CHEMISTRY

About Chemistry

Research in Chemistry

Members of the Department are organized into various research themes. Some of the current research interests are listed below, and are presented in much more detail on the Departmental website.

Analytical/Environmental

The Analytical/Environmental Thematic Research Group at McGill is involved in a wide range of exciting fundamental and applied research with focus on: state-of-the-art instrumental development in spectroscopy; imaging; chemometric and analytical bio-spectroscopy; artificial intelligence; ultra trace sampling; thermochemical, box, and cloud modelling; and state-of-the-art atmospheric kinetics and photochemistry; as well as the development and application of state-of-the-art numerical models of the chemistry of the regional and global atmosphere. Our collective research has direct implications in fields such as materials, environmental, and biomedical chemistry.

Chemical Biology

The Chemical Biology Thematic Research Group is engaged in a diverse range of research topics, which span structural biology, enzymology, nucleic acid research, signaling pathways, single-molecule biophysics, and biophysical chemistry of living tissues. Among the themes that unite the research being performed in this group is the attempt to learn new chemistry and physics from biological systems.

We have projects relating to pharmaceutically relevant enzymes such as those involved in drug metabolism and antibiotic resistance; development of therapeutic agents in the control of inflammation, cancer and viral infections; the chemical biology of NO; quantification of bioenergetic markers of metabolism; self-assembly mechanisms of the HIV-1 virion capsid; liposome microarray systems to address membrane protein dynamics and recognition; studies on reactive oxygen species translocation across the aqueous/lipid membrane interface; RNAi/antisense technologies; dynamic combinatorial chemistry; protein dynamics and function; mechanistic aspects involved in cellular adhesion and transport in membrane and zeolite channels; and cutting-edge microscopes used to examine transport, motility, and reactivity in cells.

Chemical Physics

The research interests of the members of the Chemical Physics Thematic Research Group are diverse, with groups focusing on high-end laser and NMR spectroscopies, kinetics and modelling of atmospheric chemical reactions, experimental and theoretical biophysical chemistry, polymers at interfaces, and statistical and quantum mechanics. In the field of biophysical chemistry, single molecule spectroscopy is being used to probe enzyme function as well as DNA recombination and repair. Our recent advances in image correlation spectroscopic techniques now allow researchers to precisely follow the macromolecular dynamics in living cells. In a similar vein, breakthrough ultra-fast electron diffraction experiments have opened the window to real-time observation of the making and breaking of chemical bonds. State-of-the-art multi-pulse femtosecond spectroscopy experiments are being applied to interesting and technologically important new materials such as photonic crystals and quantum dot superlattices. A molecular-level picture of polymer dynamics and structure at surfaces and interfaces is being developed through theoretical modelling, high-field solids NMR spectroscopy, electron microscopy, and other surface characterization methods. In the area of atmospheric chemistry, the chemical transformation of the atmosphere is being modelled both experimentally and theoretically to understand how these processes are currently affecting and driving climate change. Finally, we have basic theory projects relating to the experimental work just described, as well as in transport and structure in complex colloidal or zeolite systems, protein dynamics, and fundamental issues in quantum and statistical mechanics.

Materials Chemistry

The chemistry of materials is a rapidly evolving domain of research. Materials chemistry seeks to understand how composition, reactivity, and structure are related to function from a molecular perspective. The functionality of materials is expressed in a variety of areas including photonics, micro- and nano-electronics, biosystems, nanotechnology, drug delivery, catalysis, polymer science, molecular biology, and chemical and biological sensing. Activities of the Materials Chemistry Thematic Research Group are often broadly interdisciplinary. University-wide synergies among members of this group have led to the creation of the McGill Institute for Advanced Materials (MIAM) and the McGill Nanotools Facility. The latter comprises state-of-the-art **micro/nanofabrication**, atomic manipulation and high-performance computing facilities. MIAM and members of the Chemistry Department have established research links to the Quebec Centre for Advanced Materials, the Centre for Biorecognition and Biosensors, the Centre for the Physics of Materials, and the Centre for Bone and Periodontal Research. Synthetic approaches to new materials include research in dendrimers, polynucleic acid architectures, polymers that conduct electrons or light, and biopolymers. Polymer and colloid science figure prominently as does research and applications of the chemistry and physical properties of nanostructures. There is significant activity in understanding directed molecular assembly at interfaces and in the application of sophisticated spectroscopic tools to explore them.

Green and Sustainable Chemistry

Green Chemistry is a concept developed in the 1990s by pioneers Paul Anastas and John Warner. It proposes a vision for chemistry in which its products and processes are designed so as to not harm our health or our environment. The sister concept of sustainable chemistry was developed in parallel, with the idea to add the notion of ensuring the renewability of resources. Green and Sustainable Chemistry is now a strategic, key area of research development, with its own vibrant community, dedicated journals and international research centres. It is also identified as a key strategic area for McGill University, as the Department of Chemistry has pioneered the teaching of the topic since 1999. Topically Green and Sustainable Chemistry covers research using tools in organic, inorganic, physical, and biological chemistries with the goal to develop concepts and solutions to grand challenges in sustainability. This field is directly harnessing the powers of chemistry as a toolbox to enable the Sustainable Development Goals, set by the United Nations in 2015.

Synthesis/Catalysis

The Synthesis/Catalysis Research Activity Group is a collective that develops state-of-art catalysts, synthetic methodologies, reaction mechanisms, and synthetic routes for organic chemicals, natural products, and materials. The collective's major research activities at McGill include:

1. Development of novel catalysts and catalytic reactions for highly efficient organic synthesis; Green Chemistry. This includes the

study and discovery of novel transition-metal catalysts, biological catalysts, nano- and dendrimer-based catalysts for synthetic purposes; new chemical reactivity such as C-H activation, asymmetric catalysis and theory, multi-component reactions and combinatorial chemistry; innovative chemistry in alternative solvents such as water, sub-critical water, ionic liquids, and liquid CO2; photocatalytic reactions, reaction mechanisms, and physical organic chemistry; and computational chemistry.

2. Synthesis of biological compounds, organic materials, and natural products. Focus areas are total synthesis of natural products, synthesis of DNA and RNA analogues; synthesis of antiviral and anticancer nucleoside analogues, synthesis of amino acid and peptides; synthesis and study of carbohydrate derivatives; design, synthesis, and study of specialty organic chemical and materials.

Chemistry Admission Requirements and Application Procedures

Admission Requirements

The minimum academic standard for admission to the M.Sc. and Ph.D degree programs is normally a high second class standing (cGPA > 3.00). Students applying from B.Sc. to Ph.D (without completing a M.Sc.) must have a cGPA of at least 3.5. . Applicants from other institutions should have an academic background equivalent to that of a McGill graduate in the Chemistry Honours/Major programs or related fields such as Physics or Biochemistry.

Application Procedures

McGill's online application form for graduate program candidates is available at mcgill.ca/gradapplicants/apply.

See University Regulations & Resources > Graduate > Graduate Admissions and Application Procedures > Application Procedures for detailed application procedures.

Application Dates and Deadlines

Application opening dates are set by Enrolment Services in consultation with Graduate and Postdoctoral Studies (GPS), while application deadlines are set by the Department of Chemistry and may be revised at any time. Applicants must verify all deadlines and documentation requirements well in advance on the appropriate McGill departmental website; please consult the list at mcgill.ca/gps/contact/graduate-program.

Information on application deadlines is available at mcgill.ca/gradapplicants/how-apply/application-steps/application-deadlines.

Admission to graduate studies is competitive; accordingly, late and/or incomplete applications are considered only as time and space permit.

Note: Applications for Summer term admission will not be considered.

All inquiries concerning graduate work in the Department should be addressed to the Director of Graduate Studies, Department of Chemistry.

Available Programs

- Chemistry (Ph.D.)
- Chemistry (Thesis) (M.Sc.) (45 credits)

Location

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