

# CHEMISTRY (CHEM)

Dec 9, 2020

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

## 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-1111(3)** Introduction to the Chemical Properties of Matter, **CHEM-1112(3)** Basic Principles of Reactivity, or **CHEM-2801(3)** Environmental Issues: A Chemistry Perspective towards their Science requirement.

## GENERAL INFORMATION

### Prerequisites

Chemistry 40S **AND** either 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:

<b>CHEM-1111(3)</b>	Introduction to the Chemical Properties of Matter
<b>CHEM-1112(3)</b>	Basic Principles of Chemical Reactivity
<b>CHEM-2202(3)</b>	Organic Chemistry I
<b>CHEM-2203(3)</b>	Organic Chemistry II
<b>CHEM-3502(3)</b>	Intermediate Biochemistry I
<b>CHEM-3503(3)</b>	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)**, while **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)**, the course **CHEM-2202(3)** may be taken concurrently with **CHEM-3502(3)**, while **CHEM-2203(3)** may be taken concurrently with **CHEM-3503(3)**.

## REQUIREMENTS FOR THE 3-YEAR BSc IN CHEMISTRY

<b>ADMISSION REQUIREMENT</b>	Students must consult with a department advisor in planning their course of study.
<b>GRADUATION REQUIREMENT</b>	90 credit hours
<b>RESIDENCE REQUIREMENT</b>	
Degree:	Minimum 30 credit hours
Major:	Minimum 18 credit hours
<b>GENERAL DEGREE REQUIREMENT</b>	
Humanities:	12 credit hours in Humanities
Writing:	Minimum 3 credit hours of Academic Writing.
Indigenous:	3 credit hours in designated Indigenous requirement courses
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. As a result, students must take a minimum of 48 credit hours at the 2000-level or above in order to not exceed the maximum number of introductory courses.
Distribution:	Minimum three (3) credit hours from each of five (5) different subjects.
<b>MAJOR REQUIREMENT</b>	
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:

<b>CHEM-1111(3)</b> Introduction to the Chemical Properties of Matter	<b>CHEM-2302(3)</b> Quantitative Chemical Analysis
<b>CHEM-1112(3)</b> Basic Principles of Chemical Reactivity	<b>CHEM-2401(3)</b> Inorganic Chemistry I
<b>CHEM-2102(3)</b> Thermodynamics and Kinetics	<b>MATH-1101(6)</b> Introduction to Calculus
<b>OR CHEM-2103(3)</b> Atoms, Molecules and Spectroscopy	<b>OR MATH-1103(3)</b> Introduction to Calculus I
<b>CHEM-2202(3)</b> Organic Chemistry I	<b>AND MATH-1104(3)</b> Introduction to Calculus II
<b>CHEM-2203(3)</b> Organic Chemistry II	<b>PHYS-1101(6)</b> Foundations of Physics I
	<b>OR PHYS-1301(6)</b> 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 and Spectroscopy, 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.

**Students** must complete a Declaration of Major in a three-year Degree Program form, available from Student Central, 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

<b>ADMISSION REQUIREMENT</b>	Students must consult with a department advisor when planning their studies.
<b>GRADUATION REQUIREMENT</b>	120 credit hours, that is, 90 credit hours meeting the requirements for the 3-Year BSc plus 30 additional credit hours.
<b>RESIDENCE REQUIREMENT</b>	
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.  
Indigenous: 3 credit hours in designated Indigenous requirement courses  
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. As a result, students must take a minimum of 78 credit hours at the 2000-level or above in order to not exceed the maximum number of introductory courses.  
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:

<b>CHEM-1111(3)</b> Introduction to the Chemical Properties of Matter	<b>CHEM-2502(3)</b> Introduction to Biochemistry <b>OR CHEM-3502(3)</b> Intermediate Biochemistry I
<b>CHEM-1112(3)</b> Basic Principles of Chemical Reactivity	<b>CHEM-3302(3)</b> Methods of Chemical Analysis
<b>CHEM-2102(3)</b> Thermodynamics and Kinetics	<b>CHEM-3401(3)</b> Inorganic Chemistry II: Coordination Chemistry
<b>CHEM-2103(3)</b> Atoms, Molecules and Spectroscopy	<b>MATH-1101(6)</b> Introduction to Calculus
<b>CHEM-2202(3)</b> Organic Chemistry I	<b>OR MATH-1103(3)</b> Introduction to Calculus I
<b>CHEM-2203(3)</b> Organic Chemistry II	<b>AND MATH-1104(3)</b> Introduction to Calculus II
<b>CHEM-2302(3)</b> Quantitative Chemical Analysis	<b>PHYS-1101(6)</b> Foundations of Physics I
<b>CHEM-2401(3)</b> Inorganic Chemistry I	<b>OR PHYS-1301(6)</b> 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 the former **STAT-1201(6)** Intro to Stat Analysis)  
**STAT-1501(3)** Elementary Biological Statistics I  
Any Mathematics course numbered 2000 or above (MATH-2xxx) with the exceptions of MATH-2901(3) (History of Calculus) MATH-2902 (Math Prior to 1640), MATH-2905 (MATH/PHIL-2305 Philosophy and Mathematics) and MATH-2801(6) (Fundamentals of Computing), MATH-2903 Math for Early/Middle Year Teachers I.

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 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-2102(3) Thermodynamics and Kinetics, CHEM-2302(3) Quantitative Chemical Analysis, CHEM-2401(3) Inorganic Chemistry I.



**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  
**STAT-1302 (3)** Statistical Analysis II  
**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 Central.

## 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 1<sup>st</sup> 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  
 Major: Minimum 30 credit hours

### GENERAL DEGREE REQUIREMENT

Humanities: 12 credit hours in Humanities.  
 Writing: Minimum 3 credit hours of Academic Writing.  
 Indigenous: 3 credit hours in designated Indigenous requirement courses  
 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. As a result, students must take a minimum of 78 credit hours at the 2000-level or above in order to not exceed the maximum number of introductory courses.  
 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-1041** Regulatory Compliance  
**CBST-1070** Principles of Hazardous Materials Management  
**CBST-1090** Introductory Statistics  
**CBST-2017** Microbiology 2  
**CBST-3001** Advanced Biochemistry  
**ENVI-1011** Environmental Chemistry/Toxicology

The following pattern of courses is suggested:

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

## COURSE LISTINGS

Students should consult Web Advisor or the appropriate Timetable on the website for courses to be offered in the upcoming 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.

<b>CHEM-0100(3)</b>	Foundations of Chemistry	<b>CHEM-3206(3)</b>	Advanced Organic Chemistry Laboratory
<b>CHEM-1111(3)</b>	Introduction to the Chemical Properties of Matter	<b>CHEM-3302(3)</b>	Methods of Chemical Analysis
<b>CHEM-1112(3)</b>	Basic Principles of Chemical Reactivity	<b>CHEM-3401(3)</b>	Inorganic Chemistry II: Coordination Chemistry
<b>CHEM-2102(3)</b>	Thermodynamics and Kinetics	<b>CHEM-3502(3)</b>	Intermediate Biochemistry I: Structure, Function, and Energetics of Biomolecules
<b>CHEM-2103(3)</b>	Atoms, Molecules and Spectroscopy	<b>CHEM-3503(3)</b>	Intermediate Biochemistry II: Intermediary Metabolism
<b>CHEM-2202(3)</b>	Organic Chemistry I	<b>CHEM-3601(3)</b>	Environmental Chemistry
<b>CHEM-2203(3)</b>	Organic Chemistry II	<b>CHEM/ENV-3611(3)</b>	Environmental Toxicology
<b>CHEM-2302(3)</b>	Quantitative Chemical Analysis	<b>CHEM-3701(3)</b>	Directed Studies in Chemistry
<b>CHEM-2401(3)</b>	Inorganic Chemistry I	<b>CHEM-4101(3)</b>	Quantum Chemistry
<b>CHEM-2502(3)</b>	Introduction to Biochemistry	<b>CHEM-4204(3)</b>	Medicinal Chemistry
<b>CHEM-2701(3)</b>	Computer Techniques and Applications for Chemistry	<b>CHEM-4302(3)</b>	Instrumentation for Quantitative Analysis
<b>CHEM-2801(3)</b>	Environmental Issues: A Chemistry Perspective	<b>CHEM-4303(3)</b>	Analytical Separations
<b>CHEM-3101(3)</b>	Physical Chemistry of Condensed Phases	<b>CHEM-4401(3)</b>	Organometallic d-Block Chemistry
<b>CHEM-3102(3)</b>	Quantum Chemistry and Spectroscopy	<b>CHEM-4403(3)</b>	Advanced Main Group Chemistry
<b>CHEM-3202(3)</b>	Reaction Mechanisms in Organic Chemistry	<b>CHEM-4502(3)</b>	Molecular Enzymology
<b>CHEM-3204(3)</b>	Organic Structure Determination	<b>CHEM-4506(3)</b>	Methods in Biochemistry
<b>CHEM-3205(3)</b>	Organic Synthesis	<b>CHEM-4701(6)</b>	Research Projects in Chemistry
		<b>CHEM-4703(3)</b>	Topics in Chemistry

## EXPERIMENTAL COURSE LISTINGS

**CHEM-3504(3)** Plant Biochemistry

## COURSE DESCRIPTIONS

All course descriptions for all undergraduate programs can now be found in one large PDF called "All Course Descriptions" in the "Academic Calendar" section of the University website:

<http://uwinnipeg.ca/academics/calendar/index.html>