BIOCHEMISTRY (BS)

Chair: Phillip M. Sheridan, PhD

Introduction

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 biochemistry is excellent preparation for entrance into medical, dental, pharmacy, and other health related programs, as well as graduate programs in biochemistry, biotechnology, bioinformatics, medicinal chemistry, business and law.

The Department of Chemistry and Biochemistry offers two tracks that lead to a BS degree in Biochemistry. The Biochemistry BS track certified by the American Chemical Society (BCH ACS certified track)is designed for students planning to enter graduate studies in biochemistry or related fields. The Biochemistry BS track is designed for students who intend to pursue employment in industry (BCH track). Both BCH tracks are excellent preparation for pre-health professional students.

Faculty advisors in the Department will help you choose the track that best fits your interests and career plans. Students in both 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.

Both Biochemistry 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 and Pre-Dental

The Biochemistry BS tracks are excellent preparation for entering into medical and dental schools, and more than a third of the graduates from this Department 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 Biochemistry BS track, since students in this track can meet all pharmacy school entrance requirements.

MAJOR EXPERIENCES

Following their freshman year, biochemistry 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. Students may also choose to undertake biochemistry related internships for 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 course work may be required. Please note that students will receive only 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

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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

Biochemistry Major with ACS-certification

Biochemistry BS track certified by the American Chemical Society is recommended for students planning to attend graduate school in a biochemistry related field or for students who plan careers in the health professions (medical, dental, pharmacy, 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 & 301L	Fundamental Physical Chemistry and Fundamental Physical Chemistry Laboratory	4
CHM 302 & 302L	Modern Physical Chemistry and Modern Physical Chemistry Laboratory	4
Select one of the following:		4
CHM 334 & 334L	Spectrometric Analysis and Spectrometric Analysis Lab	
CHM 430 & 430L	Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory	
CHM 420	Materials Chemistry	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
BCH 302	Cellular Biochemistry	3
BCH 403 & 403L	Molecular Biology and Molecular Biology 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	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 I Laboratory	4
Total Credits		**76**

Biochemistry Track

Biochemistry BS track is designed for students who intend to pursue employment in biochemistry related industry or for students who plan to pursue careers in the health professions (medical, dental, pharmacy, etc.).

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 244	Inorganic Chemistry	3
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
Select one of the following:		4
CHM 334 & 334L	Spectrometric Analysis and Spectrometric Analysis Lab	
CHM 430 & 430L	Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory	
CHM 480	Chemistry and Biochemistry Seminar	0
CHM 481	Communicating Concepts in Chemistry and Biochemistry	3
Choose one Chemistry (CHM), Biochemistry (BCH), or Biology (BIO) Elective (300- or 400-level course)		3
Choose one Biochemistry (BCH) Elective [1]		3
BCH 301 & 301L	Introduction to Biochemistry and Introduction to Biochemistry Laboratory	4
BCH 302	Cellular Biochemistry	3
BCH 403 & 403L	Molecular Biology and Molecular Biology 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
Total Credits		**69-70**

1 Choose from any 300- or 400-level BCH course not used to fulfill specific major requirements or CHM 334 (if not used to fulfill spectroscopy requirement), CHM 450, CHM 455, BIO 419, BIO 430, or BIO 444.

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

Roadmap

Recommended Semester Schedule for Major Course Requirements

BCH ACS Certified Track

Freshman	
Fall	**Spring**
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	BIO 112 & 112L
MAT 111	MAT 112
Sophomore	
Fall	**Spring**
CHM 227 & 227L	CHM 228 & 228L
CHM 244	PHY 224 & 224L
PHY 223 & 223L	
Junior	
Fall	**Spring**
BCH 301 & 301L	BCH 302
	BCH 403 & 403L
	CHM 230 & 230L
	CHM 480
Senior	
Fall	**Spring**
CHM 301 & 301L	CHM 430 & 430L[1]
CHM 334 & 334L[1]	CHM 302 & 302L
	CHM 420
	CHM 481

1 Either CHM 334/CHM 334L or CHM 430/CHM 430L is required.

BCH ACS Certified Track with Business Minor

Freshman	
Fall	**Spring**
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	BIO 112 & 112L
MAT 111	MAT 112
Sophomore	
Fall	**Spring**
CHM 227 & 227L	CHM 228 & 228L
CHM 244	ECO 102
ECO 101	MAT 141 or ECO 255
PHY 223 & 223L	PHY 224 & 224L
Junior	
Fall	**Spring**
BCH 301 & 301L	BCH 302
	BCH 403 & 403L
	CHM 230 & 230L
	CHM 480
	MGT 101
Senior	
Fall	**Spring**
CHM 301 & 301L	CHM 302 & 302L
CHM 334 & 334L[1]	CHM 420
ACC 201	CHM 430 & 430L[1]
MKT 201	CHM 481
	FIN 201

1 Either CHM 334/CHM 334L or CHM 430/CHM 430L is required.

BCH Track

Freshman	
Fall	**Spring**
CHM 111 & 111L	CHM 112 & 112L
BIO 111 & 111L	BIO 112 & 112L
MAT 111	MAT 141, 112, or PSY 201
Sophomore	
Fall	**Spring**
CHM 244	CHM 228 & 228L

CHM 227 & 227L	PHY 202 & 202L
PHY 201 & 201L	

Junior

Fall	Spring
BCH 301 & 301L	BCH 302
	BCH 403 & 403L
	CHM 480
	BCH elective

Senior

Fall	Spring
CHM 301	CHM 430 & 430L[1]
CHM 334 & 334L[1]	CHM Elective or BCH Elective
	CHM 481

[1] Either CHM 334/CHM 334L or CHM 430/CHM 430L is required.

BCH 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
CHM 244	PHY 202 & 202L
ECO 101	ECO 102
PHY 201 & 201L	

Junior

Fall	Spring
BCH 301 & 301L	BCH 302
	BCH 403 & 403L
	CHM 480
	MGT 101
	BCH elective

Senior

Fall	Spring
CHM 301	CHM 430 & 430L[1]
CHM 334 & 334L[1]	CHM 481
ACC 201	CHM or BCH Elective
MKT 201	FIN 201

[1] Either CHM 334/CHM 334L or CHM 430/CHM 430L is required.

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 and biochemical literature sources.

Courses

BCH 301 Introduction to Biochemistry **3 Credits**

Structure and function of biological molecules. Topics include proteins, carbohydrates, nucleic acids, lipids,enzyme kinetics, ligand binding, recombinant DNA technology and cell membrane structure and transport.Three lectures and one recitation per week.

Prerequisite: BIO 111 & minimum grade of C- in CHM 228.

Offered: every fall.

BCH 301L Introduction to Biochemistry Laboratory **1 Credit**

Selected experiments demonstrating principles of comparative proteomics, Beer's Law, electrophoresis, immunodetection, and DNA fingerprinting. One four-hour lab per week.

Prerequisite: BCH 301 (or concurrent registration).

Offered: every fall.

BCH 302 Cellular Biochemistry **3 Credits**

The more biological aspects of biochemistry. Topics include signal transduction, bioenergetics, metabolism of carbohydrates, lipids, proteins and metabolic control,emphasizing hormones. Three lectures and one recitation per week.

Prerequisite: minimum grade of C- in BCH 301.

Offered: every spring.

BCH 403 Molecular Biology **3 Credits**
Biochemical processes at the cellular and molecular level. Topics include DNA structure in chromosomes, replication, repair, and recombination, DNA transcription, RNA structure and function, protein translation and regulation of these processes.
Prerequisite: minimum grade of C- in BCH 301.
Offered: spring of odd-numbered years.

BCH 403L Molecular Biology Laboratory **1 Credit**
Selected experiments demonstrating principles of PCR, SDS-PAGE, protein extraction/purification, and cell culture. One four-hour lab per week.
Prerequisite: BCH 301L & BCH 403 (or concurrent registration in BCH 403).
Fulfills College Core: Advanced Writing-Intensive
Offered: spring of odd-numbered years.

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

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

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