

BIOCHEMISTRY, 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 five different curricular options in chemistry and biochemistry:

1. Standard Chemistry Major
2. Course in Chemistry Degree Program
3. Chemistry Major with a Biochemical Option
4. Standard Biochemistry Major
5. Biochemistry Major with an Industrial Fermentation and Biotechnology Option
6. 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.

Requirements Course of Study – Bachelor of Science Degree

Complete 120 credits including 90 credits in the College of Letters & Science and with 36 of the 90 credits in L&S upper-level (numbered above 300) courses and 30 of those 36 credits in designated upper-level Natural Science. 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. Students are also required to complete University-wide General Education Requirements 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		
<i>Part A</i>		
ENGLISH 102	College Writing and Research (or equivalent)	
<i>Part B</i>		
Course designated as OWC-B; may be completed through a major-specific course requirement		
Quantitative Literacy		
<i>Part A</i>		
Select one of the following:		
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	
Or equivalent course		
<i>Part B</i>		
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**I. English Writing Requirement**

Students must satisfy the English Writing Requirement by completing ENGLISH 102 with a grade of C or higher or by placing beyond English 102 on the English Placement Test (EPT).

Note: This requirement is the same as the University General Education Requirement for Oral and Written Communication Part A. The College of Letters & Science does not have a specific requirement for a writing course beyond English 102, but students must complete the university-wide requirement for Oral and Written Communication Part B listed above.

II. Mathematics and Formal Reasoning

To satisfy the Mathematics and Formal Reasoning Requirement, Bachelors of Sciences degree students must satisfy the following two requirements:

1. Complete one of the following courses or an equivalent course:

Code	Title	Credits
MATH 211	Survey in Calculus and Analytic Geometry	4
MATH 213	Calculus with Life Sciences Applications	4
MATH 221	Honors Calculus I	5
MATH 231	Calculus and Analytic Geometry I	4

2. Complete one course (at least 3 credits) at the 200 level or above chosen from courses in Mathematics, PHILOS 212, or Letters and Science statistics courses:

Code	Title	Credits
Complete one of the following:		
3 or more credits in any 200-level or above Math course		
AFRIC 220	Introduction to Statistics in African and African Diaspora Studies	
ANTHRO 568	Introduction to Anthropological Statistics	
ATM SCI 500	Statistical Methods in Atmospheric Sciences	
BIO SCI 465	Biostatistics	
ECON 210	Economic Statistics	
GEOG 247	Quantitative Analysis in Geography	

HIST 595 The Quantitative Analysis of Historical Data

MTHSTAT 215 Elementary Statistical Analysis

PHILOS 211 Elementary Logic

POL SCI 390 Political Data Analysis

POL SCI 392 Survey Research

PSYCH 210 Psychological Statistics

SOCIO 261 Introduction to Statistical Thinking in Sociology

Note: This requirement is NOT the same as the University General Education Requirement for Quantitative Literacy Part B. To complete the BS, students must take one of the L&S approved courses. The courses listed here will satisfy the QL-B requirement.

III. Foreign Language Requirement

Two courses (minimum of 6 credits) in a language (including American Sign Language) other than English at the 100 level or above are required.

Placement testing may be used to satisfy all or part of this requirement. 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.

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

IV. International RequirementSee Approved Courses for the L&S International Requirement (<http://catalog.uwm.edu/letters-science/approved-courses-international-requirement/>) for course options.

Code	Title	Credits
Completed in one of the following ways:		9
Complete 3 courses (min. 9 cr) in a single foreign language (not including literature-in-translation or American Sign Language) at the 3rd semester level and above		
Complete 3 non-language courses (min. 9 credits) with an international content chosen from at least 2 curricular areas.		
Complete 9 credits in combination of the two options above.		

V. Breadth Requirement

Along with completing the University General Education Requirements of 3 credits in the Arts (A); 6 credits in the Humanities (HU), Social Sciences (SS), and Natural Sciences (NS/NS+); and a course with the Cultural Diversity (CD/+) designation, L&S students must complete the Breadth requirement.

Code	Title	Credits
Arts		
Select 3 credits		3
Humanities		
Complete 12 credits of L&S courses with Humanities Breadth designation; no more than 6 credits from a single subject area. *		12
Social Sciences		
Complete 12 credits of L&S Courses with Social Science Breadth designation; no more than 6 credits from a single curricular area. *		12
Natural Sciences		

Complete 12 credits of L&S Courses with Natural Sciences Breadth designation, including laboratory or field courses from three different curricular areas.* 12

Cultural Diversity

Complete 3 credits in a course with Cultural Diversity (CD) designation.** 3

* Students should check their course selections carefully with the list of approved L&S Breadth Courses (<http://catalog.uwm.edu/letters-science/breadth-requirement-course-list>). Students are advised to select at least 6 credits worth of courses in each of the Humanities, Social Science, and Natural Sciences areas that can satisfy both the campus-wide General Education Requirements and the L&S Breadth requirement.

** Students are advised to select a course that satisfies the Cultural Diversity requirement as well as a Humanities or Social Science breadth/GER requirement.

VI. 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. 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 (<http://catalog.uwm.edu/letters-science/approved-courses-research-requirement>).

VII. The Minor

The College 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. Individual departments or programs may require higher GPAs for graduation.

Prerequisite 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.

Declaration of Major Requirements

To declare a chemistry or biochemistry major, the following are required:

- completion of CHEM 102 and CHEM 104;
- completion or concurrent registration in CHEM 343; and
- a GPA of 2.500 or better in all Chem courses attempted.

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.

There are three options in the biochemistry major:

- Biochemistry General Option
- Biochemistry with Clinical Pharmacology Option
- Biochemistry with Industrial Fermentation and Biotechnology Option (which is offered jointly with the Department of Biological Sciences)

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.

Biochemistry General Option

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

CHEM 691 or CHEM 692	Senior Research (satisfies L&S research requirement) Senior Thesis	1-4
BIO SCI 150	Foundations of Biological Sciences I	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 213	Calculus with Life Sciences Applications	4
MTHSTAT 215	Elementary Statistical Analysis	3
Biological Science Electives		
Select 7 credits (see below)		
Total Credits		69-72

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 402	Immunological Techniques	3
BIO SCI 405	General Virology	3
BIO SCI 455	Cellular, Molecular and Developmental Neurobiology	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 573	Cellular Evolution	3
BIO SCI 580	Experimental Microbiology	4

Clinical Pharmacology Option

Code	Title	Credits
CHEM 102 & CHEM 104	General Chemistry and General Chemistry and Qualitative Analysis	10
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:		
CHEM 601	Biochemistry: Protein Structure and Function	
CHEM 602	Biochemistry: Cellular Processes	

CHEM 604	Biochemistry: Metabolism	
CHEM 603	Introduction to Biochemistry Laboratory	2
CHEM 691 or CHEM 692	Senior Research (satisfies L&S research requirement) Senior Thesis	1-4
BIO SCI 150	Foundations of Biological Sciences I	4
BIO SCI 152	Foundations of Biological Sciences II	4
BIO SCI 202	Anatomy and Physiology I	4
BIO SCI 325	Genetics	4
BIO SCI 383	General Microbiology	4
BIO SCI 596	Neuropharmacology	3
PHYSICS 120 & PHYSICS 121	General Physics I (Non-Calculus Treatment) and General Physics Laboratory I (Non-Calculus Treatment)	5
MATH 213	Calculus with Life Sciences Applications	4
MTHSTAT 215	Elementary Statistical Analysis	3
BMS 427	Clinical Immunology	3
BMS 428	Clinical Immunology Laboratory	1
BMS 431	Clinical Chemistry	3
BMS 432	Clinical Chemistry Laboratory Theory & Operations	1
BMS 560	Molecular and Genetic Diagnostics	2
BMS 561	Molecular Diagnostics Laboratory	1
BMS 610	Pharmacology	3
Total Credits		82-85

Industrial Fermentation and Biotechnology Option

Code	Title	Credits
CHEM 102 & CHEM 104	General Chemistry and General Chemistry and Qualitative Analysis	10
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:		
CHEM 601	Biochemistry: Protein Structure and Function	
CHEM 602	Biochemistry: Cellular Processes	
CHEM 604	Biochemistry: Metabolism	
CHEM 603	Introduction to Biochemistry Laboratory	2
CHEM 691 or CHEM 692	Senior Research (satisfies L&S research requirement) Senior Thesis	1-4
BIO SCI 150	Foundations of Biological Sciences I	4
BIO SCI 325	Genetics	4
BIO SCI 383	General Microbiology	4
BIO SCI 536	Applied Microbiology and Biotechnology	3
CHEM 541	Bioprocess Chemical Engineering	3

CHEM 537	Industrial Microbiology and Biochemistry Laboratory	2
CHEM/BIO SCI 543	Bioproduct Regulatory Protocols Laboratory	3
CHEM 489	Internship in Chemistry, Upper Division (with "Science Career Transitions" focus)	1-6
CHEM 489	Internship in Chemistry, Upper Division (satisfies L&S research requirement)	1-6
PHYSICS 120 & PHYSICS 121	General Physics I (Non-Calculus Treatment) and General Physics Laboratory I (Non-Calculus Treatment)	5
MATH 213	Calculus with Life Sciences Applications	4
MTHSTAT 215	Elementary Statistical Analysis	3
Total Credits		64-77

Suggested Timetable for the Biochemistry Major

Year 1		Credits
Semester 1		
CHEM 102	General Chemistry	5
MATH 115	Precalculus	4
BIO SCI 150	Foundations of Biological Sciences I	4
Credits		13
Semester 2		
CHEM 104	General Chemistry and Qualitative Analysis	5
MATH 213	Calculus with Life Sciences Applications	4
Credits		9
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		73

Letters & Science Advising

The College of Letters and Science provides general academic advising for all students with a major in the College, particularly as it relates to campus' general education requirements and the College's degree requirements. We also provide specialized advising for pre-professional students (pre-med, pre-dental, pre-pharmacy, etc.) regardless if their major is in Letters and Science or not. Prospective students, including high school students and students seeking to transfer to a program in Letters and Science may also receive advising from our admissions counselors.

Upon admission, students are assigned an advisor in the College advising office. Academic advising is available Monday through Friday from 8:30 a.m. to 4:30 p.m. by appointment. Appointments outside of these times may be available and phone appointments are available for online students. The advising office (<https://uwm.edu/letters-science/advising/contact-advising>) is located on the first floor of Holton Hall. Current students should call (414) 229-4654 to schedule an appointment or use the Student Success Collaborative website (<https://uwmilwaukee.campus.eab.com>) to make an appointment with your assigned advisor; online scheduling is only available if you already have a Letters & Science advisor assigned to you. Prospective students should call (414) 229-7711 or email let-sci@uwm.edu.

When students declare a major, they will receive an additional faculty advisor located within the major department who will assist with requirements for that major. Students should read the "Declaration of Major" information on the website of the major that they are interested in. In some cases, the student will need to choose a faculty advisor as part of the declaration process.

All students are cautioned to consult their Letters & Science academic advisor AND their major advisor prior to each registration period to ensure they understand all requirements. Do not rely on pre-printed sample plans, as they are intended to be samples only and may not be right for your particular situation.

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).

Honors in the 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 Degree and Honors Degree with Thesis

Granted to graduating seniors who complete Honors College requirements, as listed in the Honors College (<http://catalog.uwm.edu/opportunities-resources/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. In schools and colleges in which fewer than 15% of the traditional students have a 3.500 GPA, all-university honors will be awarded to approximately the top 15% of graduating students. A criterion GPA (not lower than 3.200) for this 15% will be calculated based on statistics from the previous comparable semester. 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.

Contact Information

Current Students contact Senior Lecturer Gloria Freschl,
freschl@uwm.edu

Prospective Students contact a Letters & Science Admissions Counselor
at
(414) 229-7711 or let-sci@uwm.edu

<http://uwm.edu/chemistry/undergraduate/biochemistry/>