Note

1. Because of space and equipment limitations in laboratory courses, priority must be given to students whose Academic Plans require those courses.

CHEM 00s

CHEM 1 LEC 0.00
Pre-University Chemistry
Essential preparation for first year chemistry courses. Formulae, nomenclature, stoichiometry, an introduction to thermochemistry, solution chemistry, chemical equilibria, acids, bases, oxidation-reduction reactions, kinetics and bonding. [Note: Successful completion of this course fulfills the University admission requirements where high school chemistry is necessary. No University credit.]
Only offered Online

CHEM 38 LEC,TUT 0.50
Introductory Organic Chemistry: Reactions
Laboratory and industrial chemical transformations amongst functional groups, mechanisms of reactions, introduction to spectroscopic methods. [Offered: W, S]
Prereq: CHEM 28/262; third year Engineering.
Antireq: CHEM 265, 267

CHEM 100s

CHEM 120 LEC,TST,TUT 0.50
Physical and Chemical Properties of Matter
The stoichiometry of compounds and chemical reactions. Properties of gases. Periodicity and chemical bonding. Energy changes in chemical systems. Electronic structure of atoms and molecules; correlation with the chemical reactivity of common elements, inorganic and organic compounds.
[Note: Offered: F. Science students must also take CHEM 120L. Successful completion of Grade 12 U Calculus and Vectors and Grade 12 U Chemistry or equivalent courses is required]
Antireq: CHEM 121
Also offered Online

CHEM 120L LAB 0.25
Chemical Reaction Laboratory 1
Selected experiments for students taking CHEM 120.
[Note: Students who are not taking, or who have not previously taken CHEM 120, will be removed from CHEM 120L. Offered: F, S]
Antireq: CHEM 121L

CHEM 123 LEC,TST,TUT 0.50
Course ID: 004040
Chemical Reactions, Equilibria and Kinetics
[Note: Science students must also take CHEM 123L. Offered: W,S]
Prereq: CHEM 120, 121;
Antireq: CHEM 125
Also offered Online

CHEM 123L LAB,TUT 0.25
Chemical Reaction Laboratory 2
Selected experiments for students taking CHEM 123.
[Note: Students who are not taking, or who have not previously taken CHEM 123, will be removed from CHEM 123L. Offered: W,S]
Antireq: CHEM 125L

CHEM 129 LEC 0.50
Introductory Spectroscopy
The electromagnetic spectrum and the production and detection of photons in various energy ranges. Elementary descriptions of atomic and molecular spectra and their use in the locations of energy levels. The use of spectra to elucidate energy states of atoms and molecules and to determine molecular structure. Aspects of ultraviolet, visible, infrared, Raman, microwave and nuclear magnetic resonance spectroscopies. [Offered: S]
Prereq: CHEM 120 or 121.
Antireq: CHEM 209
Also offered Online

CHEM 140L LAB,TUT 0.50
Introductory Scientific Calculations Laboratory
An introductory laboratory for the use and applications of computer software packages, such as Excel and Mathcad, for scientific calculations. The use of such software packages for basic calculations, data analysis, regression analysis, plotting of scientific graphs, data manipulation, and equation solving will be covered, with an emphasis placed upon chemical and biochemical concepts and applications. [Offered: F,W]
Prereq: CHEM 120; Not open to Mathematics students

CHEM 200s

CHEM 209 LEC,TUT 0.50
Introductory Spectroscopy and Structure
The nature of electromagnetic radiation and an elementary outline of quantum mechanics in one dimension. For each of microwave, infrared, Raman, electronic, photoelectron, and nuclear magnetic resonance spectroscopy, the nature of the molecular energy levels involved and the type of molecular information that can be obtained using it are examined. Introduction to diffraction methods. [Offered: F]
Prereq: CHEM 120 or 121 or NE 121.
Antireq: CHEM 129
CHEM 212 LEC, TUT 0.50  
Course ID: 004048

Structure and Bonding  
An introduction to the principles of chemical structure and bonding, with emphasis on their application to inorganic systems. Topics include: atoms, orbitals, and periodicity; localized bonding models; symmetry and group theory; and molecular orbital theory. The subjects treated in this course are foundational components for advanced studies in all areas of chemistry.  
[Offered: W, S]

Prereq: CHEM 120 or 121 and CHEM 123; Honours students only

CHEM 217 LEC 0.50  
Course ID: 013241

Chemical Bonding  
Atomic and molecular structure. Molecular symmetry. Localized bonding models. Molecular orbital theory. Structures of solids. [Not open to students in the following plans: Biochemistry, Chemical Physics, Chemistry, Computational Science (Biochemistry Specialization), Computational Science (Chemistry Specialization), Geochemistry, Science and Business (Biochemistry Specialization), Science and Business (Chemistry Specialization), Minor in Chemistry. Offered: F]

Prereq: CHEM 120 and 123.  
Antireq: CHEM 212  
Only offered Online

CHEM 220 LEC, TUT 0.50  
Course ID: 004052

Intro Analytical Chemistry  
Quantitative and analytical chemistry including ionic equilibria, classical and more recent methods. Emphasis on planning and decision-making in the analytical process. [Offered: F]

Prereq: CHEM 123 or 125; Honours Science Programs.

Antireq: CHEM 228, 223

CHEM 220L LAB 0.25  
Course ID: 004053

Analytical Chemistry Lab 1  
Selected experiments for students taking CHEM 220.

Prereq: CHEM 123L or 125L; Honours Science Programs.

Coreq: CHEM 220.

Antireq: CHEM 228L

CHEM 221 LEC, TUT 0.50  
Course ID: 004054

Multi-Component Analysis  
Instrumental analytical chemistry, including traditional and more recent methods. Emphasis on planning and decision-making in the analytical process. [Offered W, S]

Prereq: CHEM 220, 220L.

Antireq: CHEM 228, 223

CHEM 224L LAB, TUT 0.50  
Course ID: 004058

Analytical Chemistry Laboratory 2  
Extensive lab experience for students who have taken CHEM 223 or 220. [Offered: W, S]

Prereq: One of CHEM 220, 223 and One of CHEM 220L, CHEM 223L; Honours Science programs
CHEM 228 LEC 0.50  
Analytical Chemistry for Life Sciences  
Selected topics of importance to Biology students. [Offered: S]  
Prereq: CHEM 123 or 125.  
Antireq: CHEM 223, 220

CHEM 228L LAB 0.25  
Analytical Chemistry Laboratory for Life Sciences  
Selected experiments for students taking CHEM 228. [Offered: S]  
Prereq: CHEM 123L or 125L; Honours Co-op Biology or Honours Co-op Environmental Science/Ecology.  
Coreq: CHEM 228.  
Antireq: CHEM 220L, 223L

CHEM 233 LEC,TUT 0.50  
Fundamentals of Biochemistry  
Chemistry of amino acids, carbohydrates, lipids and nucleic acids, with special emphasis on representative proteins and enzymes, including hemoglobin, cytochrome c and chymotrypsin. [Offered: W,S]  
Prereq: CHEM 264 or 28/262; Honours Biochemistry, Biology, Chemistry or Environmental Science.  
Antireq: CHEM 237, PHYS 380

CHEM 237 LEC,TST,TUT 0.50  
Introductory Biochemistry  
Prereq: CHEM 28/262 or 264 or 266.  
Antireq: CHEM 233, PHYS 380  
Also offered Online

CHEM 237L LAB,TUT 0.25  
Introductory Biochemistry Laboratory  
Selected experiments for students taking CHEM 237. [Offered: F,W]  
Coreq: CHEM 237

CHEM 240 LEC,TUT 0.50  
Mathematical Methods for Chemistry  
Mathematical techniques useful for chemistry students. Introduction to complex numbers, plus topics chosen from: calculus; differential equations; vector spaces and vector algebra; matrices and determinants; elementary probability theory; basic group theory and symmetry. Applications to problems of chemical interest. [Offered: F]  
Prereq: One of MATH 128, 138 or 148; Not open to students in the Faculty of Mathematics

CHEM 250L LAB,SEM 0.25  
Physical Chemistry Laboratory 1
Selected experiments for students in year two. [Offered: F]

Prereq: CHEM 140L; Honours students only.
Antireq: CHEM 254L

**CHEM 254 LEC,TUT 0.50**

Course ID: 004064

**Introductory Chemical Thermodynamics**

An introduction to the first, second and third laws of thermodynamics and the application of these laws to ideal systems, mixtures, and chemical reactions. Thermodynamic principles are used to study changes in state, including phase changes, and to establish the link between the equilibrium constant and the properties of the substances involved in a chemical reaction. [Offered: W,S]

Prereq: CHEM 123 or 125, and One of MATH 107, 127, 137, 147 and One of MATH 108, 128, 138, 148; Honours Programs only.
Antireq: PHYS 258/358

**CHEM 262 LEC,TUT 0.50**

Course ID: 004029

**Organic Chemistry for Engineering and Bioinformatics Students**

Bonding, structure and nomenclature in organic chemistry. Physical properties and simple reactions associated with the important functional groups. [Offered: F,W; previously numbered CHEM 28]

Prereq: Chemical Engineering or Bioinformatics students.
Coreq: CHEM 262L (for Engineering students).
Antireq: CHEM 264, 266

**CHEM 262L LAB 0.25**

Course ID: 004030

**Organic Chemistry Laboratory for Engineering Students**

Selected experiments for engineering students taking CHEM 262. [Offered: F,W; previously numbered CHEM 28L]
Coreq: CHEM 262 (for Engineering students)

**CHEM 264 LEC,TUT 0.50**

Course ID: 004068

**Organic Chemistry 1**

Structure and bonding in organic chemistry. Isomerism and stereoisomerism in organic compounds. Acidity of organic compounds and substituent effects on acidity. Reaction mechanisms and energetics. Chemistry of alkanes, haloalkanes, alcohols and ethers, alkenes and alkynes. [Offered: F]

Prereq: CHEM 123 or 125; Honours Programs only.
Antireq: CHEM 28/262, 266

**CHEM 265 LEC,TUT 0.50**

Course ID: 004069

**Organic Chemistry 2**

Nucleophilic addition and substitution at CO carbon. Enolate alkylation and condensation reactions; conjugate addition reactions. Chemistry of amines and other nitrogen compounds. Applications of spectroscopic techniques in organic chemistry. [Offered: W,S]

Prereq: CHEM 264; Honours Science students only.
Antireq: CHEM 38, 267
CHEM 265L LAB 0.25  
Organic Chemistry Laboratory 1  
Selected experiments for students taking CHEM 265. [Offered: W,S]  
Prereq: Honours Science students only

CHEM 266 LEC, TST 0.50  
Basic Organic Chemistry 1  
Discussions of the structure, nomenclature and reactions of important classes of organic compounds. Stereochemistry and its role in reaction mechanisms. A detailed look at carboxylic acids and their derivatives. [Offered: F]  
Prereq: One of CHEM 120 or 121 and One of CHEM 123 or 125.  
Antireq: CHEM 28/262, 264  
Also offered Online

CHEM 266L LAB 0.25  
Organic Chemistry Laboratory  
Selected experiments for students taking (or who have taken) CHEM 266.  
[Note: Lab alternate weeks. Offered: F]

CHEM 267 LEC, TST 0.50  
Basic Organic Chemistry 2  
A continuation of the concepts of CHEM 266, including material on amines, aromatics, carbohydrates and lipids. Introduction to nuclear magnetic resonance and infrared spectroscopy. [Offered: W]  
Prereq: CHEM 28/262 or 264 or 266.  
Antireq: CHEM 38, 265  
Also offered Online

CHEM 267L LAB 0.25  
Organic Chemistry Laboratory  
Selected experiments for students taking CHEM 267.  
[Note: Lab alternate weeks. Offered: W]

CHEM 300s

CHEM 305 LEC, TUT 0.50  
Atmospheric Chemistry and Physics  
The chemistry and physics of the terrestrial atmosphere, with emphasis on the operation of major anthropogenic influences, such as ozone depletion, the greenhouse effect and tropospheric systems, such as photochemical smog. Other planetary atmospheres will be discussed in the context of their implications for the evolution of the earth's atmosphere. [Offered: W]  
Prereq: CHEM 254, 350  
(Cross-listed with EARTH 305)
Atmospheric Modelling Laboratory

This course provides an introduction to modern regional air quality modelling. The models used are Models-3, the U.S. Environmental Protection Agency's tropospheric modelling framework and MM-5, the meteorology model developed by the U.S. National Center for Atmospheric Research. The course covers the major elements in regional air quality modelling: emissions databases, chemical modelling, and the role of meteorology. A team-oriented modelling project relevant to Southern Ontario air quality will be carried out. [Offered: W]

Coreq: CHEM 305
(Cross-listed with EARTH 305L)

Transition Element Compounds and Inorganic Materials

The inorganic, organic and solid state chemistry of the d-block elements. The structure and physical properties of coordination compounds and transition metal containing solids. The role of transition metal organometallics in catalysis. [Offered: F]

Prereq: CHEM 212; Honours Science students only

Inorganic Chemistry Laboratory 2

Synthesis of transition and non-transition metal compounds. Characterization of compounds using IR, UV-VIS and NMR spectroscopy. [Offered: F]

Prereq: Honours Science students only.
Coreq: CHEM 310

Main Group and Solid State Chemistry

This course provides a detailed examination of the structure and bonding in main group and solid state compounds, including valence bond and molecular orbital theory for describing electronic structures, Hückel and extended Hückel approximations. Structures of simple solids, including close packing of spheres and derived ionic lattice types; aspects of chemical crystallography, Bravais lattices, point groups, space groups, crystal planes, and X-ray diffraction; Ionic interactions in gases and solution; the thermodynamics of acid-base interactions; descriptive chemistry and characterization of main group element compounds. [Offered: W]

Prereq: CHEM 212.
Antireq: CHEM 213

Inorganic Chemistry Laboratory 1

Introduction to synthetic inorganic chemistry. [Offered: W]

Prereq: Honours Students only.
Coreq: CHEM 313

Analytical Instrumentation

Detailed study of selected instruments and instrumental methods. Introduction to chemometrics and to computer interfacing. [Offered: W]

Prereq: CHEM 221 or 223; CHEM 224L; Level at least 3A Honours Science programs
CHEM 331 LEC,TUT 0.50
Fundamentals of Metabolism 1
Thermodynamics of metabolism. Metabolism of carbohydrates and lipids. Chemistry of oxidative phosphorylation and photosynthesis. Emphasis is put on the role and chemical mechanisms of the enzymes in these processes [Offered: F]
Prereq: CHEM 233, 265.
Antireq: CHEM 333

CHEM 333 LEC 0.50
Metabolism 1
Metabolism of carbohydrates, lipids and amino acids. [Offered: F]
Prereq: CHEM 233 or 237 and CHEM 265 or 267.
Antireq: CHEM 331

CHEM 335L LAB,TUT 0.50
Advanced Biochemistry Laboratory
Selected experiments for students having completed or concurrently taking CHEM 331. Topics to be covered include: NMR, allostery, enzymology, electrophoresis, carbohydrates, lipids, photosynthesis, and respiration. [Offered: F,W]
Prereq: CHEM 233 or 237.
Coreq: (CHEM 331 or 333) and 357

CHEM 340L LAB,TUT 0.50
Introductory Computational Chemistry Laboratory
Introduction to the theory and practice of computational methods used in chemistry. Use of molecular modeling software to investigate the electronic structure and geometry of molecules, to calculate potential energy surfaces for chemical reactions, and to predict and understand the behaviour of chemical systems. [Offered: F, W]
Prereq: CHEM 140L; CHEM 129 or 209; CHEM 212 or 264

CHEM 350 LEC,TUT 0.50
Chemical Kinetics
Basic Chemical kinetics; treatment of kinetic data; complex reaction mechanisms; fast reactions; the canonical ensemble and the canonical partition function; statistical mechanics applied to chemistry; statistical theory of reaction rates. [Offered: W]
Prereq: CHEM 209, 240, 254; Honours Students only.

CHEM 350L LAB 0.25
Physical Chemistry Laboratory 2
Selected experiments for students in year three.
[Note: Lab alternate weeks. Offered: F
Prereq: CHEM 250L; Honours Science

CHEM 356 LEC,TUT 0.50
Introductory Quantum Mechanics
Historical background; the differential equation approach to quantum mechanics; treatments of solvable problems such as the particle-in-a-box, harmonic oscillator, rigid rotator and the hydrogen atom; introduction to approximation methods for more complicated systems.

[Note: Formerly CHEM 256. Offered: F]

Prereq: CHEM 209, 240.

Antireq: PHYS 234

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<tr>
<td>CHEM 357 LEC,TUT 0.50</td>
<td>004101</td>
<td>Physical Biochemistry</td>
<td>CHEM 209, 240.</td>
</tr>
</tbody>
</table>

The use of diffusion, ultracentrifugation, osmotic pressure, electrophoresis and X-ray diffraction to study the properties of biopolymers. Hyperbolic and allosteric enzyme kinetics, inhibition and regulation. Some spectroscopies important to the life sciences. [Offered: W]

Prereq: (CHEM 123 or 125) and (CHEM 233 or 237)

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<tr>
<td>CHEM 360 LEC,TUT 0.50</td>
<td>004107</td>
<td>Organic Chemistry 3</td>
<td>CHEM 265; Honours Programs only</td>
</tr>
</tbody>
</table>

Aromaticity and simple MO theory of conjugated systems. Electrophilic and nucleophilic aromatic substitution reactions. Substituent effects on the rate of organic reactions. Linear free energy relationships. Pericyclic reactions and FMO theory. [Offered: W]

Prereq: CHEM 265; Honours Programs only

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<tr>
<td>CHEM 360L LAB 0.50</td>
<td>004108</td>
<td>Senior Organic Chemistry Laboratory</td>
<td>CHEM 265, 265L; Honours Programs only</td>
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Selected microscale synthetic experiments for students in Year Three Chemistry and Biochemistry programs, including spectroscopic identification of organic compounds. [Offered: W]

Prereq: CHEM 265, 265L; Honours Programs only

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<tr>
<td>CHEM 363 LEC 0.50</td>
<td>004110</td>
<td>Industrial Organic Chemistry</td>
<td>CHEM 124 or 264 or 266</td>
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The emphasis of this course is the underlying chemistry of organic industrial materials and the processes by which they are produced. Discussions of specific organic functional groups, their industrially important reactions and the mechanisms of such reactions will be presented. Among the specific topics to be discussed will be thermal and catalytic cracking of hydrocarbons, halogenation processes, oxidation processes, polymerization and organic dyes. [Offered: W]

Prereq: CHEM 124 or 264 or 266

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<tr>
<td>CHEM 370 LEC,TUT 0.50</td>
<td>004190</td>
<td>Introduction to Polymer Science</td>
<td>CHEM 254, (CHEM 265 or 267).</td>
</tr>
</tbody>
</table>

Basic definitions and polymer nomenclature, molecular weight averages and distributions, constitutional and configurational isomerism, rubber elasticity, step-growth and free radical chain growth polymerizations, emulsion polymerization. [Offered: F]

Prereq: CHEM 254, (CHEM 265 or 267). Antireq: CHE 542, NE 333

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<tr>
<td>CHEM 381 LEC 0.50</td>
<td>012199</td>
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**Medicinal and Bioorganic Chemistry**
Mechanisms of selected enzymes, vitamins/cofactors. Introduction to the structures and mechanism of action of selected classes of medicinal agents. [Offered: W]

*Prereq: CHEM 233, 265*

**CHEM 382L LAB, TUT 0.25**
**Advanced Organic Synthesis Laboratory**
A laboratory course intended for students in the Medicinal Chemistry Specialization of the Honours Chemistry plan. The purpose of this course is to introduce students to advanced laboratory techniques used in synthetic organic chemistry. [Offered: F]

*Prereq: CHEM 360, 360L, 381*

**CHEM 392A LAB 0.75**
**Research Project 1**
Only for exchange students.

**CHEM 392B LAB 0.75**
**Research Project 2**
Only for exchange students.

**CHEM 400s**

**CHEM 404 LEC, TUT 0.50**
**Physicochemical Aspects of Natural Waters**

*Prereq: Level at least 3A*

**CHEM 406 LEC, TUT 0.50**
**Environmental Organic Chemistry**
Anthropogenic organic compounds in the environment; how and why they get there. Phase transport through the ecosystem. Biological and non-biological chemical transformations. Prevention and remediation. [Offered: W]

*Prereq: CHEM 254, 360, 404*

**CHEM 410 LEC 0.50**
**Special Topics in Inorganic Chemistry**
For a current list of offerings see the Undergraduate Officer.  
*[Note: Formerly CHEM 413. Offered: F, W]*

*Prereq: Level at least 3A*
CHEM 420 LEC 0.50  
Special Topics in Analytical Chem  
For a current list of offerings see the Undergraduate Officer. [Formerly CHEM 425. Offered: F,W.]  
Prereq: Level at least 3A

CHEM 430 LEC 0.50  
Special Topics in Biochemistry  
For a current list of offerings see the Undergraduate Officer.  
[Note: Instructor may elect to use the third lecture hour for a tutorial or not at all. [Offered: F,W. Formerly CHEM 434]  
Prereq: Level at least 3A; CHEM 331 or CHEM 333

CHEM 432 LEC,TUT 0.50  
Metabolism 2  
Prereq: CHEM 331 or 333

CHEM 433 LEC,TUT 0.50  
Advanced Biochemistry  
Prereq: CHEM 331 or 333

CHEM 440 LEC 0.50  
Special Topics in Computational/Theoretical Chemistry  
For a current list of offerings see the Undergraduate Advisor. [Offered: F,W]  
Prereq: Level at least 3A Honours Science

CHEM 450 LEC 0.50  
Special Topics in Physical Chemistry  
For a current list of offerings see the Undergraduate Officer. [Formerly CHEM 452. Offered: F,W ]  
Prereq: Level at least 3A

CHEM 460 LEC 0.50  
Special Topics in Organic Chem  
For a current list of offerings see the Undergraduate Officer.  
[Note: Formerly CHEM 465. Offered: F, W]  
Prereq: CHEM 360; Level at least 3A
CHEM 464 LEC 0.50  
Course ID: 004182  
Spectroscopy in Organic Chemistry  
Elucidation and identification of organic structures by contemporary spectroscopic techniques. [Offered: F]  
Prereq: CHEM 265

CHEM 470 LEC 0.50  
Course ID: 013003  
Special Topics in Polymer Chemistry  
For a current list of offerings see the Undergraduate Advisor. [Offered: F,W]  
Prereq: CHEM 370

CHEM 494A LAB 0.50  
Course ID: 004194  
Research Project  
Laboratory work on a senior year research project. Enrolment into this course requires permission of the CHEM 494 co-ordinator. See the CHEM 494 coordinator for course details. No credit or grade will be provided for this course until the two-term sequence CHEM 494A/B has been completed. CHEM 494A/B may not be taken concurrently without prior permission of the CHEM 494 co-ordinator.  
Prereq: Level at least 4A Honours Chemistry, Biochemistry, Chemical Physics, Environmental Chemistry, Geochemistry

CHEM 494B LAB 0.50  
Course ID: 009910  
Research Project  
A continuation of CHEM 494A. No credit or grade will be provided for this course until the two-term sequence CHEM 494A/B has been completed. CHEM 494A/B may not be taken concurrently without prior permission of the CHEM 494 co-ordinator.  
Prereq: CHEM 494A

CHEM 495 LAB 2.50  
Course ID: 010356  
Advanced Laboratory  
This course is only for exchange students wishing to carry out an advanced research project during the fall term.  
Department Consent Required  
Prereq: Exchange students only

CHEM 496 LAB 2.50  
Course ID: 010357  
Advanced Laboratory  
This course is only for exchange students wishing to carry out a research project during the winter term.  
Department Consent Required  
Prereq: Exchange students only

CHEM 497 LAB 2.50  
Course ID: 010358  
Advanced Laboratory  
This course is only for exchange students wishing to carry out a research project during the spring term.  
Department Consent Required  
Prereq: Exchange students only