

CHEMISTRY (BS)

Chair: Phillip M. Sheridan, PhD

Introduction

Chemistry or Biochemistry graduates enter a variety of professions, including careers in research and industry, the health professions, teaching, technical writing, business, sales, patent law and civil service. A major in chemistry or biochemistry is an excellent preparation for entrance into medical, dental and pharmacy schools. It also prepares students to enter a range of graduate programs including chemistry, biochemistry, biotechnology, bioinformatics, medicinal chemistry, chemical engineering, environmental science, bioengineering, business and law.

The Department of Chemistry and Biochemistry offers three tracks that lead to a BS degree in Chemistry and one track that leads to a BS degree in Chemistry with Business. The three tracks in Chemistry include the Chemistry track that is certified by the American Chemical Society (CHM ACS certified track), Chemistry Health Professions track, and Chemistry track designed for students who intend to pursue technical employment in industry. Chemistry with Business is designed for students who want to pursue administrative or sales careers in the chemical industry. It is also an excellent degree for students who want to pursue careers in patent law.

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.

All Chemistry tracks can be completed with a business minor. This option provides a very useful preparation for employment in sales, marketing, or other industrial professions, as well as preparing students for graduate studies in business or administration

Qualifications

Students must attain the 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 requirement for a minimum grade of C- in the first course to continue with 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 Griff 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 and Pre-Dental

The Chemistry and Biochemistry BS degrees are excellent preparations for entering into medical and dental schools, and a third 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).

Pre-Pharmacy

For pre-pharmacy students we recommend the CHM Health Professions track, since students in this track can meet all pharmacy school entrance requirements. Students applying to most pharmacy schools must take the Pharmacy College Admission Test (PCAT).

Major Experiences

Following their freshman year, and sometimes earlier, chemistry and biochemistry majors are encouraged to become involved in research or other professional projects. Stipends for qualified students are often available so that work can be done on these projects during the summer and school year in the Department. Summer work in industrial laboratories and research institutions is also available. Our close relationship with local industries and institutions aids students in job placement before and after graduation. Students may also choose to undertake industrial 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 college 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 course work may be required. Please note that students will receive only one degree unless they complete 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 track is recommended for students intending advanced study (pursuing a graduate degree) in Chemistry.

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 & 420L	Materials Chemistry and Materials Chemistry Laboratory	4
CHM 430 & 430L	Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory	4
CHM 381	Scientific Literature and Communication	1
CHM 480	Communicating Concepts in Chemistry	1
CHM 481	Communicating Research Literature	1
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		75

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

For Chemistry Track

Chemistry track designed for students who intend to pursue technical employment in 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
CHM 381	Scientific Literature and Communication	1
CHM 480	Communicating Concepts in Chemistry	1
CHM 481	Communicating Research Literature	1
Choose 3 Chemistry or Biochemistry Electives (any 300- or 400- level CHM or BCH course) ¹		9
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 ²	4

or MAT 141	Inferential Statistics and Computers for Science	
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		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.

For Chemistry for Health Professions Track

The Health Professions Track is recommended for students preparing for a health-related profession (e.g. Medicine, Dentistry, 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 381	Scientific Literature and Communication	1
CHM 480	Communicating Concepts in Chemistry	1
CHM 481	Communicating Research Literature	1
	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
MAT 112 or MAT 141	Calculus II ¹ Inferential Statistics and Computers for Science	4
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		70

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

For Chemistry with Business Track

Chemistry with Business is designed for students who want to pursue administrative or sales careers in chemical industry. It is also an excellent degree 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 381	Scientific Literature and Communication	1
CHM 480	Communicating Concepts in Chemistry	1
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
MAT 112 or MAT 141	Calculus II ² Inferential Statistics and Computers for Science	4
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

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.

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 & 111L	CHM 112 & 112L
BIO 111 & 111L	MAT 112
MAT 111	

Sophomore

Fall	Spring
CHM 227 & 227L	CHM 228 & 228L
CHM 244	CHM 230 & 230L
PHY 223 & 223L	PHY 224 & 224L

Junior

Fall	Spring
CHM 301 & 301L	CHM 302 & 302L
CHM 381	CHM 430 & 430L
	CHM 480

Senior

Fall	Spring
CHM 334 & 334L	CHM Elective
BCH 301	CHM Elective
CHM 481	CHM 420 & 420L

CHM ACS Certified Track with Business Minor

Freshman

Fall	Spring
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	MAT 112
MAT 111	

Sophomore

Fall	Spring
CHM 227 & 227L	CHM 228 & 228L
ECO 101	CHM 230 & 230L
CHM 244	ECO 102
PHY 223 & 223L	MAT 141 or ECO 255
	PHY 224 & 224L

Junior

Fall	Spring
CHM 301 & 301L	CHM 302 & 302L
CHM 381	CHM 430 & 430L
MKT 201	CHM 480
	MGT 101

Senior

Fall	Spring
CHM 334 & 334L	CHM Elective
BCH 301	CHM Elective
CHM 481	FIN 201
ACC 201	CHM 420 & 420L

CHM Track

Freshman

Fall	Spring
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	MAT 112 or 141
MAT 111	

Sophomore

Fall	Spring
CHM 227 & 227L	CHM 228 & 228L
PHY 201 & 201L	PHY 202 & 202L

Junior

Fall	Spring
BCH 301	CHM 230 & 230L
CHM 244	CHM Elective
CHM 381	CHM 480

Senior

Fall	Spring
CHM 301 & 301L	CHM 430 & 430L

CHM 334 & 334L	CHM Elective
CHM 481	CHM Elective

CHM Track with Business Minor

Freshman

Fall	Spring
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	MAT 141 or ECO 255
MAT 111	

Sophomore

Fall	Spring
CHM 227 & 227L	CHM 228 & 228L
PHY 201 & 201L	PHY 202 & 202L
	ECO 102

Junior

Fall	Spring
BCH 301	CHM 230 & 230L
CHM 244	CHM Elective
CHM 381	CHM 480
ECO 101	MGT 101

Senior

Fall	Spring
CHM 301 & 301L	CHM 430 & 430L
CHM 334 & 334L	CHM Elective
CHM 481	CHM Elective
ACC 201	FIN 201
MKT 201	

CHM Health Professions Track

Freshman

Fall	Spring
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	BIO 112 & 112L
MAT 111	MAT 112 or 141

Sophomore

Fall	Spring
CHM 227 & 227L	CHM 228 & 228L
PHY 201 & 201L	PHY 202 & 202L

Junior

Fall	Spring
BCH 301	CHM 230 & 230L
CHM 244	BCH 302

CHM 381	CHM 480
Senior	
Fall	Spring
CHM 301	CHM Elective + Lab
CHM 481	SCI elective
SCI Elective + Lab	

CHM Health Professions Track with Business Minor

Freshman

Fall	Spring
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	BIO 112 & 112L
MAT 111	MAT 141 or ECO 255

Sophomore

Fall	Spring
CHM 227 & 227L	CHM 228 & 228L
PHY 201 & 201L	PHY 202 & 202L
ECO 101	ECO 102

Junior

Fall	Spring
BCH 301	CHM 230 & 230L
CHM 381	BCH 302
CHM 244	CHM 480
MKT 201	MGT 101

Senior

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

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
CHM 381	MGT 101
ACC 201	Analytical/Instrumental Chemistry with lab ¹
MKT 201	
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 & 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, physics, bioinformatics, 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 381, 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.

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 109 General Chemistry I with Review - Part I 3 Credits

General Chemistry I for science majors, Part I. This course reviews some mathematical concepts, emphasizes dimensional analysis, inorganic nomenclature, stoichiometry, solutions, basic chemical reactions, and thermochemistry. Three lectures and one recitation per week.

Fulfills College Core: Field 6 (Natural Sciences)

Offered: every fall.

<p>CHM 110 General Chemistry I with Review - Part II 3 Credits General Chemistry I for science majors, Part II, three lectures, one laboratory, and one recitation per week. This course emphasizes atomic and molecular structure, periodic properties, gas laws, and states of matter. The CHM 109 and CHM 110 sequence is equivalent to CHM 111 and a free elective. Students completing the CHM 109 and CHM 110 sequence are eligible to take CHM 112. Prerequisite: minimum grade of C- in CHM 109. Corequisite: CHM 111L. Offered: every spring.</p>	<p>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.</p>
<p>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.</p>	<p>CHM 228L Organic Chemistry II Laboratory 1 Credit One four hour lab per week. Expands on techniques for synthesis, separation, purification, and analysis of organic compounds. Prerequisite: minimum grade of C- in CHM 227L. Corequisite: CHM 228. Offered: every spring.</p>
<p>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 110 or CHM 111. Offered: every fall.</p>	<p>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.</p>
<p>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 either CHM 110 or CHM 111. Corequisite: CHM 112L. Fulfills College Core: Field 6 (Natural Sciences) Offered: every spring.</p>	<p>CHM 230L Analytical Chemistry Laboratory 1 Credit One four-hour lab per week. Fundamental techniques of quantitative analysis including titrations in multiple reaction paradigms, potentiometry, absorption spectrometry, and separation technologies. Prerequisite: minimum grade of C- in CHM 112L. Corequisite: CHM 230. Offered: spring of even-numbered years.</p>
<p>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.</p>	<p>CHM 232 Environmental Analytical Chemistry 3 Credits Environmental applications of analytical chemistry. Sampling techniques and statistical analysis of data. Soil chemistry, aquatic chemistry and atmospheric chemistry. Trace analysis with electroanalytical, liquid and gas chromatography, atomic absorption spectroscopy and ion selective electrodes. Three lectures and one recitation per week. Prerequisite: CHM 112. Corequisite: CHM 232L. Offered: anticipated spring 2023.</p>
<p>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 either CHM 110 or CHM 111. Corequisite: CHM 227L. Offered: every fall.</p>	<p>CHM 232L Environmental Analytical Chemistry Laboratory 1 Credit One four-hour lab per week. Prerequisite: CHM 112L. Corequisite: CHM 232. Offered: anticipated spring 2023.</p>
<p>CHM 227L Organic Chemistry I Laboratory 1 Credit One four-hour lab per week. Techniques for synthesis, separation, purification, and analysis of organic compounds. Prerequisite: minimum grade of C- in CHM 111L. Corequisite: CHM 227. Offered: every fall.</p>	<p>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.</p>
	<p>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.</p>

<p>CHM 301L Fundamental Physical Chemistry Laboratory 1 Credit Selected experiments demonstrating principles of thermodynamics and chemical kinetics. One four-hour lab per week. Prerequisite: minimum grade of C in CHM 230L & C in CHM 301 (or concurrent registration in CHM 301). Fulfills College Core: Advanced Writing-Intensive Offered: fall of even-numbered years.</p>	<p>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.</p>
<p>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.</p>	<p>CHM 420L Materials Chemistry Laboratory 1 Credit This laboratory develops concepts introduced in the lecture component of Materials Chemistry, CHM420, including solid-state structure, mechanical properties, semiconductors, polymers, and nanomaterials. The lab meets for four hours per week. Prerequisite: CHM 228L (may be taken concurrently). Corequisite: CHM 420. Offered: anticipated spring 2023.</p>
<p>CHM 302L Modern Physical Chemistry Laboratory 1 Credit Selected spectroscopy experiments with applications to molecular structure. One four-hour lab per week. Prerequisite: CHM 302 (or concurrent registration in CHM 302) & minimum grade of C in CHM 230L, CHM 301L, CHM 334L or CHM 430L. Offered: spring of even-numbered years.</p>	<p>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.</p>
<p>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.</p>	<p>CHM 430L Instrumental Analytical Chemistry Laboratory 1 Credit One four-hour lab per week. Atomic absorption spectroscopy, chromatography and various electrochemical techniques Prerequisite: CHM 112L & CHM 228L (or concurrent registration in CHM 228L). Corequisite: CHM 430. Offered: spring of odd-numbered years.</p>
<p>CHM 334L Spectrometric Analysis Lab 1 Credit One four-hour lab per week. Nuclear magnetic resonance, infrared, ultraviolet and mass spectrometry of organic compounds. Prerequisite: CHM 228L. Offered: every fall.</p>	<p>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.</p>
<p>CHM 344 Metal Ions in Biological Systems 3 Credits Chemical processes in biological systems, which include participation of metal ions, are covered. The course begins with the principles of coordination chemistry and structural biochemistry. The rest of the course is organized according to the functions performed by the metal centers: gene expression and signal transduction, digestion, bioenergetics and electron transfer, oxygen transport, liver functions and anticancer drugs. Prerequisite: CHM 228. Offered: occasionally.</p>	<p>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.</p>
<p>CHM 381 Scientific Literature and Communication 1 Credit First of three student-faculty seminars for majors. Introduces scientific literature, technical writing and oral communication in chemistry and allied fields. Prerequisite: CHM 228 & junior standing. Offered: every fall.</p>	<p>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: minimum grade of C- in both CHM 228 & BCH 301. Offered: spring of even-numbered years.</p>
<p>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.</p>	<p>CHM 480 Communicating Concepts in Chemistry 1 Credit Second of three student-faculty seminars for majors. Students give a 25-minute presentation on an advanced coursework topic. Emphasis is placed on the process and the mechanics of constructing a scientific talk. Prerequisite: CHM 228, CHM 381, & junior standing. Offered: every spring.</p>

CHM 481 Communicating Research Literature 1 Credit

Third of three student-faculty seminars for majors. Students give a 45-minute presentation on a scientific work from the chemical literature. Emphasis is placed on constructing a narrative and gaining a working understanding of the scientific issues in the presented paper.

Prerequisite: CHM 228, CHM 381, & junior standing.

Fulfills College Core: Oral Communication

Offered: every fall.

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.

Chemistry/SWD Generalist Dual Degree Curriculum

The Dual Degree Program (<http://catalog.canisius.edu/graduate/school-education-human-services/educator-preparation/dual-degree-content-and-msed-swd/#curriculumtext>) offers a BS in Chemistry as well as a MSeD in Adolescence 7-12 Teaching Students with Disabilities Generalist. This program leads to Initial Adolescence Certification in Chemistry as well as Initial Certification in Adolescence 7-12 SWD Generalist. Since it leads to two teaching certificates, candidates must meet the content requirements for both over the course of their curriculum. In most cases, the content area major covers those requirements. In some instances New York State has additional requirements. Please note, this dual degree program can be completed in as little as 5 years.

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 Undergraduate Courses

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 244	Inorganic Chemistry	3
CHM 301	Fundamental Physical Chemistry	3
CHM 230 & 230L	Analytical Chemistry and Analytical Chemistry Laboratory	4
CHM 381	Scientific Literature and Communication	1
CHM 480	Communicating Concepts in Chemistry	1
BCH 301 & 301L	Introduction to Biochemistry and Introduction to Biochemistry Laboratory	4
	Chemistry or Biochemistry Elective ¹	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
MAT 141	Inferential Statistics and Computers for Science	4
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 Education Courses		
EDS 101	Human Growth and Social Development: Adolescence	3
EDS 223	Foundations of Adolescent Literacy	3
EDS 360	Evaluation and Teaching Strategies	3
EDS 405	Methods of Teaching Science: Adolescence	3
EDU 250	Foundations of Education	3
EDU 356	Assessment for Diverse Learners	3
SPE 311	Nature/Needs of Childhood Students with Intellectual Disabilities & Autism Spectrum Disorders	3
SPE 341	Inclusive Strategies	3
Total Credits		83

Please note, one math, one science, one English, and one history course are needed for SWD certification.

Graduate Courses

The education curriculum is provided below for the graduate MSeD portion of the dual degree program. Several foundation courses are taken at the undergraduate level listed above with the requirements for the history major. The graduate courses begin at the 500 level and continue until completion. These courses can be taken during a student's senior year. Refer to the roadmap for further details.

Code	Title	Credits
EDU 556	Assessment for Diverse Learners ¹	3
or EDU 356	Assessment for Diverse Learners	
EDU 595	Child Abuse Workshop	0
EDU 596	Prevention of School Violence Workshop	0
EDU 597	Dignity for All Students Workshop	0
EDU 615	Research Methods	3
SPE 580	Classroom Management	3
SPE 631	Reading and Writing Process for Students with Learning and Behavioral Disorders	3
SPE 640	Learning and Behavioral Disabilities (LBD); Etiology and Research Based Interventions	3
SPE 644	Collaborative Practices on a Transdisciplinary Team	3
SPE 649	Transition Issues for Adolescents with Disabilities	3
SPE 650	Intellectual Disabilities and Autism Spectrum Disorders: Etiology & Educational Needs ¹	3
or SPE 311	Nature/Needs of Childhood Students with Intellectual Disabilities & Autism Spectrum Disorders	
SPE 652	Functional Curriculum for Students with Severe Disabilities and ASD	3
SPE 698	Seminar in Teaching and Assessment	3
SPE 693	Student Teaching	9
SPE 697	Student Teaching Seminar	0
Total Credits		39

¹ These courses may be taken at either the undergraduate or graduate level. The graduate level courses are recommended for those students coming into this program during their junior year.

EDS 223	EDS 405
EDS 360	
Senior	
Fall	Spring
CHM 301	SPE 649
SPE 311	EDU 615
EDU 356	
SPE 644	
Fifth Year	
Fall	Spring
SPE 580	EDU 595
SPE 631	EDU 596
SPE 640	EDU 597
SPE 698	SPE 693
	SPE 697

Chemistry/SWD Generalist Dual Degree Roadmap

Freshman

Fall	Spring
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	BIO 112 & 112L
MAT 111	MAT 141
	HIS

Sophomore

Fall	Spring
CHM 227 & 227L	CHM 228 & 228L
PHY 201 & 201L	PHY 202 & 202L
EDS 101	SPE 341
EDU 250	HIS

Junior

Fall	Spring
BCH 301 & 301L	CHM 230 & 230L
CHM 244	CHM/BCH Elective
CHM 381	CHM 480