

CHEMISTRY (CHEM)

Updated February 1, 2013

Note: The department/program code CHEM replaces the former code 08. Students cannot hold credit in CHEM-xxxx and the former 08.xxxx having the same course number (e.g., CHEM-1111(3) and 08.1111(3)).

Chair: D. Vanderwel; **Associate Chair:** E. Segstro; **Professors Emeriti:** B. Blackburn, H. Hutton; **Professors:** A. Ata, D. Craig, D. Goltz, K.J. Friesen; **Associate Professors:** M. Eze, A. McCubbin, C. Wiebe, C. Wong; **Assistant Professors:** J. Hollett, J. Ritch, T. Wood. **Instructors:** K. Buffie, J. Galka, D. Latimer.

DEGREES/PROGRAMS OFFERED

3-Year BSc

3-Year BSc (Business Stream)

4-Year BSc

4-Year BSc (Business Stream)

Honours BSc

Honours BSc (Business Stream)

4-Year BSc (UW/RRC)

INTRODUCTION

Chemistry is the study of the property and composition of matter, the transformations that matter may undergo, and the energies associated with such transformations. There are five main areas of chemistry: analytical chemistry, inorganic chemistry, organic chemistry, physical chemistry, and biochemistry. The department offers a solid foundation in each of these areas, plus more advanced courses for specialization at the senior level.

The Department of Chemistry offers 3-year, 4-year, and Honours BSc degrees in Chemistry. The department is also involved in several other interdisciplinary programs, most notably Biochemistry, Chemical Physics, and Environmental Studies (Chemistry Stream). An additional option available is the 4-year BSc program in Applied Chemistry, offered jointly by the University of Winnipeg and Red River College. Students pursuing a 3-year or 4-year BSc in Chemistry have the opportunity to take a Business Stream – a set of core courses in the Faculty of Business that will provide them with the skills needed to enter and succeed in industry and business. After completing the requirements of the BSc degree and the set of core courses indicated in the "Science with a Business Stream" section of the Calendar, it will be noted on the student's transcript that they have satisfied the requirements of a BSc degree with a Business stream.

Chemists are involved in many fields, including environmental protection, pharmaceutical science, forensic science, toxicology, agricultural science, food science, education, geochemistry, biochemistry, materials science, biotechnology, oceanography, computer modelling, and plant management. Graduates from a 3-year BSc in Chemistry may proceed to professional schools in a health-related area (such as pharmacy, medicine, veterinary medicine, or dentistry), or to careers as diverse as education, library science, business administration, public administration, engineering and law. Graduates with 4-year or Honours degrees in Chemistry usually proceed directly to employment or to graduate school (to obtain an MSc or PhD degree). Ultimately, most obtain jobs either as technicians, managers, consultants or research scientists in industry or in government.

Arts students, with the required prerequisites, may take **CHEM-1801(3)** Headline Chemical News, **CHEM-1111(3)** Introduction to the Chemical Properties of Matter, **CHEM-1112(3)** Basic Principles of Reactivity, or **CHEM-2801(3)** Chemistry and Society towards their Science requirement.

GENERAL INFORMATION

Prerequisites

Chemistry 40S AND Pre-Calculus or Applied Mathematics 40S are required for acceptance to the Chemistry Major program.

Laboratory Work

Laboratory work has been designed to complement the lecture material; students are able to work in small lab sections with the possibility of individual projects. In advanced labs, modern instrumental techniques and computer facilities are used extensively.

Pre-professional Program Requirements

Students planning to enter the Faculties of Dentistry or Medicine are required to take the following courses:

CHEM-1111(3)	Introduction to the Chemical Properties of Matter
CHEM-1112(3)	Basic Principles of Chemical Reactivity
CHEM-2202(3)	Organic Chemistry I
CHEM-2203(3)	Organic Chemistry II
CHEM-3502(3)	Intermediate Biochemistry I
CHEM-3503(3)	Intermediate Biochemistry II

Students planning to enter professional faculties would normally take the above courses in sequence. However, provided that a minimum grade of 75 (or equivalent) was obtained in Chemistry 40S, the course **CHEM-1111(3)** may be taken concurrently with **CHEM-2202(3)**, and **CHEM-1112(3)** may be taken concurrently with **CHEM-2203(3)**. Also, provided that a minimum grade of B+ was obtained in both **CHEM-1111(3)** and **CHEM-1112(3)** (or the former **CHEM-1101(6)**), the course **CHEM-2202(3)** may be taken concurrently with **CHEM-3502(3)**, and **CHEM-2203(3)** may be taken concurrently with **CHEM-3503(3)**.

REQUIREMENTS FOR THE 3-YEAR BSc IN CHEMISTRY

ADMISSION REQUIREMENT	Students must consult with a department advisor in planning their course of study.
GRADUATION REQUIREMENT	90 credit hours
RESIDENCE REQUIREMENT	
Degree:	Minimum 30 credit hours
Major:	Minimum 18 credit hours
GENERAL DEGREE REQUIREMENT	
Humanities:	12 credit hours in Humanities
Writing:	Minimum 3 credit hours of Academic Writing.
Maximum Introductory Courses:	Students may use a maximum of 42 credit hours at the 1000 level. Of these, a maximum of 6 credit hours may be below the 1000 level.
Distribution:	Minimum three (3) credit hours from each of five (5) different subjects.
MAJOR REQUIREMENT	
Single Major:	Minimum 33 credit hours/Maximum 48 credit hours in Major subject.
Double Major:	33 credit hours in Chemistry and specified number of credit hours in the other department/program.

Required courses:

CHEM-1111(3) Introduction to the Chemical Properties of Matter
CHEM-1112(3) Basic Principles of Chemical Reactivity
CHEM-2102(3) Thermodynamics and Kinetics
OR **CHEM-2103(3)** Atoms, Molecules and Spectroscopy
CHEM-2202(3) Organic Chemistry I
CHEM-2203(3) Organic Chemistry II

CHEM-2302(3) Quantitative Chemical Analysis
CHEM-2401(3) Inorganic Chemistry I
MATH-1101(6) Introduction to Calculus
OR **MATH-1103(3)** Introduction to Calculus I
AND **MATH-1104(3)** Introduction to Calculus II
PHYS-1101(6) Foundations of Physics I
OR **PHYS-1301(6)** Introduction to Physics

Plus an additional 12 credit hours of 2000-, 3000-, and/or 4000-level Chemistry courses.

Combined Major:

Prescribed Courses:

15 credit hours from CHEM-2102(3) Thermodynamics, CHEM-2202(3) Organic Chemistry I, CHEM-2203(3) Organic Chemistry II, CHEM-2302(3) Quantitative Chemical Analysis, CHEM-2401(3) Inorganic Chemistry I.

3 credit hours from CHEM-3101(3) Physical Chemistry of Condensed Phases, CHEM-3102(3) Quantum Chemistry, CHEM-3202(3) Reaction Mechanisms in Organic Chemistry, CHEM-3204(3) Organic Structure Determination, CHEM-3205(3) Organic Synthesis, CHEM-3302(3) Methods of Chemical Analysis, CHEM-3401(3) Inorganic Chemistry II, CHEM-3502(3) Intermediate Biochemistry I, CHEM-3503(3) Intermediate Biochemistry II, CHEM-3601(3) Environmental Chemistry, CHEM-3801(3) Polymer Chemistry.

Students must complete a Declaration of Major in a three-year Degree Program form, available from Student Services, before entering Year 2 of their studies.

Students are advised to consult with the Department when planning their studies.

REQUIREMENTS FOR THE 3-YEAR BSc IN CHEMISTRY WITH A BUSINESS STREAM

Students must complete the requirements of the 3-year BSc in Chemistry degree (see previous section) and the set of core courses indicated in the "Science with a Business Stream" section of the Calendar.

REQUIREMENTS FOR THE 4-YEAR BSc IN CHEMISTRY

ADMISSION REQUIREMENT	Students must consult with a department advisor when planning their studies.
GRADUATION REQUIREMENT	120 credit hours, that is, 90 credit hours meeting the requirements for the 3-Year BSc plus 30 additional credit hours.
RESIDENCE REQUIREMENT	
Degree:	Minimum 60 credit hours
Major:	Minimum 30 credit hours
GENERAL DEGREE REQUIREMENT	

Humanities: 12 credit hours in Humanities.
 Writing: Minimum 3 credit hours of Academic Writing.
 Maximum Introductory Courses: Students may use a maximum of 42 credit hours at the 1000 level. Of these, a maximum of 6 credit hours may be below the 1000 level.
 Distribution: Minimum three (3) credit hours from each of five (5) different subjects.

MAJOR REQUIREMENT

Single Major: Minimum 54 credit hours/Maximum 78 credit hours in the Major subject.
 Maximum total of cognate and major courses is 84 credit hours combined.
 Double Major: Minimum 54 credit hours in Chemistry and specified number of credit hours in other Major.

Required courses:

CHEM-1111(3) Introduction to the Chemical Properties of Matter	CHEM-2502(3) Introduction to Biochemistry OR CHEM-3502(3) Intermediate Biochemistry I
CHEM-1112(3) Basic Principles of Chemical Reactivity	CHEM-3302(3) Methods of Chemical Analysis
CHEM-2102(3) Thermodynamics and Kinetics	CHEM-3401(3) Inorganic Chemistry II: Coordination Chemistry
CHEM-2103(3) Atoms, Molecules and Spectroscopy	MATH-1101(6) Introduction to Calculus
CHEM-2202(3) Organic Chemistry I	OR MATH-1103(3) Introduction to Calculus I
CHEM-2203(3) Organic Chemistry II	AND MATH-1104(3) Introduction to Calculus II
CHEM-2302(3) Quantitative Chemical Analysis	PHYS-1101(6) Foundations of Physics I
CHEM-2401(3) Inorganic Chemistry I	OR PHYS-1301(6) Introduction to Physics

Minimum 3 credit hours selected from the following courses:

PSYC-2101(3) Introduction to Data Analysis
STAT-1301(3) Statistical Analysis I **OR STAT-1302(3)** Statistical Analysis II (or the former STAT-1201(6) Introduction to Statistical Analysis)
STAT-1501(3) Elementary Statistics for Biological and Health Sciences I
 Any Mathematics course numbered 2000 or above (MATH-2xxx) with the exceptions of MATH-2901(3) (History of Calculus) and MATH-2801(6) (Fundamentals of Computing).

Plus an additional 21 credit hours of 2000-, 3000- and/or 4000-level Chemistry courses.

Selection of Chemistry Courses: The 4-Year major requires a minimum of 54 credit hours in Chemistry. Since some senior courses are given in alternate years, all 4-Year majors are urged to seek academic advising within the Department **EACH YEAR** to avoid potential scheduling problems.

The following pattern of Chemistry courses is suggested:

Year 1 - 6 credit hours: **CHEM-1111(3)** Introduction to the Chemical Properties of Matter; **CHEM-1112(3)** Basic Principles of Chemical Reactivity.

Year 2 - 12 to 18 credit hours of the following required courses: **CHEM-2102(3)** Thermodynamics and Kinetics; **CHEM-2103(3)** Atoms, Molecules and Spectroscopy; **CHEM-2202(3)** Organic Chemistry I; **CHEM-2203(3)** Organic Chemistry II; **CHEM-2302(3)** Quantitative Chemical Analysis; **CHEM-2401(3)** Inorganic Chemistry I; **CHEM-2502 (3)** Introduction to Biochemistry; **CHEM-3302(3)** Methods of Chemical Analysis; **CHEM-3401(3)** Inorganic Chemistry II.

Note: If **CHEM-3401(3)** is selected then **CHEM-2202(3)** and **CHEM-2203(3)** must also be taken in Year 2. Students are advised to consult with the Department.

Year 3 - 18 credit hours in Chemistry, including the required courses that were not taken in Year 2.

Year 4 - 18 credit hours in Chemistry.

Note: A student would normally specialize in one or more areas of Chemistry (Analytical, Organic, Physical, Inorganic, Biochemistry) in Years 3 and 4 and should seek advice concerning course selection.

Note: It is recommended the following be taken in :

Year 1: **MATH-1101(6)** Introduction to Calculus **OR** the equivalent **MATH-1103(3)** Introduction to Calculus I
AND MATH-1104(3) Introduction to Calculus II

Year 1 or 2: **PHYS-1101(6)** Foundations of Physics I **OR PHYS-1301(6)** Introduction to Physics

Students must complete a 4-Year BSc Degree form, available from Student Services.

Combined Major:

Prescribed Courses:

15 credit hours from CHEM-2202(3) Organic Chemistry I, CHEM-2203(3) Organic Chemistry II, CHEM-2101(3) Thermodynamics, CHEM-2302(3) Quantitative Chemical Analysis, CHEM-2401(3) Inorganic Chemistry I.

3 credit hours from CHEM-3101(3) Physical Chemistry of Condensed Phases, CHEM-3102(3) Quantum Chemistry, CHEM-3202(3) Reaction Mechanisms in Organic Chemistry, CHEM-3204(3) Organic Structure Determination, CHEM-3205(3) Organic Synthesis, CHEM-3302(3) Methods of Chemical Analysis, CHEM-3401(3) Inorganic Chemistry II, CHEM-3502(3) Intermediate Biochemistry I, CHEM-3503(3) Intermediate Biochemistry II, CHEM-3601(3) Environmental Chemistry, CHEM-3801(3) Polymer Chemistry.

REQUIREMENTS FOR THE 4-YEAR BSc IN CHEMISTRY WITH A BUSINESS STREAM

Students must complete the requirements of the 4-year BSc in Chemistry degree (see previous section) and the set of core courses indicated in the "Science with a Business Stream" section of the Calendar.

REQUIREMENTS FOR THE BSc (HONOURS) IN CHEMISTRY

ADMISSION REQUIREMENT

Students must have completed 30 credit hours.
Students must consult with and have the approval of the Department Chair or the Chair's designate when planning their studies.

GRADUATION REQUIREMENT

Graduation GPA Requirement:

120 credit hours
To graduate with a BSc (Honours), students must have a minimum GPA of 3.0 on all major (Chemistry) courses which will be calculated on all course attempts in the major, and a minimum GPA of 2.75 on all non-major courses which will be calculated as for the general degree.

RESIDENCE REQUIREMENT

Degree:

Honours:

Minimum 60 credit hours
Minimum 30 credit hours, including minimum 18 credit hours at upper level (3000/4000) of which a minimum of 9 credit hours at 4000 level.

GENERAL DEGREE REQUIREMENT

Humanities:

Writing:

Maximum Introductory Courses:

Distribution:

12 credit hours in Humanities.
Minimum 3 credit hours of Academic Writing.
Students may use a maximum of 42 credit hours at the 1000 level. Of these, a maximum of 6 credit hours may be below the 1000 level.
Minimum three (3) credit hours from each of five (5) different subjects.

HONOURS REQUIREMENT

Single Honours:

Minimum 60 credit hours in the Major subject.
Minimum 30 credit hours in upper-level (3000 and 4000) Honours subject courses of which a minimum of 12 credit hours must be at the 4000 level.

Required courses:

CHEM-1111(3) Introduction to the Chemical Properties of Matter

CHEM-1112(3) Basic Principles of Chemical Reactivity

CHEM-2102(3) Thermodynamics and Kinetics

CHEM-2103(3) Atoms, Molecules and Spectroscopy

CHEM-2202(3) Organic Chemistry I

CHEM-2203(3) Organic Chemistry II

CHEM-2302(3) Quantitative Chemical Analysis

CHEM-2401(3) Inorganic Chemistry I

CHEM-2502(3) Introduction to Biochemistry

OR CHEM-3502(3) Intermediate Biochemistry I

CHEM-3302(3) Methods of Chemical Analysis

CHEM-3401(3) Inorganic Chemistry II

CHEM-4302(3) Instrumentation for Quantitative Analysis

CHEM-4303(3) Analytical Separations

CHEM-4701(6) Research Projects in Chemistry

MATH-1101(6) Introduction to Calculus

OR MATH-1103(3) Introduction to Calculus I

AND MATH-1104(3) Introduction to Calculus II

PHYS-1101(6) Foundations of Physics I

OR PHYS-1301(6) Introduction to Physics

Minimum 3 credit hours selected from the following courses:

PSYC-2101(3) Introduction to Data Analysis

STAT-1301(3) Statistical Analysis I **OR STAT-1302(3)** Statistical Analysis II (**OR** the former **STAT-1201(6)** Intro to Stat Analysis)

STAT-1501(3) Elementary Statistics for Biological and Health Sciences I

Any Mathematics course numbered 2000 or above (MATH-2xxx) with the exceptions of MATH-2901(3) (History of Calculus) and MATH-2801(6) (Fundamentals of Computing). Plus an additional 15 credit hours of 2000-, 3000- and/or 4000 level Chemistry courses.

Plus an additional 18 credit hours selected from at least 2 departments and from the following list:

BIOL-1115(3) Cells and Cellular Process

BIOL-1116(3) Evolution, Ecology and Biodiversity

BIOL-2301(3) Genetics

BIOL-3303(3) Molecular Genetics and Genomics

BIOL-3221(3) Cell Biology

BIOL-3901(3) Microorganisms and Disease

GEOG-1201(3) Introductory Atmospheric Science

GEOG-1202(3) Introductory Earth Science

GEOG-2213(3) Introductory Soil Science

GEOG-2214(3) Soil-Vegetation Systems

MATH-1201(3) Linear Algebra I

MATH-2101(6) Intermediate Calculus

MATH-2102(3) Differential Equations I

MATH-2103(3) Differential Equations II

MATH-2203(3) Linear Algebra II

MATH-3101(6) Advanced Calculus

PHYS-2105 (3) Mathematical Physics I

PHYS-2106 (3) Mathematical Physics II

PHYS-2201(6) Electricity and Magnetism

PHYS-2302(6) Foundations of Physics II

STAT-1301 (3) Statistical Analysis I and

STAT-1302 (3) Statistical Analysis II or the former

STAT-1201 (6) Introduction to Statistical Analysis

STAT-2001(3) Statistical Analysis for Chemists and Biologists

STAT-2501(3) Statistical Quality Control
STAT-2903(3) Introduction to Statistical Computing

Students must complete an Honours BSc Degree form, available from Student Services.

REQUIREMENTS FOR THE HONOURS BSc IN CHEMISTRY WITH A BUSINESS STREAM

Students must complete the requirements of the Honours BSc in Chemistry degree (see previous section) and the set of core courses indicated in the "Science with a Business Stream" section of the Calendar.

REQUIREMENTS FOR THE UNIVERSITY OF WINNIPEG / RED RIVER COLLEGE 4-YEAR BSc (JOINT PROGRAM IN APPLIED CHEMISTRY)

INTRODUCTION

This is a joint degree program whereby students take courses at both The University of Winnipeg and Red River College in a prescribed sequence.

Students are required to complete courses at both institutions. Students will begin their program of study by completing 60 credit hours of course work at The University of Winnipeg. The next 30 credit hours are completed at Red River College and then students return to The University of Winnipeg to complete the final 30 credit hours. Students successfully completing the entire program will receive a joint degree parchment from Red River College and The University of Winnipeg. **N.B. Transfer of courses between institutions applies only to students who are officially registered in the joint program.**

ADMISSION REQUIREMENT

Students must meet the entrance requirements for admission to The University of Winnipeg. Applications to the program in Applied Chemistry must be completed through the Admissions Office of The University of Winnipeg by March 1st in order to enter the program in September.

GRADUATION REQUIREMENT

120 credit hours, that is, 90 credit hours meeting the requirements for the BSc General plus 30 additional credit hours.

RESIDENCE REQUIREMENT

Degree: Minimum 60 credit hours
Honours: Minimum 30 credit hours

GENERAL DEGREE REQUIREMENT

Humanities: 12 credit hours in Humanities.
Writing: Minimum 3 credit hours of Academic Writing.
Maximum Introductory Courses: Students may use a maximum of 42 credit hours at the 1000 level. Of these, a maximum of 6 credit hours may be below the 1000 level.
Distribution: Minimum three (3) credit hours from each of five (5) different subjects.

Required Courses:

(These are the Core courses for all Applied Chemistry BSc students)

UW COURSES

CHEM-1111(3)	Introduction to the Chemical Properties of Matter
CHEM-1112(3)	Basic Principles of Chemical Reactivity
CHEM-2102(3)	Thermodynamics and Kinetics
CHEM-2103(3)	Atoms, Molecules and Spectroscopy
CHEM-2202(3)	Organic Chemistry I
CHEM-2203(3)	Organic Chemistry II
CHEM-2302(3)	Quantitative Chemical Analysis
CHEM-2401(3)	Inorganic Chemistry I
CHEM-3302(3)	Methods of Chemical Analysis
CHEM-3401(3)	Inorganic Chemistry II: Coordination Chemistry
CHEM-3601(3)	Environmental Chemistry
CHEM-4302(3)	Instrumentation for Quantitative Analysis

CHEM-4303 (3) Analytical Separations

PLUS

BIOL-1115(3)	Cells and Cellular Process
BIOL-1116(3)	Evolution, Ecology and Biodiversity
RHET-1103(3)	Academic Writing: Sciences
MATH-1101(6)	Introduction to Calculus
OR MATH-1103(3) Introduction to Calculus I	
AND MATH-1104(3) Introduction to Calculus II	
PHYS-1301(6)	Introduction to Physics
PLUS	
12 Credit hours Humanities	
18 Credit hours Electives	

RRC COURSES

CBST-1014	Microbiology 1
CBST-1025	Data Analysis
CBST-1031	Introductory Biochemistry
CBST-1040	Quality Systems
CBST-1070	Principles of Hazardous Materials Management
CBST-1090	Introductory Statistics
CBST-2017	Microbiology 2
CBST-3001	Advanced Biochemistry
ENVI-1011	Environmental Chemistry/Toxicology
CBST-1041	Regulatory Compliance

The following pattern of courses is suggested:

4-Year Program			
Year 1 - University of Winnipeg		Year 2 - University of Winnipeg	
CHEM-1111(3)	Introduction to the Chemical Properties of Matter	CHEM-2102(3)	Thermodynamics and Kinetics
CHEM-1112(3)	Basic Principles of Chemical Reactivity	CHEM-2103(3)	Atoms, Molecules and Spectroscopy
BIOL-1115(3)	Cells and Cellular Processes	CHEM-2202(3)	Organic Chemistry I
BIOL-1116(3)	Evolution, Ecology and Biodiversity	CHEM-2203(3)	Organic Chemistry II
RHET-1103(3)	Academic Writing: Sciences	CHEM-2302(3)	Quantitative Chemical Analysis
MATH-1101(6)	Introduction to Calculus	CHEM-3302(3)	Methods of Chemical Analysis
OR the equivalent		6 Credit hours Electives	
MATH-1103(3) Introduction to Calculus I		6 Credit hours Humanities	
AND MATH-1104(3) Introduction to Calculus II			
PHYS-1301(6) Introduction to Physics			
3 Credit hours Humanities			
Year 3 - Red River College		Year 4 - University of Winnipeg	
CBST-1014	Microbiology 1	CHEM-2401(3)	Inorganic Chemistry I
CBST-1025	Data Analysis	CHEM-3401(3)	Inorganic Chemistry II: Coordination Chemistry
CBST-1031	Introductory Biochemistry	CHEM-3601(3)	Environmental Chemistry
CBST-1040	Quality Systems	CHEM-4302(3)	Instrumentation for Quantitative Analysis
CBST-1041	Regulatory Compliance	CHEM-4303 (3)	Analytical Separations
CBST-1070	Principles of Hazardous Materials Management	3 Credit hours Humanities	
CBST-1090	Introductory Statistics	12 Credit hours Electives	
CBST-2017	Microbiology 2		
CBST-3001	Advanced Biochemistry		
ENVI-1011	Environmental Chemistry/Toxicology		

COURSE LISTINGS

Students should consult the appropriate Timetable, available from the Records Office for courses to be offered during the current term. A number of senior courses are offered on a rotation basis and are given in alternate years. Students are advised to consult with the Department in advance when planning their curriculum.

CHEM-0100(3) Foundations of Chemistry

CHEM-1111(3) Introduction to the Chemical Properties of Matter
CHEM-1112(3) Basic Principles of Chemical Reactivity
CHEM-1801(3) Headline Chemistry News
CHEM-2102(3) Thermodynamics and Kinetics
CHEM-2103(3) Atoms, Molecules and Spectroscopy
CHEM-2202(3) Organic Chemistry I
CHEM-2203(3) Organic Chemistry II
CHEM-2302(3) Quantitative Chemical Analysis
CHEM-2401(3) Inorganic Chemistry I
CHEM-2502(3) Introduction to Biochemistry
CHEM-2701(3) Computer Techniques and Applications for Chemistry
CHEM-2801(3) Chemistry and Society
CHEM-3101(3) Physical Chemistry of Condensed Phases
CHEM-3102(3) Quantum Chemistry and Spectroscopy
CHEM-3202(3) Reaction Mechanisms in Organic Chemistry
CHEM-3204(3) Organic Structure Determination
CHEM-3205(3) Organic Synthesis
CHEM-3206(3) Advanced Organic Chemistry Laboratory
CHEM-3302(3) Methods of Chemical Analysis

CHEM-3401(3) Inorganic Chemistry II: Coordination Chemistry
CHEM-3502(3) Intermediate Biochemistry I: Structure, Function, and Energetics of Biomolecules
CHEM-3503(3) Intermediate Biochemistry II: Intermediary Metabolism
CHEM-3601(3) Environmental Chemistry
CHEM/ENV-3611(3) Environmental Toxicology
CHEM-3701(P) Directed Studies in Chemistry
CHEM-3801(3) Polymer Chemistry
CHEM-4101(3) Molecular Structure, Spectroscopy, and Reactivity
CHEM-4204(3) Medicinal Chemistry
CHEM-4302(3) Instrumentation for Quantitative Analysis
CHEM-4303(3) Analytical Separations
CHEM-4401(3) Inorganic Chemistry III: Organometallic Chemistry
CHEM-4502(3) Molecular Enzymology
CHEM-4506(3) Methods in Biochemistry
CHEM-4701(6) Research Projects in Chemistry
CHEM-4703(3) Topics in Chemistry

COURSE DESCRIPTIONS

CHEM-0100(3) FOUNDATIONS OF CHEMISTRY (Le3) The purpose of this course is to prepare students for CHEM-1111(3) Introduction to the Chemical Properties of Matter and CHEM-1112(3) Basic Principles of Chemical Reactivity. Topics include the characterization of chemical substances, chemical reactions, chemical quantities, and chemical systems. Standing in this course will satisfy the prerequisites for CHEM-1111(3) and CHEM-1112(3) (in place of Chemistry 40S, Pre-Calculus Mathematics 40S, and/or Applied Mathematics 40S). Non-science majors wishing to take a chemistry course for science credit should take CHEM-2801(3) Chemistry and Society.
RESTRICTION: Students with standing in CHEM-1111(3), CHEM-1112(3), or the former CHEM-1101(6) cannot register for this course. This course CANNOT be used as a credit towards the Chemistry or Biochemistry majors.

CHEM-1111(3) INTRODUCTION TO THE CHEMICAL PROPERTIES OF MATTER (Le3, La3) This includes an introduction to atomic and molecular structure, chemical bonding, chemical reactivity, to the bulk properties of matter, and the descriptive chemistry of elements. The laboratory component introduces students to basic chemistry laboratory practice and techniques. The fundamental concepts of chemical reactivity covered in this course and CHEM-1112(3) provide the essential foundation for students who wish to continue with Chemistry or Biochemistry as a major, and for students of Biology, Physics, Physical Geography, Environmental Studies, and Experimental Psychology.
PREREQUISITES: Chemistry 40S and Pre-Calculus Mathematics 40S or Applied Mathematics 40S; or CHEM-0100(3).
RESTRICTION: Students with standing in the former CHEM-1101(6) will not receive credit for this course.

CHEM-1112(3) BASIC PRINCIPLES OF CHEMICAL REACTIVITY (Le3, La3) This course includes an introduction to chemical kinetics, chemical thermodynamics and equilibrium, and to acid/base and oxidation/reduction chemical reactions. The laboratory component introduces students to some of the basic techniques of practical chemistry. The fundamental concepts of chemical reactivity covered in this course and CHEM-1111(3) provide the essential foundation for students who wish to continue with Chemistry or Biochemistry as a major, and for students of Biology, Physics, Physical Geography, Environmental Studies, and Experimental Psychology.

PREREQUISITE: Chemistry 40S and Pre-Calculus Mathematics 40S or Applied Mathematics 40S; or CHEM-0100(3).

RESTRICTION: Students with standing in the former CHEM-1101(6) will not receive credit for this course.

CHEM-1801(3) HEADLINE CHEMISTRY NEWS (Le3) This course provides students with a basic understanding of (chemical) science issues in the news. As concerns over our health, food, environment and economy receive expanding media coverage, we are frequently left with an incomplete scientific understanding of the issues. In this course, experts from the Department of Chemistry (and beyond) translate the chemistry behind the issues of the day into accessible and understandable facts. The course content varies with time in order to remain current, with details outlined on the departmental web-site. CHEM-1801(3) may be used to fulfill the Science requirement for the BA degree.

CHEM-2102(3) THERMODYNAMICS AND KINETICS (Le3, La3) This course describes the principles and applications of thermodynamics, and the rates and mechanisms of chemical reactions. Laboratory work consists of experiments in the thermodynamics and kinetics of gases and solutions, and computer applications in data analysis and problem solving.
PREREQUISITES: CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)) and MATH-1103(3) and MATH-1104(3) or MATH-1101(6)).
RESTRICTION: Students with standing in the former CHEM-2101(6) will not receive credit for this course.

CHEM-2103(3) ATOMS, MOLECULES AND SPECTROSCOPY (Le3, La3) This course is an introduction to quantum chemistry, with applications in atomic and molecular structure and spectroscopy. Laboratory work consists of experiments in molecular spectroscopy and computational methods for determining molecular structures and properties.
PREREQUISITES: CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)) and MATH-1103(3) and MATH-1104(3) or MATH-1101(6)).
RESTRICTION: Students with standing in the former CHEM-2101(6) will not receive credit for this course.

CHEM-2202(3) ORGANIC CHEMISTRY I (Le3, La3) This course is an introductory study of aliphatic carbon compounds. Topics to be covered include bonding;

hybridization; resonance; acids and bases; the structure, nomenclature, synthesis and reactions of alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers and amines; the stereo chemistry of organic compounds; and, nucleophilic substitution and elimination reactions and their use in organic synthesis. The laboratory includes an introduction to techniques commonly used in organic chemistry, through the preparation, purification and characterization of organic compounds.

PREREQUISITES: CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)).

NOTE: CHEM-1111(3) may be used as a corequisite provided a minimum grade of 75 or equivalent was obtained in Chemistry 40S.

RESTRICTION: Students with standing in the former CHEM-2201(6) will not receive credit for this course.

CHEM-2203(3) ORGANIC CHEMISTRY II (Le3, La3) This course is an introductory study of the chemistry and structural identification of common aliphatic and aromatic organic compounds. Topics include the structure, nomenclature, synthesis and reactions of aromatic hydrocarbons, phenols, aldehydes, ketones, enolates, carboxylic acids, sulfur- and phosphorus-containing compounds, and free-radicals. Spectroscopic instrumentation for structure determination is discussed, with an emphasis on infra-red (IR) and nuclear magnetic resonance (NMR) spectroscopy, and mass spectrometry (MS). The laboratory includes an introduction to techniques commonly used in organic chemistry, through the preparation, purification and characterization of compounds.

PREREQUISITE: CHEM-2202(3).

NOTE: CHEM-1112(3) may be used as a corequisite provided a minimum grade of 75 or equivalent was obtained in Chemistry 40S.

RESTRICTION: Students with standing in the former CHEM-2201(6) will not receive credit for this course.

CHEM-2302(3) QUANTITATIVE CHEMICAL ANALYSIS (Le3, La3) This is a first course in analytical chemistry which examines ionic equilibria in aqueous solutions and their use in chemical analysis. This course covers both volumetric and gravimetric analysis with a detailed examination of the pertinent equilibria involved in precipitation, acid-base, and complexometric systems. The lab consists of a series of experiments designed to develop strong analytical techniques.

PREREQUISITES: CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)).

RESTRICTION: Students with standing in the former CHEM-2301(6) will not receive credit for this course.

CHEM-2401(3) INORGANIC CHEMISTRY I (Le3, La3) This course provides an introduction to Inorganic Chemistry with a focus on fundamental concepts. The first part of the course deals with understanding and predicting molecular bonding and structure with examples taken mostly from the main group. The second part of the course deals with understanding and explaining the trends in chemical behaviour with emphasis being placed on the main group elements. Laboratory work demonstrates reactivity trends discussed in lecture and introduces the techniques associated with the synthesis and characterization of main group compounds.

PREREQUISITES: CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)).

RESTRICTION: Students with standing in the former CHEM-3402(3) may not receive credit for this course.

CHEM-2502(3) INTRODUCTION TO BIOCHEMISTRY (Le3, La3) This is an introductory course in biochemistry. Topics include: the structural characteristics and biological

properties of biomolecules (carbohydrates, lipids, proteins, and nucleic acids); basic enzymology; and metabolism. Examples of the application of the principles of biochemistry to the study and treatment of human diseases are discussed.

PREREQUISITES: CHEM-1111(3), CHEM-1112(3), and CHEM-2202(3)

COREREQUISITE: CHEM-2202(3) may be taken as a co-requisite.

RESTRICTION: Students with standing in the former CHEM-2501(3) may not receive credit for this course. Students with a B or higher in CHEM-3502(3) or CHEM-3503(3) may not receive credit for this course.

CHEM-2701(3) COMPUTER TECHNIQUES AND APPLICATIONS FOR CHEMISTRY (Le3, La3) This course introduces students to computer applications in the field of Chemistry. Topics include data handling; basic statistical analysis; graphing; drawing chemical structures, equations, and diagrams; computations; molecular modelling and minimum energies; and the incorporation of diagrams, graphs, molecular structures, and equations directly into scientific documents.

PREREQUISITE: Minimum grade of C in both CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)).

CHEM-2801(3) CHEMISTRY AND SOCIETY (Le3) The course begins with an introduction to the fundamentals of chemistry, including atomic structure, the nature of chemical bonds, nomenclature, and an introduction to chemical reactions. These fundamentals are then applied to examine a selected range of topics in the environmental, consumer, and health related areas. Topics such as plastics and recycling, food chemistry, pesticides, drugs, detergents, global warming and/or acid rain are examined from a chemical perspective.

PREREQUISITE: Chemistry 40S or ENV-1600(3) or permission of instructor.

RESTRICTION: Student with standing in the former CHEM-2601(6) will not receive credit for this course.

Notes: CHEM-2801(3) may be used to fulfil the Science requirement for the BA degree. It can also be used for credit towards the Chemistry major in the 5-Year BEd/BSc degree.

THIS COURSE IS NOT DESIGNED FOR CHEMISTRY MAJORS. CHEM-2801(3) **CANNOT** be used for credit towards the Chemistry or Biochemistry majors.

CHEM-3101(3) PHYSICAL CHEMISTRY OF CONDENSED PHASES (Le3) This course examines the thermodynamics, structures, and physical properties of liquids, solids and surfaces. Topics include phase transitions, chemical reactions, ionic solutions, and transport properties (conductivity, diffusion, viscous flow, surface tension, and capillarity).

PREREQUISITE: CHEM-2102(3) or permission of instructor.

CHEM-3102(3) QUANTUM CHEMISTRY AND SPECTROSCOPY (Le3) This course examines the quantum theory of chemical bonding, molecular properties, and spectroscopy.

PREREQUISITE: CHEM-2103(3).

CHEM-3202(3) REACTION MECHANISMS IN ORGANIC CHEMISTRY (Le3) This course deals with the application of physical chemical principles to organic compounds and their reactions. It includes topics such as the effects of structure on reactivity, heterolytic reaction mechanisms, acidity functions, catalysis, solvent effects, and isotope effects.

PREREQUISITES: CHEM-2202(3) and CHEM-2203(3) (or the former CHEM-2201(6)).

RESTRICTION: Students with standing in the former CHEM-3201(6) will not receive credit for this course.

CHEM-3204(3) ORGANIC STRUCTURE DETERMINATION (Le3) This course teaches the application of spectroscopic techniques (1D and 2D multinuclear NMR, IR, MS, UV) to organic structure determination. Classical methods still in common use are briefly covered.

PREREQUISITES: CHEM-2202(3) and CHEM-2203(3) (or the former CHEM-2201(6)).

RESTRICTION: Students with standing in the former CHEM-3201(6) will not receive credit for this course.

CHEM-3205(3) ORGANIC SYNTHESIS (Le3) This course deals with the synthesis of organic compounds. Topics include synthetic strategies, conformational analysis, use of protecting groups, and chiral induction. Molecular orbital theory will be introduced and applied to the study of pericyclic reactions.

PREREQUISITE: CHEM-2202(3) and CHEM-2203(3) (or the former CHEM-2301(6)).

RESTRICTION: Students with standing in the former CHEM-4202(3) will not receive credit for this course.

CHEM-3206(3) ADVANCED ORGANIC CHEMISTRY LABORATORY (La6) This course provides students with advanced laboratory experience in Organic Chemistry. Students are exposed to the theory and application of methods for experimental design; purification of reagents; working with air/moisture sensitive reagents; and, the isolation, purification and identification of natural products. Students set up and conduct several experiments and formulate reports on their work.

PREREQUISITE: Minimum grade of C in CHEM-2203(3).

COREREQUISITE: None.

CHEM-3302(3) METHODS OF CHEMICAL ANALYSIS (Le3, La3) This course introduces students to the procedures of analytical chemistry including sampling, preparation of the sample for analysis, instrument calibration, and statistical treatment of data. Specific analytical methods discussed include electrochemistry and atomic and molecular spectroscopy. This involves a series of analyses using instrumental techniques.

PREREQUISITE: CHEM-2302(3).

RESTRICTION: Students with standing in the former CHEM-2301(6) will not receive credit for this course.

CHEM-3401(3) INORGANIC CHEMISTRY II: COORDINATION CHEMISTRY (Le3, La3) This course examines the bonding, structure, and reactivity of coordination compounds of the transition metals. Building on the fundamentals covered in CHEM-2401, we discuss the nature of the metal-ligand bond, including its effect on physical and chemical properties of metal complexes. General trends in transition metal coordination chemistry are examined with an emphasis on understanding and predicting the reactivity and structures of coordination compounds. Laboratory work involves synthesis and characterization of transition metal coordination compounds.

PREREQUISITE: CHEM-2202(3) (or the former CHEM-2404(3)), and CHEM-2401(3).

COREREQUISITE: CHEM-2203(3).

RESTRICTION: Students with standing in the former CHEM-3402(3) or CHEM-3404(3) will not receive credit for this course.

CHEM-3502(3) INTERMEDIATE BIOCHEMISTRY I: STRUCTURE, FUNCTION, AND ENERGETICS OF BIOMOLECULES (Le3, La3) Topics to be examined in this course include the structure and function of biomolecules, including carbohydrates, lipids, nucleic acids, proteins, and "high energy" phosphate compounds (emphasizing the inter-relationship of structure and function); mechanisms and kinetics of enzyme-catalyzed reactions; membrane transport; and bioenergetics.

PREREQUISITES: CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)), CHEM-2202(3) and CHEM-2203(3) (or the former CHEM-2201(6)) and BIOL-1115(3) (or the former BIOL-1111(6)).

NOTE: CHEM-2202(3) may be used as a corequisite providing that a minimum grade of B+ was obtained in CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)).

RESTRICTION: Students with standing in the former CHEM-3501(6) will not receive credit for this course.

CHEM-3503(3) INTERMEDIATE BIOCHEMISTRY II: INTERMEDIARY METABOLISM (Le3, La3) This course examines major catabolic and anabolic pathways, and their regulation and integration.

PREREQUISITE: CHEM-3502(3).

NOTE: CHEM-2203(3) may be used as a corequisite providing that a minimum grade of B+ was obtained in CHEM-1111(3) and CHEM-1112(3) (or the former CHEM-1101(6)).

RESTRICTION: Students with standing in the former CHEM-3501(6) will not receive credit for this course.

CHEM-3601(3) ENVIRONMENTAL CHEMISTRY (Le3) This course in environmental organic chemistry describes the properties, partitioning behaviour and reactivity of organic contaminants and their influence on the distribution, transport and fate of the chemical in the environment. Recent literature is used to discuss current issues in environmental chemistry, with an emphasis on long-range transport and global distribution of persistent, toxic and bioaccumulative contaminants.

PREREQUISITES: CHEM-2202(3) and CHEM-2203(3) (or the former CHEM-2201(6)) and CHEM-2302(3) (or the former CHEM-2301(6)) or permission of the instructor.

CHEM/ENV-3611(3) ENVIRONMENTAL TOXICOLOGY (Le3) This course provides an understanding of how and why chemicals may damage humans and other organisms. Students learn basic principles of toxicology and environmental chemical exposure, and detailed analysis of the body's defenses against toxicants and the physiological and/or biochemical mechanisms by which toxicants cause effects. Toxicological modeling and environmental risk assessment are introduced. Students apply these principles to explore emerging topics of interest in their own disciplines.

PREREQUISITES: CHEM-2202 (3) and CHEM-2203 (3) or the former CHEM-2201 (6).

CHEM-3701(3) DIRECTED STUDIES IN CHEMISTRY (P)

This course is designed to allow students the opportunity to conduct individual research under the supervision of a faculty member. The study may take the form of a literature review, may be experimental in nature or may involve analysis of existing data. Permission to enrol is dependent on the availability of a suitable faculty member and the approval of the Chair of Chemistry.

PREREQUISITES: Students should normally have completed 12 credit hours of Chemistry courses.

RESTRICTION: Enrolment in this course is limited by the availability of faculty to serve as supervisors. Students must obtain written permission from the Department Chair to register for the course **in addition to** the prerequisite.

CHEM-3801(3) POLYMER CHEMISTRY (Le3) This course includes the synthesis of organic and inorganic polymers, reaction mechanisms, structure determination, polymer modification and design of polymers for specific applications.

PREREQUISITES: CHEM-2202(3) and CHEM-2203(3) (or the former CHEM-2201(6)).

CHEM-4101(3) MOLECULAR STRUCTURE, SPECTROSCOPY, AND REACTIVITY (Le3) This course

examines modern topics in physical chemistry such as the quantum theory of molecular structure and reactivity, laser chemistry, nuclear magnetic resonance, and materials science.

PREREQUISITE: CHEM-2103(3).

CHEM-4204(3) MEDICINAL CHEMISTRY (Le3) This course deals with an introduction to pharmaceuticals from natural sources and their biosynthetic origin. This also includes various methods of synthesis, and studies on structure-activity relationships of anti-inflammatory, anti-cancer and anti-microbial chemotherapeutic agents.

PREREQUISITES: CHEM-2202(3) and CHEM-2203(3).

CHEM-4302(3) INSTRUMENTATION FOR QUANTITATIVE ANALYSIS (Le3) This course discusses the basic electronic principles and design of instrumentation for molecular and atomic spectroscopy as well as quantitative mass spectrometry. Students taking this course gain an appreciation of a variety of topics including basic electronics, signal acquisition, noise and signal enhancement. Apart from the classroom, students also participate in practical demonstrations in the laboratory. Theory and applications for a variety of techniques available in this course include the following: atomic absorption and atomic emission spectroscopy, atomic mass spectrometry and x-ray fluorescence.

PREREQUISITES: CHEM-2302(3) and CHEM-3302(3).

RESTRICTION: Students with standing in the former CHEM-4301(6) may not receive credit for this course.

CHEM-4303 (3) ANALYTICAL SEPARATIONS (Le3, La3)

The crucial role of analytical separations in chemistry and biochemistry, both qualitative and quantitative, is discussed in detail. Theoretical background, principles of instrumentation, and applications are detailed for important chromatographic and mass spectrometric techniques for chemical isolation and identification. The laboratory exercises provide a unique opportunity to gain practical experience with modern techniques, including gas and liquid chromatography and mass spectrometry.

PREREQUISITES: CHEM-2202(3) and CHEM-2203(3) (or the former CHEM-2201(6)) and CHEM-3302(3) (or the former CHEM-2301(6)).

RESTRICTION: Students with standing in the former CHEM-4301(6) may not receive credit for this course.

CHEM-4401(3) INORGANIC CHEMISTRY III:

ORGANOMETALLIC CHEMISTRY (Le3) The bonding, structure and reactivity of compounds containing metal-carbon bonds are examined. Emphasis is on the reactions of organo-transition metal compounds and their use in the development of modern industrial catalysts.

PREREQUISITE: CHEM-3401(3) (or the former CHEM-3404(3)).

RESTRICTION: Students with standing in the former CHEM-4402(6) may not receive credit for this course.

CHEM-4502(3) MOLECULAR ENZYMOLOGY (Le3) This course examines aspects of the structure, function, and regulation of enzymes. Topics include the inter-relationship of enzyme structure and function, current theories of the chemical basis of enzyme catalysis, enzyme kinetics, and the regulation of enzyme activity. Applications of our current understanding of enzyme biochemistry are discussed.

PREREQUISITE: CHEM-3503(3) (or the former CHEM-3501(6)).

CHEM-4506(3) METHODS IN BIOCHEMISTRY (Le3, La3)

This course examines the application of physical methods to problems of biochemical interest. Topics to be covered include the isolation and stabilization of proteins; sub-cellular fractionation; methods for the assay of protein activity; the

determination of enzyme kinetic parameters; purification and analysis of biomolecules (especially proteins) by selective precipitation (varying pH, salt concentration, and solvent), liquid chromatography (ion exchange, gel filtration, and affinity chromatography) and electrophoresis (slab gel and capillary); ultracentrifugation; and, biochemical applications of the use of radioisotopes. Although emphasis is placed on the application of these techniques to proteins, application to other classes of biomolecules are examined as appropriate.

PREREQUISITES: CHEM-3503(3) (or the former CHEM-3501(6)). CHEM-4502(3) is highly recommended.

CHEM-4701(6) RESEARCH PROJECTS IN CHEMISTRY

(P) This course is designed to allow students to investigate a specific research problem. Students work with a faculty member in a particular area of research while learning the techniques and methodology related to chemical research. Students are strongly urged to consult with the department at least two months in advance of any anticipated registration in this course, as approval for any planned project must be obtained from a specific faculty member as well as from the Department Chair.

PREREQUISITE: Student should normally have completed 30 credit hours of Chemistry courses.

RESTRICTION: Enrolment in this course is limited by the availability of faculty to serve as supervisors. Students must obtain written permission from the Department Chair to register for the course.

CHEM-4703(3) TOPICS IN CHEMISTRY (Le3) Special topics in an area of analytical, environmental, inorganic, organic, physical, or biochemistry are addressed. Please consult the Chemistry Department for the current topic.

RESTRICTION: Written permission from the Department Chair is required to take this course.

EXPERIMENTAL COURSE

CHEM-3104(3) THE CHEMISTRY AND PHYSICS OF CONDENSED MATTER (LE)

This course teaches the basics of the physics and chemistry of solids. Topics covered include crystal structures, reciprocal space, diffraction, lattice vibrations, free electron theory, solid state reactions, semiconductors and the basics of superconductivity and magnetism. Particular emphasis will be focused on modern topics in solid state chemistry and condensed matter physics.

PREREQUISITES: Mathematics 1101(6), and Physics 3301(6) or Chemistry 2102(3)

RESTRICTION: Students with standing in PHYS-4301(3) will not receive credit for this course.