CHEMISTRY, BS

The Department of Chemistry and Biochemistry curriculum provides a thorough undergraduate education for students planning careers as research scientists, industrial chemists, and educators in universities or in secondary schools. In addition, department courses provide a foundation in the basic science of chemistry to students majoring in biological or physical sciences, students planning a career in medicine or other health-related fields, students in the College of Engineering and Applied Science, and students in the liberal arts. Especially in its graduate programs, the department stresses interdisciplinary approaches, as exemplified by the Laboratory for Surface Studies and the Great Lakes WATER Institute. It also cooperates with chemists of the Milwaukee area's industrial and scientific community.

Course of Study: Major Options in Chemistry and Biochemistry

Students may choose from four different curricular options in chemistry and biochemistry:

1. Chemistry Major
2. Chemistry Major with a Biochemical Option
3. Biochemistry Major
4. Biochemistry Major with a Clinical Pharmacology Option (BS only)

Undergraduate research is encouraged strongly for students in any of the chemistry options. In some cases, students may start research with a faculty member as early as their first year at UWM. Information about research opportunities may be obtained from the department office or from SAACS (the American Chemical Society student affiliate group). Pre-medical students who choose to follow one of the chemistry or biochemistry options should see the L&S pre-professional programs section in this catalog and should consult their pre-medical advisor and an advisor in chemistry regularly.

The opportunity to participate in research as an undergraduate is a distinct advantage for UWM undergraduates. At most large, research universities, research opportunities for undergraduates are limited; there are fewer of them and they often are reserved for juniors or seniors. At UWM, you can get involved as early as your first year. Students work directly with faculty and graduate students on their current research projects, and sometimes find themselves published in a peer-reviewed journal right alongside the faculty member. Participating in undergraduate research is an excellent way to enhance your resume for graduate school or employment.

Chemistry is the study of the elementary parts and substances that make up our world, both the parts that occur in nature as well as man-made objects.

Chemistry is known as the "central science" because of its relationship to all other sciences. Because it is the foundation of other sciences, UWM Chemistry alumni are prepared to go on to countless number of professional roles. While your first impression may be that chemistry majors all end up working in a laboratory surrounded by beakers and test tubes, there is more to the major than that.

Our majors go into medical research, healthcare professions, manufacturing (particularly research and development), scientific writing and marketing, law (particularly areas of law that deal with science such as intellectual property), forensics and toxicology, aspects of engineering and production, teaching, sales, consulting, and government agency work.

Requirements

Code	Title	Credits
General Education Requirements		30
L&S Requirements (general and major requirements)		110-125
Total Credits		**140-155**

Credit numbers reflect total possible credits towards degree. Due to the ability to count courses towards more than one requirement, credit amounts will vary. Please work with your academic advisor on your plan of study.

Preparatory Coursework

Based on individual placement results, some students may be required to complete preparatory coursework before enrolling in the courses listed here. This may include English language or composition preparation, developmental math, introductory chemistry, and/or student support courses for students participating in the First Year Bridge program.

General Education Requirements (GER)

UW-Milwaukee has General Education Requirements (https://catalog.uwm.edu/policies/undergraduate-policies/#generaleducationtext) that must be met in order to earn a bachelor's or associate degree. They include at minimum 30 credits (10 courses) in six categories that are designed to assure basic student competencies and provide a broad body of knowledge as a context for specialization.

Some degree requirements may fulfill GERs. Please review the requirements and consult with your academic advisor.

Code	Title	Credits
General Education Categories and Credits		
Civics and Perspectives (CP)		6
Communication and Literacy (CL)		6
Humanities and Arts (HA)		6
Mathematics and Quantitative Reasoning (MQR)		3
Natural Science and Wellness (NSW/NSWL)		6
Social and Behavioral Science (SBS)		3
Total Credits		**30**

Letters and Science Course of Study – Bachelor of Science Degree

Complete 120 credits including 75 credits in the College of Letters & Science, with 36 of the 75 credits in L&S upper-level (numbered 300 or above) courses and 30 of those 36 credits in designated L&S Advanced Natural Science courses (https://catalog.uwm.edu/letters-science/approved-courses-advanced-natural-science/).

The College requires that students complete, in residence at UWM, at least 15 credits in upper-division (numbered 300 or above) courses in their major. The College also requires that students complete at least 30 credits overall in residence at UWM. For additional residency and transfer credit limitations, see L&S Undergraduate Policies and Regulations (https://catalog.uwm.edu/letters-science/#policiesandregulationstext).

Students are also required to complete the University-wide General Education Requirements (https://catalog.uwm.edu/policies/

undergraduate-policies/#bachelorsdegreegeneraleducation) and the specific L&S requirements listed below.

To complete a major, students must satisfy all the requirements of the major as stated in this catalog. Students who declare their majors within five years of entering the UW System as a degree candidate may satisfy the requirements outlined in any catalog issued since the time they entered. Credits used to satisfy the major also may be used to satisfy other degree requirements.

College of Letters & Science Requirements

The degree requirements in the College of Letters and Science build on the University General Education Requirements to provide a broad base of knowledge as well as an array of skills cited by employers as critical to professional success: critical thinking, problem solving, oral and written communication, ability to work well with others, and adaptability to change.

For the Bachelor of Science (B.S.), students must complete the UWM General Education Requirements as well as these L&S requirements: the International requirement, the Breadth requirement (with extra courses in Advanced Natural Science required), a Natural Science Lab requirement, the Research requirement, and a Language other than English requirement. The International requirement develops student potential for cross-cultural understanding in a globalizing world. The Breadth requirement ensures that students take classes in a wide variety of subjects, across humanities, natural sciences, and social sciences. The Research requirement calls for students to build critical thinking and oral and written communication skills through conducting an independent research project in their major. The Language other than English requirement further develops student proficiency in a language other than English. And, the requirement that students take an L&S Natural Science lab ensures exposure to and practice with the scientific method in action.

I. Total Credits and Upper-Division Courses Requirement

Students must complete 120 credits including 75 credits in the College of Letters & Science with 36 of those 75 credits in L&S upper-level (numbered 300 and above) courses.

II. L&S Advanced Natural Sciences Requirement

For the Bachelor of Science, students must complete 30 credits of the 36 credits required in upper-division courses in designated L&S Advanced Natural Science courses (https://catalog.uwm.edu/letters-science/approved-courses-advanced-natural-science/).

III. Language other than English Requirement

Students doing the B.S. must fulfill a language other than English requirement by successfully completing the second semester of university work or equivalent in one language other than English (including all languages other than English and American Sign Language).

Language courses (including American Sign Language) other than English taken in high school may be used to satisfy all or part of this requirement. One year of high school language equates to one semester of college work. Proficiency tests approved by the Languages faculty may be used to satisfy all or part of this requirement.

IV. International Requirement

To meet the International Requirement, students must successfully complete some two-course (minimum 6 credits) combination of:

1. Courses with L&S approved international content (see Courses Approved for the L&S International Requirement (https://catalog.uwm.edu/letters-science/approved-courses-international-requirement/) for course options).
2. Any study-abroad course(s).

Students who graduated secondary school in a country other than the U.S. are exempt from this requirement.

IV. Breadth Requirement

In addition to completing the University General Education Requirements, L&S students must complete the Breadth requirement to obtain deeper experience across our three substantive divisions.

The L&S Breadth requirement calls for 9 credits each in L&S courses designated L&S Humanities, L&S Natural Sciences, and L&S Social Sciences breadth. One of the L&S Natural Science breadth courses must be a laboratory or fieldwork course.

Please refer to the list of Courses Approved for the L&S Breadth Requirement (https://catalog.uwm.edu/letters-science/breadth-requirement-course-list/).

V. The Major

The College requires that students attain at least a 2.0 GPA in all credits in the major attempted at UWM. In addition, students must attain a 2.0 GPA on all major credits attempted, including any transfer work. Individual departments or programs may require higher GPAs for graduation. Some departmental majors require courses from other departments. Students should contact their major department for information on whether those credits will count as part of the major GPA. The College requires that students must complete, in residence at UWM, at least 15 credits in upper-division (numbered 300 or above) courses in their major.

Research Requirement

Within their majors, students must complete a research experience approved by the L&S faculty. A list of courses satisfying the research requirement in each major can be found here (https://catalog.uwm.edu/letters-science/approved-courses-research-requirement/).

VI. The Minor

Students are encouraged to consider completing a minor, but it is not required. To complete a minor, the College of Letters and Science requires that students attain at least a 2.0 GPA in all credits in the minor attempted at UWM. In addition, students must attain a 2.0 GPA on all minor credits attempted, including any transfer work. The minor must contain at least 9 credits in upper-division (numbered 300 and above) courses at UWM.

Preparation for Majors in Chemistry and Biochemistry

General chemistry is a prerequisite to all further courses in chemistry. This requirement is satisfied by CHEM 102 and CHEM 104. Students without high school chemistry or whose background in science is weak may need to take CHEM 100 first.

Mathematics and physics also are required for a major in chemistry. Three semesters of calculus and two semesters of calculus-based physics (or equivalents) are prerequisites to physical chemistry, which, in turn, is required for the advanced chemistry courses that are part of the major.

Students considering a major in chemistry or biochemistry should enroll in general chemistry and mathematics in their first semester, if at all possible, and physics should be started as soon as its prerequisites are met. Because the study of chemistry is cumulative, postponing one's start in math and chemistry courses is likely to delay completion of the degree. It is recommended that chemistry majors follow the suggested sequence for the Course in Chemistry degree program as closely as possible for the first two years.

Students are urged to contact the Chemistry and Biochemistry Department for academic advice as soon as they believe they have an interest in a major in chemistry.

Students who are interested in graduate work in biochemistry should follow the standard chemistry major with a biochemical option.

Chemistry Major Requirements

Students must complete the courses listed below, including at least 15 upper-division (numbered 300 and above) credits in the major in residence at UWM. The College of Letters & Science requires that students attain at least a 2.0 GPA on all credits in the major attempted at UWM. In addition, students must attain a 2.0 GPA on all major credits attempted, including any transfer work.

Standard Chemistry Major Option

The standard chemistry major option may be followed in either the Bachelor of Science or Bachelor of Arts degree. It provides a suitable background for students preparing for employment in chemistry and related scientific fields or for subsequent graduate study.

Code	Title	Credits
CHEM 102 & CHEM 104	General Chemistry and General Chemistry and Qualitative Analysis	10
CHEM 221	Elementary Quantitative Analysis	4
CHEM 311	Introduction to Inorganic Chemistry	3
CHEM 343	Organic Chemistry	3
CHEM 344	Organic Chemistry Laboratory	2
CHEM 345	Organic Chemistry	3
CHEM 524	Instrumental Analysis	3
CHEM 561	Physical Chemistry I	3
CHEM 562	Physical Chemistry II	3
CHEM 563	Physical Chemistry Laboratory	2
CHEM 582	Advanced Chemistry Laboratory I	2
or CHEM 584	Advanced Chemistry Laboratory II	
CHEM 501	Introduction to Biochemistry	3
or CHEM 611	Physical Inorganic Chemistry	
Select two credits total from the following options in research (satisfies L&S research requirement):		2
CHEM 691	Senior Research	
CHEM 692	Senior Thesis	
MATH 231	Calculus and Analytic Geometry I	4
MATH 232	Calculus and Analytic Geometry II	4
MATH 233	Calculus and Analytic Geometry III	4
Recommended course:		
MATH 234	Linear Algebra and Differential Equations	
Select one of the following options:		10
Option 1:		
PHYSICS 209 & PHYSICS 214	Physics I (Calculus Treatment) and Lab Physics I (Calculus Treatment)	
PHYSICS 210 & PHYSICS 215	Physics II (Calculus Treatment) and Lab Physics II (Calculus Treatment)	
Option 2:		
PHYSICS 219	Physics I: Calculus-Based, Studio Format	
PHYSICS 220	Physics II: Calculus-Based, Studio Format	
Total Credits		**65**

Standard Chemistry Major with a Biochemical Option

The standard chemistry major with a biochemical option differs from the standard major option in that some of the chemistry courses required by the standard option are omitted, and courses in biochemistry and biological sciences are added. Some students planning further study in biochemistry, molecular biology, or medicine may prefer this option.

Code	Title	Credits
CHEM 102 & CHEM 104	General Chemistry and General Chemistry and Qualitative Analysis	10
CHEM 221	Elementary Quantitative Analysis	4
CHEM 311	Introduction to Inorganic Chemistry	3
CHEM 343	Organic Chemistry	3
CHEM 344	Organic Chemistry Laboratory	2
CHEM 345	Organic Chemistry	3
CHEM 524	Instrumental Analysis	3
CHEM 561	Physical Chemistry I	3
CHEM 562	Physical Chemistry II	3
CHEM 563	Physical Chemistry Laboratory	2
CHEM 501	Introduction to Biochemistry	3
Select two of the following:		6
CHEM 601	Biochemistry: Protein Structure and Function	
CHEM 602	Biochemistry: Cellular Processes	
CHEM 604	Biochemistry: Metabolism	
CHEM 603	Introduction to Biochemistry Laboratory	2
Select two credits total from the following options in research (satisfies L&S research requirement):		2
CHEM 691	Senior Research	
CHEM 692	Senior Thesis	
BIO SCI 150	Foundations of Biological Sciences I	4
BIO SCI 325	Genetics	4
MATH 231	Calculus and Analytic Geometry I	4
MATH 232	Calculus and Analytic Geometry II	4
MATH 233	Calculus and Analytic Geometry III	4
Recommended course:		
MATH 234	Linear Algebra and Differential Equations	
Select one of the following options:		10
Option 1:		

PHYSICS 209 & PHYSICS 214	Physics I (Calculus Treatment) and Lab Physics I (Calculus Treatment)
PHYSICS 210 & PHYSICS 215	Physics II (Calculus Treatment) and Lab Physics II (Calculus Treatment)
Option 2:	
PHYSICS 219	Physics I: Calculus-Based, Studio Format
PHYSICS 220	Physics II: Calculus-Based, Studio Format
Total Credits	**79**

Suggested Timetables for Standard Chemistry Major, Courses in Chemistry Degree, and Standard Chemistry Major with a Biochemical Option

Model Four-Year Program

Year 1		
Semester 1		**Credits**
CHEM 102	General Chemistry	5
MATH 115	Precalculus	4
	Credits	**9**
Semester 2		
CHEM 104	General Chemistry and Qualitative Analysis	5
MATH 231	Calculus and Analytic Geometry I	4
	Credits	**9**
Year 2		
Semester 1		
CHEM 343	Organic Chemistry	3
CHEM 221	Elementary Quantitative Analysis	4
MATH 232	Calculus and Analytic Geometry II	4
	Credits	**11**
Semester 2		
CHEM 344	Organic Chemistry Laboratory	2
CHEM 345	Organic Chemistry	3
MATH 233	Calculus and Analytic Geometry III	4
PHYSICS 209	Physics I (Calculus Treatment)	4
PHYSICS 214	Lab Physics I (Calculus Treatment)	1
	Credits	**14**
Year 3		
Semester 1		
CHEM 311	Introduction to Inorganic Chemistry	3
CHEM 501	Introduction to Biochemistry (or take in spring) [1]	3
PHYSICS 210	Physics II (Calculus Treatment)	4
PHYSICS 215	Lab Physics II (Calculus Treatment)	1
	Credits	**11**
Semester 2		
CHEM 561	Physical Chemistry I	3
CHEM 524	Instrumental Analysis	3
	Credits	**6**
Year 4		
Semester 1		
CHEM 562	Physical Chemistry II	3
CHEM 563	Physical Chemistry Laboratory	2
CHEM 582	Advanced Chemistry Laboratory I (or take in spring) [1,2]	2
Select one of the following:		1-2
CHEM 691	Senior Research	
CHEM 692	Senior Thesis	
	Credits	**8-9**
Semester 2		
CHEM 584	Advanced Chemistry Laboratory II (or take in fall) [1,2]	2
CHEM 582	Advanced Chemistry Laboratory I [1,2]	2
CHEM 611	Physical Inorganic Chemistry [1]	3
Select one of the following:		1-2
CHEM 691	Senior Research	
CHEM 692	Senior Thesis	
	Credits	**8-9**
	Total Credits	**76-78**

1 Courses that may be optional for standard chemistry major; required for the Course in Chemistry degree.

2 Courses that are omitted for the standard chemistry major with the biochemical option. In addition, students must take CHEM 501, CHEM 603, and two courses selected from CHEM 601, CHEM 602, CHEM 604, and CHEM 614. BIO SCI 150 and BIO SCI 325 also are required for the biochemistry option.

Chemistry BA/BS Learning Outcomes

Students graduating from the BA or BS programs in Chemistry will be able to:

- Perform mathematical analysis of problems, including those with chemistry content.
- Carry out logical and analytic approaches to chemical problems, both when mathematics is involved and in more conceptual areas.
- Demonstrate an understanding of chemical reactions, including the ability to predict products, mechanisms, and rates.
- Demonstrate an understanding of chemical compounds in biological systems, inorganic systems, and organic systems.
- Demonstrate an understanding of the basic principles of chemical bonding.
- Apply physical laws to molecular scale systems.
- Carry out chemical synthesis and other reactions in the laboratory.
- Utilize laboratory equipment to make meaningful measurements on molecular scale systems.
- Demonstrate competence in error analysis.
- Interpret experimental data, including obtaining fits to appropriate mathematical expressions.
- Demonstrate the ability to keep a well-organized laboratory notebook.
- Demonstrate competence in experimental design.
- Conduct undergraduate research to the satisfaction of the research advisor.

Letters & Science Advising

During your time at UWM, you may have multiple members of your success team, including advisors, peer mentors and success coaches. Letters & Science students typically work with at least two different types of advisors as they pursue their degrees: professional college advisors and faculty advisors. L&S college advisors advise across your entire degree program while departmental faculty advisors focus on the major.

College advisors are located in Holton Hall (or virtually for online students) and serve as your primary advisor. They are your point person for your questions about navigating college and completing your degree. College advisors will:

- Assist you in defining your academic and life goals.
- Help you create an educational plan that is consistent with those goals.
- Assist you in understanding curriculum, major and degree requirements for graduation, as well as university policies and procedures.
- Provide you with information about campus and community resources and refer you to those resources as appropriate.
- Monitor your progress toward graduation and completion of requirements.

Faculty advisors mentor students in the major and assist them in maximizing their development in the program. You will begin working with a faculty advisor when you declare your major. Faculty advisors are an important partner and will:

- Help you understand major requirements and course offerings in the department.
- Explain opportunities for internships and undergraduate research and guide you in obtaining those experiences.
- Serve as an excellent resource as you consider potential graduate programs and career paths in your field.

Students are encouraged to meet with both their college advisor and faculty advisor at least once each semester. Appointments are available in-person, by phone or by video.

Currently enrolled students should use the Navigate360 website (https://uwm.navigate.eab.com/) to make an appointment with your assigned advisor or call (414) 229-4654 if you do not currently have an assigned Letters & Science advisor. Prospective students who haven't enrolled in classes yet should call (414) 229-7711 or email let-sci@uwm.edu.

Honors in the Major

Students in any of the chemistry or biochemistry options who meet all of the following criteria are awarded honors in the major upon graduation:

- 3.500 cumulative GPA in all UWM graded credits;
- 3.750 GPA in all UWM chemistry credits;
- 3.500 GPA in all advanced credits in chemistry (numbered above 300); and
- Six credits of senior thesis with an average grade of B or better.

Students who believe they may qualify for honors in chemistry should apply to the department during their last semester of study.

A departmental "Undergraduate Awards Program and Research Symposium" is held each spring to highlight undergraduate research accomplishments and honor students who have distinguished themselves in various areas. Among the awards are the Durward Layde Memorial Fellowship, the Chemistry Emeritus Award for the Outstanding Junior, the McFarland Awards for the best undergraduate research poster presentations, as well as awards for Outstanding Performance in Introductory Chemistry, Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry (Kovacic Award), and Physical Chemistry (Vanselow Award).

College of Letters and Science Dean's Honor List

GPA of 3.750 or above, earned on a full-time student's GPA on 12 or more graded credits in a given semester.

Honors College Degree and Honors College Degree with Distinction

Granted to graduating seniors who complete Honors College requirements, as listed in the Honors College (https://catalog.uwm.edu/honors-college/) section of this site.

Commencement Honors

Students with a cumulative GPA of 3.500 or above, based on a minimum of 40 graded UWM credits earned prior to the final semester, will receive all-university commencement honors and be awarded the traditional gold cord at the December or May Honors Convocation. Please note that for honors calculation, the GPA is **not** rounded and is truncated at the third decimal (e.g., 3.499).

Final Honors

Earned on a minimum of 60 graded UWM credits: Cum Laude - 3.500 or above; Magna Cum Laude - 3.650 or above; Summa Cum Laude - 3.800 or above.