# CHEMISTRY (BS)

**Chair: Phillip M. Sheridan, PhD**

## Introduction

Chemistry graduates enter a variety of professions, including careers in research and industry, the health sciences, teaching, technical writing, business, sales, patent law and civil service. A major in chemistry is excellent preparation for entrance into medical, dental, pharmacy, physician assistant (PA) and other health related programs, as well as graduate programs including chemistry, medicinal chemistry, environmental science, food science, materials science, business, and law.

The Department of Chemistry and Biochemistry offers four tracks that lead to a BS degree in Chemistry. The Chemistry BS track certified by the American Chemical Society (CHM ACS certified track) is designed for students planning to enter graduate studies in chemistry or related fields. The Chemistry for Health Sciences BS track is designed specifically for pre-med, pre-dental, pre-pharmacy, pre-pharmacy assistant, and other pre-health students (CHM HT track). The Chemistry BS track is designed for students who intend to pursue technical employment in industry (CHM track). The Chemistry with Business BS track is designed for students who want to pursue administrative or sales careers in the chemical industry, or in patent law (CHM BUS track).

Faculty advisors in the Department will help you choose the track that best fits your interests and career plans. Students in all program tracks will gain hands-on experience with a wide variety of modern, sophisticated laboratory instrumentation; this helps provide the experience necessary to be competitive in today's job market and/or to gain entrance into highly ranked graduate programs and health professional programs.

All Chemistry tracks can be completed with a business minor. This option offers valuable skills for employment in sales, marketing, or other industrial professions, as well as preparing students for the business aspects of careers in the sciences or health professions.

## Qualifications

Students must attain a grade of C or greater in General Chemistry II (CHM 112) and C- or greater in Organic Chemistry II (CHM 228) in order to progress into the major. Several two-semester courses (CHM 111 and CHM 112, CHM 227 and CHM 228, BCH 301 and BCH 302) have a required minimum grade of C- in the first course to continue to the second course.

## ACADEMIC Advisement

All students have an academic advisor. For students who have declared a major, an advisor is assigned in their respective academic department. For students who are still deciding on a major, they will be assigned a staff member from the Center for Student Success for advisement including course selection prior to registration.

Meetings with academic advisors are required prior to students receiving their PIN for course registration each semester. All students should work closely with their advisor in discussing career expectations, choosing their major electives, developing their entire academic program and planning their co-curricular or supplemental academic experiences.

## Special Programs Offered by the Department

### Early Assurance Program with University at Buffalo Medical School or Syracuse Medical School

Qualified students may apply to the University at Buffalo Medical School or Syracuse University Medical School during their sophomore year. Those accepted will be admitted into the Medical School freshman class after their graduation from Canisius.

### Early Assurance Program with University at Buffalo Dental School

Qualified students may apply to the University at Buffalo Dental School during their sophomore year. Those accepted will be admitted into the Dental School freshman class after their graduation from Canisius.

### Pre-Medical, Pre-Dental, Pre-Pharmacy, Pre-Physician Assistant and other Health Science Careers

The Chemistry Health Sciences BS track is recommended for students interested in pre-med, pre-pharmacy, pre-dental, pre-physician assistant, and other health science programs. All Chemistry BS tracks are excellent preparation for admission to medical, dental, pharmacy and physician assistant schools, and more than half of the graduates from this Department typically enter into these programs. Students applying to medical or dental schools must take the Medical College Admission Test (MCAT) or Dental Admission Test (DAT).

### Major Experiences

Following their freshman year, chemistry majors are encouraged to become involved in research projects with Department faculty. Stipends for are available to work on these projects during the summer in the Department. Summer work at other research institutions or clinical experience is also encouraged. Our relationship with industries and institutions aids students in job placement before and after graduation. Students may also choose to undertake chemistry related internships for advanced elective course credit.

## Double Majors

Students who wish to expand their educational opportunities may decide to declare a double major. This decision may be based on career goals, planned graduate studies, and/or other student interests. Before a student declares a double major, it is important to meet with the appropriate academic departments for advisement. In order to declare a double major, the student must complete the Major/Minor Declaration form. This form will be submitted electronically and reviewed and approved by each department chairperson as well as the appropriate associate dean.

Per university policy, each additional major requires a minimum of 15 credits that do not apply to the student's first or subsequent major. Some double major combinations can be completed within the minimum 120 credit hour degree requirement, but in other cases, additional coursework may be required. Please note that students will only receive **one** degree unless completing the dual degree (https://catalog.canisius.edu/undergraduate/academics/curricular-information/) requirement, including at least 150 undergraduate credit hours, regardless of the number of majors they complete. Both (all) majors appear on a student's transcript.

# Minors in Other Disciplines

Minors provide students the opportunity to pursue additional interests but generally do not require as many courses as a major. Minors generally range from five to eight required courses. To receive a minor, the student must complete at least 9 credit hours of coursework distinct from their other credentials (i.e., majors, other minors). The complete list of minors is available on the Canisius website (https://www.canisius.edu/academics/programs/undergraduate/?type%5B%5D=17) and in the catalog (https://catalog.canisius.edu/undergraduate/minors/) and provides links to each minor. Some majors and minors can be completed within the minimum 120 credit hour degree requirement, but in some cases additional coursework may be required. Students must complete the appropriate minor request form.

# Curriculum

## An Ignatian Foundation

All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/core-curriculum/) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/all-college-honors-program/). Many schools refer to their college-wide undergraduate requirements as "general education" requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

## Free Electives

Students may graduate with a bachelor's degree with more but not less than 120 credit hours. Free electives are courses in addition to the Canisius Core Curriculum or All-College Honors Curriculum and major requirements sufficient to reach the minimum number of credits required for graduation. The number of credits required to complete a bachelor's degree may vary depending on the student's major(s) and minor(s).

## Major Requirements

## For ACS-certified Chemistry Track

The ACS-certified Chemistry BS track is recommended for students planning to attend graduate school in a chemistry relate field.

| Code | Title | Credits |
|---|---|---|
| CHM 111 & 111L | General Chemistry I and General Chemistry I Laboratory | 4 |
| CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 4 |
| CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4 |
| CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4 |
| CHM 230 & 230L | Analytical Chemistry and Analytical Chemistry Laboratory | 4 |
| CHM 244 | Inorganic Chemistry | 3 |
| CHM 301 & 301L | Fundamental Physical Chemistry and Fundamental Physical Chemistry Laboratory | 4 |
| CHM 302 & 302L | Modern Physical Chemistry and Modern Physical Chemistry Laboratory | 4 |
| CHM 334 & 334L | Spectrometric Analysis and Spectrometric Analysis Lab | 4 |
| CHM 420 | Materials Chemistry | 3 |
| CHM 430 & 430L | Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory | 4 |
| CHM 480 | Chemistry and Biochemistry Seminar | 0 |
| CHM 481 | Communicating Concepts in Chemistry and Biochemistry | 3 |
| Choose 2 Chemistry or Biochemistry Electives (any 300- or 400- level CHM or BCH course) [1] | | 6 |
| BCH 301 | Introduction to Biochemistry | 3 |
| BIO 111 & 111L | Introductory Biology I and Introductory Biology Laboratory I | 4 |
| MAT 111 | Calculus I | 4 |
| MAT 112 | Calculus II | 4 |
| PHY 223 & 223L | General Physics for Physical Science Majors I and General Physics for Physical Science Majors I Laboratory | 4 |
| PHY 224 & 224L | General Physics for Physical Science Majors II and General Physics for Physical Science Majors II Laboratory | 4 |
| **Total Credits** | | **74** |

[1] Students may use PHY 332 or PHY 226 with lab as a Chemistry Elective.

## For Chemistry Track

The Chemistry BS track is designed for students who intend to pursue technical employment in chemistry related industry.

| Code | Title | Credits |
|---|---|---|
| CHM 111 & 111L | General Chemistry I and General Chemistry I Laboratory | 4 |
| CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 4 |
| CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4 |
| CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4 |
| CHM 230 & 230L | Analytical Chemistry and Analytical Chemistry Laboratory | 4 |
| CHM 244 | Inorganic Chemistry | 3 |
| CHM 301 & 301L | Fundamental Physical Chemistry and Fundamental Physical Chemistry Laboratory | 4 |
| CHM 334 & 334L | Spectrometric Analysis and Spectrometric Analysis Lab | 4 |
| CHM 430 & 430L | Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory | 4 |
| Choose 3 Chemistry or Biochemistry Electives (any 300- or 400- level CHM or BCH course) [1] | | 9 |
| CHM 480 | Chemistry and Biochemistry Seminar | 0 |
| CHM 481 | Communicating Concepts in Chemistry and Biochemistry | 3 |
| BCH 301 | Introduction to Biochemistry | 3 |
| BIO 111 & 111L | Introductory Biology I and Introductory Biology Laboratory I | 4 |
| MAT 111 | Calculus I | 4 |
| select one of the following: | | 3-4 |
| MAT 112 | Calculus II | |

| | | |
|---|---|---|
| MAT 141 | Inferential Statistics and Computers for Science | |
| PSY 201 | Basic Statistics for Behavioral Sciences | |
| PHY 201 & 201L | College Physics I and College Physics I Laboratory | 4 |
| PHY 202 & 202L | College Physics II and College Physics II Laboratory | 4 |
| **Total Credits** | | **69-70** |

[1] Students may use PHY 332 or PHY 226 with lab as a Chemistry Elective.
[2] Students minoring in business may take ECO 255 in lieu of MAT 112 or MAT 141 or PSY 201.

## For Chemistry for Health Sciences Track

The Chemistry for Health Sciences BS track is recommended for students preparing for a health-related profession (medical, dental, pharmacy, physician assistant, etc.).

| Code | Title | Credits |
|---|---|---|
| CHM 111 & 111L | General Chemistry I and General Chemistry I Laboratory | 4 |
| CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 4 |
| CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4 |
| CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4 |
| CHM 230 & 230L | Analytical Chemistry and Analytical Chemistry Laboratory | 4 |
| CHM 244 | Inorganic Chemistry | 3 |
| CHM 301 | Fundamental Physical Chemistry | 3 |
| CHM 480 | Chemistry and Biochemistry Seminar | 0 |
| CHM 481 | Communicating Concepts in Chemistry and Biochemistry | 3 |
| Choose a Chemistry or Biochemistry Elective (any 300- or 400- level CHM or BCH course) with lab | | 4 |
| Science Elective (choose from CSC 111 or any 300- or 400-level course in CHM, BCH, BIO, or PHY) | | 3 |
| Science Elective with Lab (choose any 300- or 400-level course in CHM, BCH, BIO, or PHY) | | 4 |
| BCH 301 | Introduction to Biochemistry | 3 |
| BCH 302 | Cellular Biochemistry | 3 |
| BIO 111 & 111L | Introductory Biology I and Introductory Biology Laboratory I | 4 |
| BIO 112 & 112L | Introductory Biology II and Introductory Biology Laboratory II | 4 |
| MAT 111 | Calculus I | 4 |
| select one of the following: | | 3-4 |
| MAT 112 | Calculus II | |
| MAT 141 | Inferential Statistics and Computers for Science | |
| PSY 201 | Basic Statistics for Behavioral Sciences | |
| PHY 201 & 201L | College Physics I and College Physics I Laboratory | 4 |
| PHY 202 & 202L | College Physics II and College Physics II Laboratory | 4 |
| **Total Credits** | | **69-70** |

[1] Students minoring in business may take ECO 255 in lieu of MAT 112 or MAT 141 or PSY 201.

## For Chemistry with Business Track

The Chemistry with Business BS track is designed for students who want to pursue administrative or sales careers in chemical industry. It is also an excellent track for students who want to pursue careers in patent law.

| Code | Title | Credits |
|---|---|---|
| **Required Science Courses** | | |
| CHM 111 & 111L | General Chemistry I and General Chemistry I Laboratory | 4 |
| CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 4 |
| CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4 |
| CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4 |
| CHM 301 | Fundamental Physical Chemistry | 3 |
| Choose one of the following: | | 4 |
| CHM 230 & 230L | Analytical Chemistry and Analytical Chemistry Laboratory | |
| CHM 334 & 334L | Spectrometric Analysis and Spectrometric Analysis Lab | |
| CHM 430 & 430L | Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory | |
| Choose a Chemistry or Biochemistry Elective (any 300- or 400- level CHM or BCH course) [1] | | 3 |
| CHM 480 | Chemistry and Biochemistry Seminar | 0 |
| CHM 481 | Communicating Concepts in Chemistry and Biochemistry | 3 |
| BCH 301 & 301L | Introduction to Biochemistry and Introduction to Biochemistry Laboratory | 4 |
| BIO 111 & 111L | Introductory Biology I and Introductory Biology Laboratory I | 4 |
| BIO 112 & 112L | Introductory Biology II and Introductory Biology Laboratory II | 4 |
| MAT 111 | Calculus I | 4 |
| select one of the following: | | 3-4 |
| MAT 112 | Calculus II | |
| MAT 141 | Inferential Statistics and Computers for Science | |
| PSY 201 | Basic Statistics for Behavioral Sciences | |
| PHY 201 & 201L | College Physics I and College Physics I Laboratory | 4 |
| PHY 202 & 202L | College Physics II and College Physics II Laboratory | 4 |
| **Required Business Courses** | | |
| ACC 201 | Financial Accounting | 3 |
| ECO 101 | Principles of Macroeconomics | 3 |
| ECO 102 | Principles of Microeconomics | 3 |
| FIN 201 | Introduction to Corporate Finance | 3 |
| MGT 101 | Introduction to Management | 3 |
| MKT 201 | Principles of Marketing | 3 |
| **Elective** | | |

| | |
|---|---|
| Select one course in business, law, or science [3] | 3 |
| **Total Credits** | **77-78** |

1 CHM 481 does not satisfy this requirement.
2 Students in this track may take ECO 255 in lieu of MAT 112 or MAT 141 or PSY 201
3 Choose one course from the following: CSC 111, IBUS 301, PSC 320, PSC 321, ACC 202, any 200-level or higher ECO course, or any 300- or 400-level course in CHM, BCH, BIO, PHY, MGT, or MKT.

## Additional Course Considerations

MAT 211 is highly recommended for students interested in pursuing a PhD degree. In addition, MAT 219 and MAT 222 are highly recommended for students interested in pursuing a PhD degree in physical, inorganic, or analytical chemistry.

# Roadmap

## Recommended Semester Schedule for Major Course Requirements

### CHM ACS Certified Track

| Freshman | |
|---|---|
| **Fall** | **Spring** |
| CHM 111<br>& 111L | CHM 112<br>& 112L |
| BIO 111<br>& 111L | MAT 112 |
| MAT 111 | |
| **Sophomore** | |
| **Fall** | **Spring** |
| CHM 227<br>& 227L | CHM 228<br>& 228L |
| CHM 244 | CHM 230<br>& 230L |
| PHY 223<br>& 223L | PHY 224<br>& 224L |
| **Junior** | |
| **Fall** | **Spring** |
| CHM 301<br>& 301L | CHM Elective |
| | CHM 302<br>& 302L |
| | CHM 480 |
| **Senior** | |
| **Fall** | **Spring** |
| CHM 334<br>& 334L | CHM Elective |
| BCH 301 | CHM 420 |
| | CHM 430<br>& 430L |
| | CHM 481 |

### CHM ACS Certified Track with Business Minor

| Freshman | |
|---|---|
| **Fall** | **Spring** |
| CHM 111<br>& 111L | CHM 112<br>& 112L |
| BIO 111<br>& 111L | MAT 112 |
| MAT 111 | |
| **Sophomore** | |
| **Fall** | **Spring** |
| CHM 227<br>& 227L | CHM 228<br>& 228L |
| ECO 101 | CHM 230<br>& 230L |
| CHM 244 | ECO 102 |
| PHY 223<br>& 223L | MAT 141 or ECO 255 |
| | PHY 224<br>& 224L |
| **Junior** | |
| **Fall** | **Spring** |
| CHM 301<br>& 301L | CHM Elective |
| MKT 201 | CHM 302<br>& 302L |
| | CHM 480 |
| | MGT 101 |
| **Senior** | |
| **Fall** | **Spring** |
| CHM 334<br>& 334L | CHM Elective |
| BCH 301 | FIN 201 |
| ACC 201 | CHM 420 |
| | CHM 430<br>& 430L |
| | CHM 481 |

### CHM Track

| Freshman | |
|---|---|
| **Fall** | **Spring** |
| CHM 111<br>& 111L | CHM 112<br>& 112L |
| BIO 111<br>& 111L | MAT 112, 141, or PSY 201 |
| MAT 111 | |
| **Sophomore** | |
| **Fall** | **Spring** |
| CHM 244 | CHM 228<br>& 228L |
| CHM 227<br>& 227L | PHY 202<br>& 202L |
| PHY 201<br>& 201L | |

**Junior**

| Fall | Spring |
|---|---|
| BCH 301 | CHM 230<br>& 230L |
| | CHM Elective |
| | CHM 480 |

**Senior**

| Fall | Spring |
|---|---|
| CHM 301<br>& 301L | CHM 430<br>& 430L |
| CHM 334<br>& 334L | CHM 481 |
| | CHM Elective |
| | CHM Elective |

## CHM Track with Business Minor

**Freshman**

| Fall | Spring |
|---|---|
| CHM 111<br>& 111L | CHM 112<br>& 112L |
| BIO 111<br>& 111L | MAT 141 or ECO 255 |
| MAT 111 | |

**Sophomore**

| Fall | Spring |
|---|---|
| CHM 227<br>& 227L | CHM 228<br>& 228L |
| CHM 244 | PHY 202<br>& 202L |
| PHY 201<br>& 201L | ECO 102 |

**Junior**

| Fall | Spring |
|---|---|
| BCH 301 | CHM 230<br>& 230L |
| ECO 101 | CHM Elective |
| | CHM 480 |
| | MGT 101 |

**Senior**

| Fall | Spring |
|---|---|
| CHM 301<br>& 301L | CHM 430<br>& 430L |
| CHM 334<br>& 334L | CHM 481 |
| ACC 201 | CHM Elective |
| MKT 201 | CHM Elective |
| | FIN 201 |

## CHM Health Sciences Track

**Freshman**

| Fall | Spring |
|---|---|
| CHM 111<br>& 111L | CHM 112<br>& 112L |
| BIO 111<br>& 111L | BIO 112<br>& 112L |
| MAT 111 | MAT 112, 141, or PSY 201 |

**Sophomore**

| Fall | Spring |
|---|---|
| CHM 227<br>& 227L | CHM 228<br>& 228L |
| CHM 244 | PHY 202<br>& 202L |
| PHY 201<br>& 201L | |

**Junior**

| Fall | Spring |
|---|---|
| BCH 301 | CHM 230<br>& 230L |
| | CHM 480 |
| | BCH 302 |

**Senior**

| Fall | Spring |
|---|---|
| CHM 301 | CHM 481 |
| SCI Elective + Lab | CHM Elective + Lab |
| | SCI elective |

## CHM Health Sciences Track with Business Minor

**Freshman**

| Fall | Spring |
|---|---|
| CHM 111<br>& 111L | CHM 112<br>& 112L |
| BIO 111<br>& 111L | BIO 112<br>& 112L |
| MAT 111 | MAT 141 or ECO 255 |

**Sophomore**

| Fall | Spring |
|---|---|
| CHM 227<br>& 227L | CHM 228<br>& 228L |
| CHM 244 | PHY 202<br>& 202L |
| PHY 201<br>& 201L | ECO 102 |
| ECO 101 | |

**Junior**

| Fall | Spring |
|---|---|
| BCH 301 | CHM 230<br>& 230L |
| MKT 201 | CHM 480 |
| | BCH 302 |
| | MGT 101 |

**Senior**

| Fall | Spring |
|---|---|
| CHM 301 | CHM 481 |
| ACC 201 | CHM Elective + Lab |
| SCI Elective + Lab | SCI Elective |
| | FIN 201 |

## CHM with Business Track

| Freshman | |
|---|---|
| **Fall** | **Spring** |
| CHM 111 & 111L | CHM 112 & 112L |
| BIO 111 & 111L | BIO 112 & 112L |
| MAT 111 | MAT 141 or 112 |
| **Sophomore** | |
| **Fall** | **Spring** |
| CHM 227 & 227L | CHM 228 & 228L |
| PHY 201 & 201L | PHY 202 & 202L |
| ECO 101 | ECO 102 |
| **Junior** | |
| **Fall** | **Spring** |
| BCH 301 & 301L | CHM 480 |
| ACC 201 | MGT 101 |
| MKT 201 | Analytical/Instrumental Chemistry with lab[1] |
| **Senior** | |
| **Fall** | **Spring** |
| CHM 301 | BCH or CHM Elective |
| FIN 201 | Major Elective[2] |

1 Choose one of the following analytical/instrumental courses with its associated laboratory: CHM 230, CHM 334, or CHM 430.

2 Choose one course in business, law, or science: a 300 level course or higher in MGT, ACC 202, ECO 102 or a 200 level course or higher in ECO, IBUS 301, PSC 320, PSC 321, a 300 or 400 level course in CHM, BCH, BIO, or PHY, or CSC 111.

# Learning Goals and Objectives

## Student Learning Goal 1:

### Knowledge; Demonstrate an understanding of fundamental chemical concepts.

**Students will:**

- Objective A Demonstrate broad knowledge of chemical concepts.
- Objective B Analyze and predict the effects of chemical changes.

## Student Learning Goal 2:

### Professional Skills; Work effectively in a professional or laboratory setting.

**Students will:**

- Objective A Carry out experiments (follow directions, manipulate materials and lab apparatus, record data).
- Objective B Use modern instrumentation (prepare samples, operate systems, troubleshoot common problems, organize and label data).
- Objective C Demonstrate knowledge of chemical, instrumental and workplace safety.

## Student Learning Goal 3:

### Communication; Be proficient in the communication of chemical information.

**Students will:**

- Objective A Construct and deliver an effective oral presentation.
- Objective B Write an effective, properly formatted scientific report.
- Objective C Identify, access and use chemical literature sources.

# Minor

Students majoring in various disciplines such as biology, mathematics, computer science, psychology and business can benefit from pursuing a minor in chemistry. The chemistry minor requires a student to complete the following sequence of courses:

| Code | Title | Credits |
|---|---|---|
| CHM 111 & 111L | General Chemistry I and General Chemistry I Laboratory | 4 |
| CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 4 |
| CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4 |
| CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4 |
| Select one of the following: | | 4 |
| CHM 230 & 230L | Analytical Chemistry and Analytical Chemistry Laboratory | |
| CHM 334 & 334L | Spectrometric Analysis and Spectrometric Analysis Lab | |
| CHM 430 & 430L | Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory | |
| Select one of the following: | | 3 |
| CHM 244 | Inorganic Chemistry | |
| CHM 301 | Fundamental Physical Chemistry | |
| Select one 300 level course or higher in CHM or BCH.[1] | | 3 |
| **Total Credits** | | **26** |

1 CHM 480 or CHM 481 individually do not satisfy this requirement.

Minors are an important part of the undergraduate curriculum. If students declare a minor by sophomore year, they can usually complete it in a timely manner. Students should work with their advisor to determine if it is possible that the minor can be completed by graduation.

To receive a minor, a student must complete at least 9 credit hours of coursework distinct from their major(s) and from other minors, and students must complete more than 50% of the coursework required for the minor at Canisius. Please note that "ancillary/supporting" courses required for a major may still count as distinct courses as long as the remaining coursework still meets the 30 credit-hours required for a major. For more information about minor policies, please see the Declaring Majors and Minors (http://catalog.canisius.edu/undergraduate/academics/student-records/declaring-majors-minors/) page in the catalog.

# Combined Degree Programs

- 4+1 Chemistry BS/Adolescence 7-12, Teaching Students with Disabilities (All Grades) MSEd (http://catalog.canisius.edu/undergraduate/division-

arts-education-sciences/school-natural-environmental-animal-sciences/chemistry/4-1-chemistry-bs-adolescence-swd-msed/)

# Courses

**CHM 104 Energy, Environment, and Society** **3 Credits**
Designed to provide a better understanding of energy and our environment, including man's interaction with his environment and the consequences facing society today.
**Fulfills College Core:** Field 6 (Natural Sciences), Global Awareness
**Offered:** every fall.

**CHM 111 General Chemistry I** **3 Credits**
General Chemistry I for science majors. Inorganic nomenclature, stoichiometry, solutions, basic chemical reactions, thermochemistry, atomic and molecular structure, periodic properties, gas laws, and states of matter. Three lectures and one recitation per week.
**Corequisite:** CHM 111L.
**Fulfills College Core:** Field 6 (Natural Sciences)
**Offered:** every fall.

**CHM 111L General Chemistry I Laboratory** **1 Credit**
Covers techniques of measurements, decantation, and filtration; use of a data acquisition system with temperature probe, pressure sensor, and spectrophotometer; analysis of data and developing a conclusion based on data trends. One three-hour lab per week.
**Corequisite:** CHM 111.
**Offered:** every fall.

**CHM 112 General Chemistry II** **3 Credits**
General Chemistry II for science majors. Properties of solutions (including colligative properties), kinetics, chemical equilibrium concepts, calculations involving acid/base and precipitation equilibria, thermodynamics (second and third law), electrochemistry, nuclear chemistry, and chemistry of the environment. A minimum grade of C in CHM 112 is required for all chemistry and biochemistry majors. Three lectures and one recitation per week.
**Prerequisite:** minimum grade of C- in CHM 111. **Corequisite:** CHM 112L.
**Fulfills College Core:** Field 6 (Natural Sciences)
**Offered:** every spring.

**CHM 112L General Chemistry II Laboratory** **1 Credit**
Builds on techniques developed in CHM 111L and covers solution dilution, titration, pipetting, and use of a pH electrode and current probe. One three-hour lab per week.
**Prerequisite:** minimum grade of C- in CHM 111L. **Corequisite:** CHM 112.
**Offered:** every spring.

**CHM 227 Organic Chemistry I** **3 Credits**
Fundamental treatment of organic chemistry. Bonding, structure, nomenclature, and stereochemistry of organic functional groups. Mechanisms and reactivity in substitution and elimination reactions. Three lectures and one recitation per week.
**Prerequisite:** minimum grade of C- in CHM 111 and CHM 112. **Corequisite:** CHM 227L.
**Offered:** every fall.

**CHM 227L Organic Chemistry I Laboratory** **1 Credit**
Techniques for synthesis, separation, purification, and analysis of organic compounds. One four-hour lab per week.
**Prerequisite:** minimum grade of C- in CHM 111L. **Corequisite:** CHM 227.
**Offered:** every fall.

**CHM 228 Organic Chemistry II** **3 Credits**
Continuation of organic chemistry. Chemistry and reaction mechanisms of unsaturated compounds, and oxygen and nitrogen-containing functional groups. Introduction to the organic chemistry of carbohydrates, lipids and peptides. Three lectures and one recitation per week.
**Prerequisite:** minimum grade of C- in CHM 227. **Corequisite:** CHM 228L.
**Offered:** every spring.

**CHM 228L Organic Chemistry II Laboratory** **1 Credit**
Expands on techniques for synthesis, separation, purification, and analysis of organic compounds. One four hour lab per week.
**Prerequisite:** minimum grade of C- in CHM 227L. **Corequisite:** CHM 228.
**Offered:** every spring.

**CHM 230 Analytical Chemistry** **3 Credits**
Principles and methodology of modern analytical chemistry presented with particular emphasis on statistical error analysis, titrations, solution equilibrium, and potentiometry. Three lectures and one recitation per week.
**Prerequisite:** minimum grade of C in CHM 112. **Corequisite:** CHM 230L.
**Offered:** spring of even-numbered years.

**CHM 230L Analytical Chemistry Laboratory** **1 Credit**
Fundamental techniques of quantitative analysis including titrations in multiple reaction paradigms, potentiometry, absorption spectrometry, and separation technologies. One four-hour lab per week.
**Prerequisite:** minimum grade of C- in CHM 112L. **Corequisite:** CHM 230.
**Offered:** spring of even-numbered years.

**CHM 232 Environmental Analytical Chemistry** **3 Credits**
Environmental applications of analytical chemistry. Sampling techniques and statistical analysis of data. Aquatic chemistry and atmospheric chemistry. Analysis with traditional methods, electroanalytical, liquid and gas chromatography, elemental spectroscopy and ion selective electrodes. Three lectures per week.
**Prerequisite:** CHM 112. **Corequisite:** CHM 232L.
**Offered:** spring of odd-numbered years.

**CHM 232L Environmental Analytical Chemistry Laboratory** **1 Credit**
Introduction and demonstration of fundamental techniques of quantitative analysis including titrations, potentiometry, spectrometry, chromatography, and separation technologies. One 75-minute lab per week.
**Prerequisite:** CHM 112L. **Corequisite:** CHM 232.
**Offered:** spring of odd-numbered years.

**CHM 244 Inorganic Chemistry** **3 Credits**
Electronic configuration of atoms, periodic classification of the elements, nature of chemical bonding, symmetry and application of group theory to molecular orbitals, structures and thermodynamics of solids, bonding in metals and semiconductors, acid/base concepts, electrochemistry, isomerism, bonding, reactions and spectroscopy of coordination compounds, and other aspects of modern inorganic chemistry. Three lectures and one recitation per week.
**Prerequisite:** minimum grade of C in CHM 112.
**Offered:** every fall.

**CHM 301 Fundamental Physical Chemistry** **3 Credits**
Fundamental topics in thermodynamics, kinetics, and quantum chemistry. Three lectures and one recitation per week.
**Prerequisite:** minimum grade of C in CHM 112, successful completion of MAT 111 or MAT 110, and a year of physics (PHY 201 & PHY 202 or PHY 223 & PHY 224).
**Offered:** every fall.

**CHM 301L Fundamental Physical Chemistry Laboratory** **1 Credit**
Selected experiments demonstrating principles of thermodynamics, including bomb calorimetry, and chemical kinetics. One four-hour lab per week.
**Prerequisite:** CHM 301 (or concurrent registration in CHM 301).
**Fulfills College Core:** Advanced Writing-Intensive
**Offered:** fall of odd-numbered years.

**CHM 302 Modern Physical Chemistry** **3 Credits**
Introduction to quantum chemistry with applications to the structure of atoms and molecules. Molecular spectroscopy. Three lectures and one recitation per week.
**Prerequisite:** minimum grade of C in CHM 112, CHM 244, successful completion of MAT 111 or MAT 110, MAT 112, a year of physics (PHY 201 & PHY 202 or PHY 223 & PHY 224).
**Offered:** spring of even-numbered years.

**CHM 302L Modern Physical Chemistry Laboratory** **1 Credit**
Selected spectroscopy and computational chemistry experiments with applications to molecular structure. One four-hour lab per week.
**Prerequisite:** CHM 302 (or concurrent registration in CHM 302).
**Offered:** spring of even-numbered years.

**CHM 334 Spectrometric Analysis** **3 Credits**
Spectrometric methods for the elucidation of chemical structures. Includes nuclear magnetic resonance, infrared, ultraviolet and mass spectrometry. Emphasis on organic compounds. Three lectures per week.
**Prerequisite:** CHM 228.
**Offered:** every fall.

**CHM 334L Spectrometric Analysis Lab** **1 Credit**
Nuclear magnetic resonance, infrared, ultraviolet and mass spectrometry of organic compounds. One four-hour lab per week.
**Prerequisite:** CHM 228L.
**Offered:** every fall.

**CHM 402 Advanced Physical Chemistry** **3 Credits**
Introduction to statistical thermodynamics. Applications of group theory to chemical bonding and molecular spectroscopy. Angular momentum coupling in atomic and molecular spectroscopy. Three lectures per week.
**Prerequisites:** MAT 111 & MAT 112; CHM 244; CHM 302 (may be taken concurrently); and either PHY 201 & PHY 202 or PHY 223 & PHY 224.
**Offered:** occasionally.

**CHM 420 Materials Chemistry** **3 Credits**
A survey of topics and applications in modern materials chemistry including solid state materials, semiconductors, polymers, nanomaterials, and introductions to mechanical properties, device fabrication, and structure-activity relationships.
**Prerequisite:** CHM 228 & CHM 244 (or concurrent registration in CHM 244). **Corequisite:** CHM 420L.
**Offered:** anticipated spring 2023.

**CHM 430 Instrumental Analytical Chemistry** **3 Credits**
Advanced instrumental methods of analysis including spectroscopy, chromatography and various electrochemical techniques. Three lectures per week.
**Prerequisite:** CHM 112 & CHM 228 (or concurrent registration in CHM 228).
**Offered:** spring of odd-numbered years.

**CHM 430L Instrumental Analytical Chemistry Laboratory** **1 Credit**
Atomic absorption spectroscopy, chromatography and various electrochemical techniques. One four-hour lab per week.
**Prerequisite:** CHM 112L & CHM 228L (or concurrent registration in CHM 228L). **Corequisite:** CHM 430.
**Offered:** spring of odd-numbered years.

**CHM 450 Research in Chemistry** **3 Credits**
Independent research under the direction of the chemistry faculty. Students are required to spend 9 hours per week conducting research. CHM 450 may be taken in place of a chemistry elective without lab. Research and consultation times to be arranged after approval of department chair.
**Prerequisite:** permission of department chair.
**Offered:** fall & spring.

**CHM 451 Research in Chemistry** **4 Credits**
Independent research under the direction of the chemistry faculty. Students are required to spend 12 hours per week conducting research. CHM 451 may be taken in place of a chemistry elective with lab. Research and consultation times to be arranged after approval of department chair.
**Prerequisite:** permission of department chair.
**Offered:** fall & spring.

**CHM 455 Medicinal Chemistry** **3 Credits**
Chemical principles are used to explain the interaction of drugs with biological targets. Strategies used in the design and development of medicines are discussed.
**Prerequisite:** CHM 228 & BCH 301.
**Offered:** spring of even-numbered years.

**CHM 480 Chemistry and Biochemistry Seminar** **0 Credits**
Chemistry and biochemistry majors attend seminars given by senior chemistry and biochemistry majors, and external speakers.
**Prerequisite:** CHM 228.
**Offered:** every spring.

**CHM 481 Communicating Concepts in Chemistry and Biochemistry** **3 Credits**
Seminar for chemistry and biochemistry majors. Introduces scientific literature and oral communication in chemistry and biochemistry. Students learn how to prepare and then deliver a polished scientific presentation. Students also attend seminars given by external speakers on chemistry and biochemistry topics.
**Prerequisite:** CHM 228 and CHM 480.
**Fulfills College Core:** Oral Communication
**Offered:** every spring.

**CHM 490 Chemistry Internship** **3 Credits**
Internships in chemical or biochemical industry under the direction of company and faculty supervisors.
**Prerequisite:** permission of department chair & associate dean.
**Offered:** fall & spring.

**CHM 499 Independent Study** **3-4 Credits**
Independent study under the direction of the chemistry faculty. Independent studies require an application and approval by the associate dean.
**Prerequisite:** permission of the instructor, department chair, & associate dean.
**Offered:** fall & spring.