BIOCHEMISTRY, BA

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 freshman year. 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 freshman 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.

Biochemistry is a specialty within chemistry that focuses on the basic substances and elements that make up living creatures, including plants, animals and humans.

Biochemistry is a popular major for students preparing to go on to medical school, veterinary school, dental school or other similar healthcare professional programs that require a foundation in both biology and chemistry. However, students also pursue many other types of paths including lab research in areas related to water, healthcare, and manufacturing; forensics work for municipalities or agencies; agriculture; genetics; scientific writing and promotion; sales and marketing in science fields; food safety and production; legal consulting on scientific matters; pharmaceutical production; and more.

Graduate studies in Biochemistry can be found under the Chemistry and Biochemistry (http://uwm.edu/letters-science/programs/?classification=GRAD) department, with both a Master of Science and the terminal PhD available.

Course of Study – Bachelor of Arts Degree

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

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. 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 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.

University General Education Requirements (GER)

Code	Title	Credits
Oral and Written Communication		
Part A		
Achieve a grade of C or better in the following course:		
ENGLISH 102	College Writing and Research (or equivalent)	
Part B		
Course designated as OWC-B; may be completed through a major-specific course requirement		
Quantitative Literacy		
Part A		
Earn at least 3 credits with a grade of C or higher in one of the following courses or an equivalent course, or achieve a placement code of at least 30 on the mathematics placement test (or other appropriate test, as determined by the Mathematical Sciences Department)		
MATH 102	Mathematical Literacy for College Students II	
MATH 103	Contemporary Applications of Mathematics	
MATH 105	Introduction to College Algebra	
MATH 108	Algebraic Literacy II	
MATH 111	Introduction to Logic - Critical Reasoning [1]	
or PHILOS 111	Introduction to Logic - Critical Reasoning	
MATH 116	College Algebra	
Or equivalent course		
Part B		
Course designated as QL-B; may be completed through a major-specific course requirement		

Arts	
Select 3 credits	3
Humanities	
Select 6 credits	6
Social Sciences	
Select 6 credits	6
Natural Sciences	
Select 6 credits (at least two courses including one lab)	6
UWM Foreign Language Requirement	
Complete Foreign Language Requirement through:	
Two years (high school) of a single foreign language	
Two semesters (college) of a single foreign language	
Or equivalent	
UWM Cultural Diversity Requirement	
One course from the Arts, Humanities, or Social Sciences must also satisfy UWM's Cultural Diversity requirement	

[1] Math 111 and Philosophy 111 are jointly offered and count as repeats of one another. Students cannot receive credit for both courses.

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 Arts (B.A.), you must complete the UWM General Education Requirements as well as these L&S requirements: the International requirement, the Breadth requirement, and the Research requirement. The International requirement develops your potential for cross-cultural understanding in a globalizing world. The Breadth requirement ensures that you take classes in a wide variety of subjects, across humanities, natural sciences, and social sciences. The Research requirement calls for you to build your critical thinking and oral and written communication skills through conducting an independent research project, usually in your major.

For the Bachelor of Arts (B.A.) you will also complete the Language other than English requirement, to further develop your understanding of cultures through language.

I. Total Credits and Upper-Division Courses Requirement

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

II. Language other than English Requirement

Students doing the BA must fulfill the language other than English requirement by either successfully completing the fourth semester of university work or equivalent in one language other than English, or by successfully completing the second semester of university work or equivalent in two languages other than English (including all world languages 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.

Completion of the L&S Language Requirement also satisfies the university-wide Language other than English GER, but not vice versa.

III. International Requirement

To meet the International Requirement, students must successfully complete some three course (minimum 9 credits) combination of

1. language other than English (*not* including American Sign Language) at 3rd semester level or above, ***and/or***
2. non-language 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).

IV. Breadth Requirement

In addition to completing the University General Education Requirements, L&S students must complete the Breadth requirement.

The L&S Breadth requirement calls for 6 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. These courses must be beyond and in addition to courses in those areas used to satisfy General Education Requirements.

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 of Letters and Science 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. Contact your 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.

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.

Biochemistry Major Requirements

The biochemistry major differs from the standard chemistry major with a biochemical option in a number of ways intended to provide for students a more intensive education in biochemistry so that they are prepared for work in the biochemical industry upon completing their baccalaureate degree. Students who are interested in graduate work in biochemistry should follow the standard chemistry major with a biochemical option.

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.

Code	Title	Credits
Required		
CHEM 102 & CHEM 104	General Chemistry and General Chemistry and Qualitative Analysis	10
CHEM 221	Elementary Quantitative Analysis	4
CHEM 343	Organic Chemistry	3
CHEM 344	Organic Chemistry Laboratory	2
CHEM 345	Organic Chemistry	3
CHEM 560	Biophysical Chemistry	3
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 152	Foundations of Biological Sciences II	4
BIO SCI 325	Genetics	4
PHYSICS 120 & PHYSICS 121	General Physics I (Non-Calculus Treatment) and General Physics Laboratory I (Non-Calculus Treatment)	5
PHYSICS 122 & PHYSICS 123	General Physics II (Non-Calculus Treatment) and General Physics Laboratory II (Non-Calculus Treatment)	5
MATH 205	Introductory Finite Mathematics	3
MATH 211	Survey in Calculus and Analytic Geometry I	4
MTHSTAT 215	Elementary Statistical Analysis	3
Biological Science Electives		
Select 3 credits (see below)		3
Total Credits		**73**

Biological Science Electives

Code	Title	Credits
BIO SCI 315	Cell Biology	3
BIO SCI 316	Laboratory in Genetics and Cell Biology	2
BIO SCI 356	Developmental Biology	3
BIO SCI 383	General Microbiology	4
BIO SCI 401	Immunology	3
BIO SCI 405	General Virology	3
BIO SCI 490	Molecular Genetics	3
BIO SCI 529	Molecular Biology of Microorganisms	3
BIO SCI 539	Laboratory Techniques in Molecular Biology	4
BIO SCI 540	Microbial Diversity and Physiology	3
BIO SCI 564	Endocrinology	3
BIO SCI 572	Functional Genomics	3
BIO SCI 580	Experimental Microbiology	4

Suggested Timetable for the Biochemistry Major

Year 1		
Semester 1		**Credits**
CHEM 102	General Chemistry	5
MATH 211	Survey in Calculus and Analytic Geometry I	4
BIO SCI 150	Foundations of Biological Sciences I	4
	Credits	**13**
Semester 2		
CHEM 104	General Chemistry and Qualitative Analysis	5
MATH 205	Introductory Finite Mathematics	3
BIO SCI 152	Foundations of Biological Sciences II	4
	Credits	**12**
Year 2		
Semester 1		
CHEM 221	Elementary Quantitative Analysis	4

CHEM 343	Organic Chemistry	3
PHYSICS 120 & PHYSICS 121	General Physics I (Non-Calculus Treatment) and General Physics Laboratory I (Non-Calculus Treatment)	5
MTHSTAT 215	Elementary Statistical Analysis	3
	Credits	**15**
Semester 2		
CHEM 344	Organic Chemistry Laboratory	2
CHEM 345	Organic Chemistry	3
PHYSICS 122 & PHYSICS 123	General Physics II (Non-Calculus Treatment) and General Physics Laboratory II (Non-Calculus Treatment)	5
BIO SCI 325	Genetics	4
CHEM 399	Special Chemical Problems:	2
	Credits	**16**
Year 3		
Semester 1		
CHEM 560	Biophysical Chemistry	3
CHEM 501	Introduction to Biochemistry	3
	Credits	**6**
Semester 2		
BIO SCI Elective		4
CHEM 602 or CHEM 604	Biochemistry: Cellular Processes or Biochemistry: Metabolism	3
CHEM 603	Introduction to Biochemistry Laboratory	2
	Credits	**9**
Year 4		
Semester 1		
CHEM 601	Biochemistry: Protein Structure and Function	3
CHEM 691 or CHEM 692	Senior Research or Senior Thesis	2
	Credits	**5**
	Total Credits	**76**

Biochemistry BA/BS Learning Outcomes

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

- Perform mathematical analysis of problems, including those with biochemistry and 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, in organic 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.