CHEM-FRSC 3720H: Advanced Topics in Forensic Chemistry (Sc) (see Forensic Science)**

» **CHEM 4010Y, 4011H, 4012H: Project Course in Chemistry (Sc)**
Study, usually involving experimental research, under the supervision of a faculty member; includes two seminars and a written thesis. At least eight hours per week. Pre- or co-requisite: Two Chemistry lecture half-courses at the 4000 level; an average of 75% in all previous Chemistry courses; and permission of instructor. Contact coordinator as soon as possible and no later than the end of the preceding Winter term.

» **CHEM 4020D: Project Course in Chemistry (double credit) (Sc)**
Approximately 16 hours per week; otherwise, as CHEM 4010Y. Pre- or co-requisite: Two Chemistry lecture half-courses at the 4000 level; an average of 75% in all previous Chemistry courses; and permission of instructor.

» **CHEM 4030Y, 4031H, 4032H: Project Course in Biochemistry (Sc)**
Study, usually involving experimental research, under the supervision of a faculty member; includes two seminars and a written thesis. At least eight hours per week. Pre- or co-requisite: Two CHEM or BIOL lecture half-courses at the 4000 level; an average of 75% in all previous Chemistry courses; and permission of the instructor. Contact coordinator as soon as possible and no later than the end of the previous Winter term. Only available to students who are pursuing the Biochemistry & Molecular Biology degree and may not be combined with more than 1.0 credit in a project course in any other discipline.

» **CHEM-BIOL 4040D: Project Course in Biochemistry (double credit) (Sc)**
At least 16 hours per week; otherwise as CHEM 4030Y. May not be combined with any other project courses for credit toward the Biochemistry & Molecular Biology degree. Prerequisite: An average of 75% in all previous Chemistry courses and permission of instructor.

» **CHEM 4110H: Medicine and Chemistry: The Design, Synthesis, and Analysis of Drugs (Sc)**
Medicinal and pharmaceutical chemistry are highly interdisciplinary areas of practical and applied chemistry that are adjoined with chemical and structural biology and flank areas such as biochemistry, molecular biology, pharmacology, toxicology, and veterinary and human medicine. This course presents the design, synthesis, and analysis of pharmaceutical and bio-active molecules. Prerequisite: CHEM 3102H and 3110H.

» **CHEM 4140H: Polymeric Materials (Sc)**
Polymers are one of the most far-reaching chemical developments in everyday life. This course explores the chemistry of polymer materials including their synthesis, characterization, and applications, with a focus on the major classes of polymers and recent advances in polymer materials. Prerequisite: CHEM 2100H and 2110H.

» **CHEM 4200H: Organometallic Chemistry (Sc)**
Chemistry of organic and inorganic ligands at metallic centres, including the carbon-metal bond, catalysis, organic ligand transformations, and reactions at metallic centres. Prerequisite: CHEM 2200H.

» **CHEM 4220H: Inorganic Materials (Sc)**
Structure and bonding theory in inorganic molecules is expanded for extended structures (clusters and solids). Topics include band structures in metals, semiconductors, and insulators; superconductors and nanoscale materials. Prerequisite: CHEM 3200H or both CHEM 2200H and 4200H.

» **CHEM-BIOL 4300H: Bioinorganic Chemistry (Sc)**
The essential biological roles of metals are usually acknowledged but seldom discussed in most biochemistry courses. Includes an introduction to coordination chemistry and a survey of the roles of metals in enzyme catalysis, oxygen transport, photosynthesis, cell mobility, gene expression, and environmental toxicity. Prerequisite: CHEM-BIOL 3310H and 3320H; or CHEM 2200H and CHEM-BIOL 2300H.

» **CHEM-BIOL 4310H: Current Topics in Biochemistry (Sc)**
A survey of the questions that are of greatest interest to biochemists. Relies extensively on reading and understanding primary literature sources published within the last four years. Students give presentations in class as part of the course evaluation. Prerequisite: CHEM-BIOL 3310H and 3320H.

» **CHEM 4400H: Mass Spectrometry (Sc)**
An introduction to the principles and modern applications of mass spectrometry in chemical analysis. Topics include fundamentals of ion chemistry, ionization techniques, mass-analyzer and detector design, and applications of hybrid and tandem instrumental design in analytical and organic chemistry and biochemistry. Prerequisite: CHEM 2500H.

» **CHEM-ERSC 4410H: Fundamentals and Applications of ICP-MS (Sc)**
Theory of spectrometric techniques for elemental analysis. Students become acquainted with the current literature and research in analytical/environmental chemistry. Prerequisite: CHEM-ERSC 3400H or 3410H or permission of instructor.

» **CHEM 4430H: Applications of NMR Spectroscopy (Sc)**
Focuses on the practical employment of NMR within organic, biochemical, and environmental fields. Provides a review of the basic theory and instrumentation of NMR, introduces simple 1D, followed by more complex 2D and 3D spectral acquisition and interpretation techniques, and includes heteronuclear elements. Prerequisite: CHEM 2100H, 2110H, and 2500H. Highly recommended: CHEM 3410H. Excludes CHEM 4130H.

» **CHEM 4500H: Photochemistry (Sc)**
Introduction to theory and practice of photochemistry. Topics include interaction of matter with light, unimolecular decomposition, energy transfer processes, photochemical activation, and organic photochemistry, as well as applications in environmental and industrial processes. Prerequisite: CHEM 2500H.

» **CHEM 4515H: Chemical Thermodynamics and Reaction Kinetics (Sc)**
Modern chemical thermodynamics and kinetics. Introduction to statistical thermodynamics: molecular interpretation of entropy and internal energy. Reaction rate theories: gas phase and solution reaction dynamics. Prerequisite: CHEM 2500H, CHEM 3520H, and MATH 1120H; or permission of instructor. Recommended: MATH 2110H and 2120H. Excludes CHEM 3510H.

» **CHEM 4520H: Principles of Water Science and Technology (Sc)**
Designed for students whose main background is in chemistry, this course is an expanded study of the unique properties and role of water in nature and technology. Topics include essential properties of water and aqueous mixtures, chemistry behind clean drinking water, municipal wastewater treatment, water chemistry in power generation systems. Prerequisite: One of CHEM 2500H or 3520H or both CHEM-ERSC 2610H and 2620H.

» **CHEM-FRSC 4710H: Molecules of Murder (Sc)**
Provides a chemical perspective of molecules related to death and poisoning found in contemporary contexts. We explore a range of natural and synthetic molecules and how they are integrated into the applied analytical studies of decomposition, bodily fluid identification, contemporary toxicology, and other specialized topics in forensic chemistry. Prerequisite: CHEM 2110H, 2300H, and 3400H.

» **CHEM 4900Y, 4901H, 4902H: Reading Course (Sc)**
Topics from one of the following fields: analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, physical chemistry, and theoretical chemistry. Project work outside the laboratory may be involved. Offered only by prior arrangement through department office.