

BIOCHEMISTRY (BS/MS)

The BS/MS program in Biochemistry allows currently Loyola University Chicago undergraduate students to obtain both a Bachelor's and Master's degree in a compressed time period. This program structure is beneficial for those planning to take a gap year between undergraduate graduation, medical school, dental school, or other higher education. The research experience and courses with faculty you know and love allow you to build the references that will help you successfully transition to your next step. Your coursework keeps your chemical intuition sharp when preparing for admissions tests.

Students complete the bachelor's degree, but also take two graduate courses as undergraduates their senior year that count toward both their Bachelor's and Master's degree. By doing so, the 6 additional graduate courses can be finished in a single year for this 4+1 program.

Related Programs

Combined

- Chemistry (BS/MS) (<https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/chemistry-bsms/>)

Curriculum

Students complete the bachelor's degree, but also take two graduate courses as undergraduates their senior year that count toward both their Bachelor's and Master's degree. By doing so, the additional graduate courses can be finished in a single year for this Accelerated Bachelor's/Master's program.

Chemistry is taking a modern, integrated approach to foundational coursework.

- Aligns with the latest American Chemical Society (ACS) and American Association of Medical Colleges (AAMC) standards & guidelines
- Themes: structure-activity relationships; culture and practice of science; energy; polymers, proteins, and macromolecules; sustainability; chemical synthesis, purification, characterization, and analysis.
- With such knowledge and skills, you should be prepared to further excel in upper-level coursework that specializes your work in the specific major you have chosen.

In addition to the required courses listed below, CHEM 300 Undergraduate Research is strongly recommended. Credit hours earned in CHEM 300 Undergraduate Research or CHEM 380 Chemistry Seminar do not count as elective hours satisfying the BS degree requirement. Both CHEM 300 Undergraduate Research and CHEM 380 Chemistry Seminar are required for Departmental honors. The CHEM-BS degree is accredited by the American Chemical Society.

Code	Title	Hours
BS Requirements		
<i>Chemistry Courses Required</i>		
CHEM 160	Chemical Structure and Properties	3
CHEM 161	Chemical Structure and Properties Laboratory	1
CHEM 180	Chemical Reactivity I	3
CHEM 181	Chemical Reactivity I Lab	1
CHEM 240	Chemical Reactivity II	3
CHEM 242	Chemical Synthesis Laboratory	2

CHEM 260	Quantitative Methods in Chemistry	3
CHEM 272	Analytical Chemistry Laboratory	2
CHEM 305	Physical Biochemistry for the Biological Sciences	3
CHEM 306	Physical Biochemistry Lab	1
CHEM 307	Inorganic Chemistry	3
CHEM 370	Biochemistry I	3
CHEM 371	Biochemistry II	3
CHEM 372	Biochemistry Laboratory I	2
CHEM 373	Biochemistry Laboratory II	2

Biochemistry Focus Elective

Select one of the following: 3

CHEM 365	Proteomics
CHEM 385	Advanced Enzyme Kinetics and Mechanisms
CHEM 386	The Chemistry of Enzymes
CHEM 387	Plant Biochemistry
CHEM 388	Biophysical Chemistry

Biochemistry Elective

Select one of the following: 3

CHEM 323	Medicinal Chemistry
CHEM 365	Proteomics
CHEM 385	Advanced Enzyme Kinetics and Mechanisms
CHEM 387	Plant Biochemistry
CHEM 388	Biophysical Chemistry
CHEM 396	Special Topics in Biochemistry
BIOL 380	Genetics and Evolution of Development
BIOL 382	Molecular Genetics
BIOL 388	Bioinformatics
BIOL 389	Introduction to Pharmacology

Physics Courses Required

PHYS 121	College Physics I with Calculus Lecture/Discussion	3
PHYS 122	College Physics II with Calculus Lecture/Discussion	3
PHYS 111L	College Physics Laboratory I	1
PHYS 112L	College Physics Lab II	1

Math Courses Required

MATH 131	Applied Calculus I	3
or MATH 161	Calculus I	
MATH 132	Applied Calculus II	3
or MATH 162	Calculus II	
STAT 203	Introduction to Probability & Statistics	3

Biology Required Courses

BIOL 101	General Biology I	3
BIOL 102	General Biology II	3
BIOL 111	General Biology I Lab	1
BIOL 112	General Biology II Lab	1
BIOL 251	Cell Biology	3
BIOL 282	Genetics	3
BIOL 283	Genetics Laboratory	1

MS Requirements 30

Course-Based MS in Chemistry

CHEM 401	Chemistry Methodology and Communication
----------	---

Select four (4) from the following

CHEM 424	Molecular Characterization Part A
CHEM 435	Special Topics in Physical Chemistry
CHEM 445	Special Topics in Inorganic Chemistry
CHEM 455	Special Topics in Analytical Chemistry
CHEM 465	Special Topics in Biochemistry
CHEM 480	Chemistry for Teachers I
Chemistry Research (no more than 3 credit hours)	
400-Level CHEM Electives (15 credit hours) ¹	

Thesis-Based MS in Chemistry

CHEM 401	Chemistry Methodology and Communication
----------	---

Select one of the following:

CHEM 424	Molecular Characterization Part A
CHEM 435	Special Topics in Physical Chemistry
CHEM 445	Special Topics in Inorganic Chemistry
CHEM 455	Special Topics in Analytical Chemistry
CHEM 465	Special Topics in Biochemistry

Required 12 credit hours in one of the following

CHEM 429	Research in Organic Chemistry
CHEM 439	Research in Physical Chemistry
CHEM 449	Research in Inorganic Chemistry
CHEM 459	Research in Analytical Chemistry
CHEM 469	Research in Biochemistry

Select any four courses from any area of concentration: Organic, Inorganic, Physical, Analytical, Education. (12 credit hours) (p. 2)

CHEM 605	Master's Study
CHEM 595	Thesis Supervision

Total Hours

103

¹ Elective courses can be distributed or in a specialized area as determined by student. A list of all 400 level Chemistry courses can be found here (<https://catalog.luc.edu/graduate-professional/graduate-school/arts-sciences/chemistry-biochemistry/#coursestext>).

- Core requirements (<https://catalog.luc.edu/undergraduate/university-requirements/university-core/>)
- Please visit http://www.luc.edu/cas/academics_degreerequirements.shtml#college (https://www.luc.edu/cas/academics_degreerequirements.shtml/#college) to view other CAS requirements.
- For chemistry course descriptions and pre and co-requisite information, please visit here (<https://catalog.luc.edu/undergraduate/arts-sciences/chemistry-biochemistry/#coursestext>).

All chemistry majors are assigned a chemistry faculty advisor. Please meet with your advisor on a regular basis, at least twice a year, for assistance with your chemistry schedule, research possibilities, graduate school information and more. If you do not know who your advisor is please call the chemistry department at 773/508-3100 or come to the department office located in Flanner Hall room 125.

MS Areas of Specialization

Code	Title	Hours
Analytical		
CHEM 455	Special Topics in Analytical Chemistry ¹	3

Biochemistry

CHEM 465	Special Topics in Biochemistry ²	3
CHEM 470	Biochemistry I	3
Education		
CHEM 480	Chemistry for Teachers I	3
Inorganic		
CHEM 441	Advanced Inorganic Chemistry	3
CHEM 445	Special Topics in Inorganic Chemistry ³	3
Organic		
CHEM 423	Medicinal Chemistry	3
CHEM 424	Molecular Characterization Part A	3
CHEM 425	Special Topics in Organic Chemistry ⁴	3
Physical		
CHEM 435	Special Topics in Physical Chemistry ⁵	3

¹ Topics can include Archeometry and Adv Analytical Chemistry.

² Topics can include: Plant Biochemistry; The Chemistry of Enzymes; Biochemistry of Lipids; Adv Approaches in Biochemistry; Adv Enzyme Kinetics and Mechanisms; Molecular Immunology; Biochemistry of Renewable Energy; and Proteomics.

³ Topics can include: Medicinal Inorganic Chemistry; Electron & X-Ray Methods; and Molecular Characterization Part B.

⁴ Topics can include: Orgo Structure Determination; Strategy & Tactics of Org Chem; Func Dyes Biomed Imaging; Adv Orgo-Synthesis and Mech; Comp Organomet Chem; and Advanced Organic Synthesis.

⁵ Topics can include: Exp Tech of Surface Science; Survey of Modern Physical Chem; Surface Chem and Analysis; Thermodynam/Protein Structures; and Computational Chemistry.

Suggested Sequence of Courses

The below sequence of courses is meant to be used as a suggested path for completing coursework. An individual student's completion of requirements depends on course offerings in a given term as well as the start term for a major or graduate study. Students should consult their advisor for assistance with course selection.

Students **not** placing in MATH 118 Precalculus II or higher cannot start the Chemistry sequence until MATH 117 Precalculus I is completed with a grade of C- or better. Such students are advised to enroll in first-year Chemistry courses in the summer sessions (after meeting the math requirement) in order to complete the major in four years.

Course	Title	Hours
Freshman		
Fall		
BIOL 101 & BIOL 111	General Biology I and General Biology I Lab	4
CHEM 160	Chemical Structure and Properties	3
CHEM 161	Chemical Structure and Properties Laboratory	1
MATH 131 or MATH 161	Applied Calculus I or Calculus I	3-4
Hours		11-12

Spring

BIOL 102 & BIOL 112	General Biology II and General Biology II Lab	4
CHEM 180	Chemical Reactivity I	3

CHEM 181	Chemical Reactivity I Lab	1
MATH 132 or MATH 162	Applied Calculus II or Calculus II	3-4
Hours		11-12
Sophomore		
Fall		
BIOL 282	Genetics	3
CHEM 240	Chemical Reactivity II	3
PHYS 121	College Physics I with Calculus Lecture/ Discussion	3
PHYS 111L	College Physics Laboratory I	1
STAT 203	Introduction to Probability & Statistics	3
Hours		13
Spring		
BIOL 251	Cell Biology	3
BIOL 283	Genetics Laboratory	1
CHEM 242	Chemical Synthesis Laboratory	2
CHEM 260	Quantitative Methods in Chemistry	3
PHYS 122	College Physics II with Calculus Lecture/ Discussion	3
PHYS 112L	College Physics Lab II	1
Hours		13
Junior		
Fall		
CHEM 272	Analytical Chemistry Laboratory	2
CHEM 305	Physical Biochemistry for the Biological Sciences	3
CHEM 370	Biochemistry I	3
Hours		8
Spring		
CHEM 306	Physical Biochemistry Lab	1
CHEM 307	Inorganic Chemistry	3
CHEM 371	Biochemistry II	3
Hours		7
Senior		
Fall		
CHEM 372	Biochemistry Laboratory I	2
Biochemistry Elective		3
CHEM 400-Level Course		3
Hours		8
Spring		
CHEM 373	Biochemistry Laboratory II	2
Biochemistry Elective		3
400-Level CHEM Course		3
Hours		8
Master's		
Complete requirements of MS degree in consultation with Graduate Program Director.		24
Hours		24
Total Hours		103-105

¹ Capstone Course: CHEM 314 Instrumental Analysis for Junior or Senior year

CHEM 300 Undergraduate Research and CHEM 380 Chemistry Seminar are strongly recommended and required to receive Departmental Honors with graduation. Credit hours earned in CHEM 300 Undergraduate Research and/or CHEM 380 Chemistry Seminar do not count as elective hours satisfying the CHEM-BS degree requirement. CHEM 361 Principles of Biochemistry does not count towards the CHEM-BS degree.

Mathematics Preparedness for Chemistry

Students intending to register for a chemistry course will need a background in mathematics that is commensurate with the computational requirements of the chemistry course. Evidence of math preparedness is obtained from results of the ACT/SAT and of a Mathematics Placement Assessment (MPA) administered by the College in conjunction with the Department of Mathematics and Statistics. Students who are found to be mathematically under prepared are required to pass the appropriate course or sequence of courses in mathematics with a grade of "C-" or better before they register for a chemistry course. More information regarding placement by ACT/SAT and the MPA can be found at <http://www.luc.edu/math/placement/>.

Thesis Requirement

In addition to coursework, students in Thesis-based MS in Chemistry will write and defend a research thesis. Once students have completed coursework and are solely working on the thesis they will be enrolled in the appropriate study or supervision course to maintain good standing in the university.

College of Arts and Sciences Graduation Requirements

All Undergraduate students in the College of Arts and Sciences are required to take two Writing Intensive courses (6 credit hours) as well as complete a foreign language requirement at 102-level or higher (3 credit hours) or a language competency test. More information can be found here (<https://www.luc.edu/cas/college-requirements/>).

Guidelines for Accelerated Bachelor's/Master's Programs

Terms

- **Accelerated Bachelor's/Master's programs:** In this type of program, students share limited credits between their undergraduate and graduate degrees to facilitate completion of both degrees.
- **Shared credits:** Graduate level credit hours taken during the undergraduate program and then applied towards graduate program requirements will be referred to as shared credits.

Admission Requirements

Accelerated Bachelor's/Master's programs are designed to enhance opportunities for advanced training for Loyola's undergraduates. Admission to these programs must be competitive and will depend upon a positive review of credentials by the program's admissions committee. Accordingly, the admission requirements for these programs may be higher than those required if the master's degree were pursued entirely after the receipt of a bachelor's degree. That is, programs may choose to have more stringent admissions requirements in addition to those minimal requirements below.

Requirements:

- Declared appropriate undergraduate major,
- By the time students begin taking graduate courses as an undergraduate, the student has completed approximately 90 credit hours, or the credit hours required in a program that is accredited by a specialty organization,¹
- A minimum cumulative GPA for coursework at Loyola that is at or above the program-specific requirements, a minimum major GPA that is at or above the program-specific requirements, and/or appropriate designated coursework for evaluation of student readiness in their discipline.²

Students not eligible for the Accelerated Bachelor's/Master's program (e.g., students who have not declared the appropriate undergraduate major) may apply to the master's program through the regular admissions process. Students enrolled in an Accelerated Bachelor's/Master's program who choose not to continue to the master's degree program upon completion of the bachelor's degree will face no consequences.³

Ideally, a student will apply for admission (or confirm interest in proceeding towards the graduate degree in opt-out programs) as they approach 90 credit hours. Programs are encouraged to begin advising students early in their major so that they are aware of the program and, if interested, can complete their bachelor's degree requirements in a way that facilitates completion of the program. Once admitted as an undergraduate, Program Directors should ensure that students are enrolled using the plan code associated with the Accelerated Bachelor's/Master's program. Using the plan code associated with the Accelerated Bachelor's/Master's program will ensure that students may be easily identified as they move through the program. Students will not officially matriculate into the master's degree program and be labeled as a graduate student by the university, with accompanying changes to tuition and Financial Aid (see below), until the undergraduate degree has been awarded. Once admitted to the graduate program, students must meet the academic standing requirements of their graduate program as they complete the program curriculum.

¹ Programs that have specialized accreditation will adhere to the admissions criteria provided by, or approved by, their specialized accreditors.

² The program will identify appropriate indicators of student readiness for graduate coursework (e.g., high-level performance in 300 level courses). Recognizing differences between how majors are designed, we do not specify a blanket requirement.

³ If students choose not to enroll in the Accelerated Bachelor's/Master's program, they still must complete all of the standard requirements associated with the undergraduate degree (e.g., a capstone).

For more information on Admissions requirements, visit here (<https://gpm.luc.edu/portal/admission/?tab=home>).

Curriculum

Level and progression of courses. The Accelerated Bachelor's/Master's programs are designed to be competitive and attractive to our most capable students. Students admitted to Accelerated Bachelor's/Master's programs should be capable of meeting graduate level learning outcomes. Following guidance from the Higher Learning Commission, only courses taken at the 400 level or higher (including 300/400 level courses taken at the 400 level) will count toward the graduate program.^{1,2}

Up to 50% of the total graduate level credit hours, required in the graduate program, may come from 300/400 level courses where the

student is enrolled in the 400 level of the course. Further, at least 50% of the credit hours for the graduate program must come from courses that are designed for and restricted to graduate students who have been admitted to a graduate program at Loyola (e.g., enrolled in plan code that indicates the Accelerated Bachelor's/Master's program, typically ending with the letter "D").³

In general, graduate level coursework should not be taken prior to admission into the Accelerated Bachelor's/Master's program. Exceptions may be granted for professional programs where curriculum for the Accelerated Bachelor's/Master's program is designed to begin earlier. On the recommendation of the program's Graduate Director, students may take one of their graduate level courses before they are admitted to the Accelerated Bachelors/Master's program if they have advanced abilities in their discipline and course offerings warrant such an exception.⁴ Undergraduate degree requirements outside of the major are in no way impacted by admission to an Accelerated Bachelor's/Master's program.⁵

Shared credits. Undergraduate courses (i.e., courses offered at the 300 level or below) cannot be counted as shared credits nor count towards the master's degree. Up to 50% of the total graduate level credit hours, required in the graduate program, may be counted in meeting both the undergraduate and graduate degree requirements. Of those shared credits, students in an Accelerated Bachelor's/Master's program should begin their graduate program with the standard introductory course(s) for the program whenever possible. So that students may progress through the Accelerated Bachelor's/Master's program in a timely manner, undergraduate programs are encouraged to design their curriculum such that a student can complete some required graduate credit hours while completing the undergraduate degree. For instance, some of the graduate curriculum should also satisfy electives for the undergraduate major.

The program's Graduate Director will designate credit hours to be shared through the advising form and master's degree conferral review process. Shared credit hours will not be marked on the undergraduate record as having a special status in the undergraduate program. They will be included in the student's undergraduate earned hours and GPA. Graduate credit hours taken during the undergraduate program will not be included in the graduate GPA calculation.

¹ If students wish to transfer credits from another university to Loyola University Chicago, the program's Graduate director will review the relevant syllabus(es) to determine whether it meets the criteria for a 400 level course or higher.

² Programs with specialized accreditation requirements that allow programs to offer graduate curriculum to undergraduate students will conform to those specialized accreditation requirements.

³ In rare cases, the Graduate Director may authorize enrollment in a 400-level course for a highly qualified and highly motivated undergraduate, ensuring that the undergraduate's exceptional participation in the graduate class will not diminish in any way the experience of the graduate students regularly enrolled.

⁴ For example, if a particular course is only offered once every 2-3 years, and a student has demonstrated the necessary ability to be successful, the Graduate Director may allow a student to take a graduate level course to be shared prior to the student being formally admitted to the graduate program. See, also, footnote 3.

⁵ Students should not, for example, attempt to negotiate themselves out of a writing intensive requirement on the basis of admission to a graduate program.

Graduation

Degrees are awarded sequentially. All details of undergraduate commencement are handled in the ordinary way as for all students in the School/College/Institute. Once in the graduate program, students abide by the graduation deadlines set forth by the graduate program. Students in these programs must be continuously enrolled from undergraduate to graduate degree program unless given explicit permission by their program for a gap year or approved leave of absence. In offering the option of an Accelerated Bachelor's/Master's program, the university is making possible the acceleration of a student's graduate degree completion. It should be understood that students may not request deferral of their matriculation into the Master's degree program. If students would like to delay their graduate studies after earning the undergraduate degree, they may apply for admission to the traditional master's degree program. Any application of graduate credit earned while in the undergraduate program is subject to the policies of the graduate degree granting school.

Learning Outcomes

- answer knowledge and comprehension type questions related to fundamental chemical concepts and demonstrate fluency with basic facts, terminology, and principles in the various subfields of chemistry.
- understand and describe the chemical basis of life, our natural resources and environments, and the universe.
- retrieve, research, synthesize, and critically evaluate scientific literature.
- design and implement experiments that test predictive hypotheses, gather relevant data, analyze results, and interpret the significance of these results.
- operate state of the art equipment used by chemists and biochemists.
- engage in scientific reasoning with claims based on supported evidence and communicate effectively results and interpretations of scientific research.