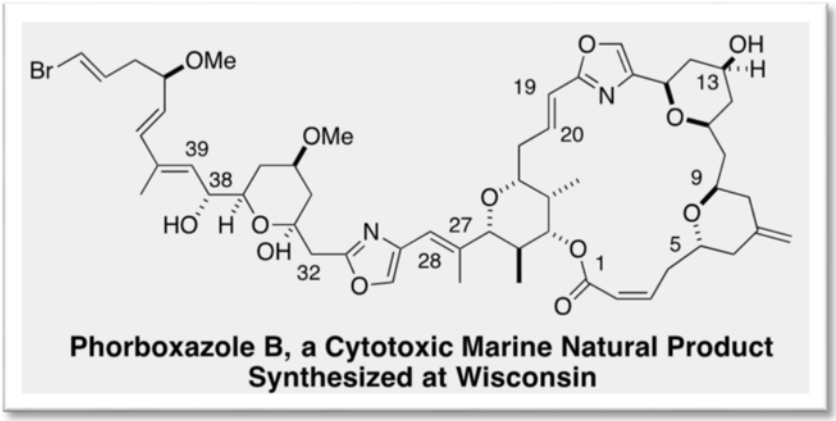
University of Wisconsin–Madison
Department of Chemistry

Curriculum Guide for Chemistry Majors
2017 – 2018



Katie McCullough
Chemistry Advisor
Room 1321D Chemistry
klmccullough@wisc.edu
(608) 262-8898

Dr. Jeanne Hamers
Undergraduate Chemistry Director & Chemistry Advisor
Room 1328 Chemistry
jhamers@wisc.edu
(608) 263-4852

Dr. Cheri Barta
Undergraduate Research Director
Room 2110 Chemistry
cbarta@chem.wisc.edu
(608) 262-6533

Undergraduate Chemistry Office
Room 1328 Chemistry
undergrad@chem.wisc.edu
(608) 263-2424

Considering a major in Chemistry? Join our prospective chemistry majors email list!
http://chem.wisc.edu/content/majoring-chemistry

To schedule an advising appointment with the chemistry major advisor, go to:
http://chem.wisc.edu/content/undergraduate-advising

Rev. 2/18/2018

REQUIRED CHEMISTRY COURSES FOR THE CHEM ISTRY MAJOR

(37 credits)

A. General Chemistry

Choose one from: CHEM 109 Advanced General Chemistry (5 cr)
CHEM 109H Advanced General Chemistry Honors (5 cr)
CHEM 115 Chemical Principles I (5 cr) (enrollment by invitation only)
CHEM 104 (5 cr) (CHEM 103 is a prerequisite.)

CHEM 109, 109H, or 115 is recommended, but CHEM 103/104 also fulfils this requirement.

B. Analytical Chemistry[1]

CHEM 329 Fundamentals of Analytical Science (4 cr)
or CHEM 116 Chemical Principles II (5 cr) (only open to students who took CHEM 115)

C. Inorganic Chemistry

CHEM 311 Chemistry Across the Periodic Table (4 cr)

D. Organic Chemistry[2]

CHEM 343 Introductory Organic Chemistry (3 cr)
CHEM 344 Introductory Organic Chemistry Laboratory (2 cr)
CHEM 345 Intermediate Organic Chemistry (3 cr)

E. Physical Chemistry[3]

CHEM 561 Physical Chemistry I (3 cr) *or* CHEM 565 Biophysical Chemistry (4 cr)[4]
CHEM 562 Physical Chemistry II (3 cr)
CHEM 563 Physical Chemistry Laboratory I (1 cr)
CHEM 564 Physical Chemistry Laboratory II (1 cr)

F. Advanced Non-laboratory Course work (5 cr) Choose from any 500-600 level courses in chemistry or biochemistry that are not research courses. Options include CHEM 505 Industrial Chemistry (3 cr), CHEM 511 Inorganic Chemistry (3 cr), CHEM 524 Chemical Instrumentation (3 cr; only 2 cr count for advanced non-lab work), CHEM 547 Advanced Organic Chemistry (3 cr), BIOCHEM 501 Introduction to Biochemistry (3 cr), and BIOCHEM 507 & 508 General Biochemistry I & II (3 cr each). Additional courses that count include CHEM 421 Polymeric Materials, CBE 440 Chemical Engineering Materials, CBE 540 Polymer Science & Technology, and CBE 547 Introduction to Collide and Interface Science. The extra credits associated with CHEM 116 and CHEM 565 also count towards the 5 credits.

G. Additional laboratory work (3 cr) Choose from the following lab courses: CHEM 346 Intermediate Organic Laboratory (1-2 cr; fall only), CHEM 524 Chemical Instrumentation (3 cr; only 1 cr counts for lab work; spring only), CHEM 681/682 Senior Honors Thesis, CHEM 691/692 Senior Thesis, or CHEM 699 Directed Study. Biochemistry research courses (681/682, 691/692, and 699), BMOLCHEM 504 Human Biochemistry Lab[5] (3 cr; only 2 cr count for lab work; spring & summer only), and CBE 599 are also accepted. Note that students need to first find a research advisor before enrolling in one of the directed study or thesis courses.

---

[1] Students are strongly encouraged to take either CHEM 329 or CHEM 116 (if invited) to fulfill the Analytical Chemistry requirement. However, CHEM 327 may be substituted for this requirement.

[2] CHEM 343 must be taken first, followed by CHEM 345. CHEM 344 may be taken concurrently with or after CHEM 345.

[3] It is recommended that CHEM 563 be taken concurrently with CHEM 562 and that CHEM 564 be taken after completion of CHEM 562. Especially strong students needing to complete physical chemistry in two semesters may take CHEM 563 concurrently with CHEM 561 (or 565) and CHEM 564 concurrently with CHEM 562.

[4] CBE 310 Chemical Process Thermodynamics or MS&E 330 Thermodynamics of Materials may be substituted for this requirement. These options are only recommended for students who are also majoring CBE or MS&E.

[5] BMOLCHEM 504 is not recommended for students who are also majoring in Biochemistry, because it overlaps significantly with required biochemistry course work.

MATH AND PHYSICS REQUIREMENTS

Calculus and calculus-based physics classes are also required for the chemistry major. Specifically, MATH 221 Calculus I (5 cr) and MATH 222 Calculus II (4 cr) are required. Students are encouraged to take these courses in their first year. MATH 222 is a good match with the quantitative skills required in CHEM 329. MATH 234 Calculus-Functions of Several Variables (4 cr) and MATH 320 Linear Algebra and Differential Equations (3 cr) are not required, but they are highly recommended. Students with MATH 221 and 222 credit from AP Calculus are especially encouraged to take further math.

Physics 207 - 208 General Physics I & II (5 cr each) are the recommended physics courses for chemistry majors, but Physics 201 - 202 General Physics I & II (5 cr each, intended for engineering students) are also accepted. These physics courses include a three-hour laboratory. Most chemistry majors take physics in their second year. Students interested in chemistry with a biological emphasis will often take biology in their second year and then take physics and biochemistry in their third year.

POSSIBLE PATHWAYS THROUGH THE CHEMISTRY MAJOR

The following pages show several possible course sequences for the required chemistry courses. These suggestions are all based on a four-year undergraduate degree. Those students who plan to take longer or take courses in the summer can decompress these schedules. In presenting just five pathways we hope that students will have enough information to tailor course sequences to best obtain their educational objectives.

Pathway 1 – Compressed Schedule

Pathway 1 includes all intermediate courses in the first two years. With this route 29-30 credits would be completed by the end of year 3.

Pathway 1	Semester I	Semester II
Year 1	CHEM 109 (5 cr) [3/1/3][6]	CHEM 329 (4 cr) [2/1/8]
	MATH 221 (5 cr) [3/2/0]	MATH 222 (4 cr) [3/2/0]
Year 2	CHEM 343 (3 cr) [3/0/0]	CHEM 344 (2 cr) [0/2/6]
	CHEM 311 (4 cr) [3/1/3]	CHEM 345 (3 cr) [3/0/0]
	Physics 207 (5 cr) [3/2/3]	Physics 208 (5 cr) [3/2/3]
Year 3	CHEM 346 (1-2 cr) [0/2/8]	CHEM 562 (3 cr) [3/1/0]
	CHEM 561 or 565 (3-4 cr) [3-4/1/0]	CHEM 563 (1 cr) [0/0/4]
Year 4	CHEM 564 (1 cr) [0/0/4]	CHEM Electives
	CHEM Electives	

[6] The notation [3/1/3] means that the course has 3 hours of lecture, 1 hour of discussion and 3 hours of laboratory.

Pathway 2 – Less Compressed Schedules

Pathway 2 offers a series of less demanding pathways compared to pathway 1. There are three versions of this pathway. Compared to pathway 1, pathway 2a delays CHEM 311 to the second semester of year 3 and pushes the physical chemistry courses back a semester.

Pathway 2a	Semester I	Semester II
Year 1	CHEM 109 (5 cr) [3/1/3]	CHEM 329 (4 cr) [2/1/8]
	MATH 221 (5 cr) [3/2/0]	MATH 222 (4 cr) [3/2/0]
Year 2	CHEM 343 (3 cr) [3/0/0]	CHEM 344 (2 cr) [0/2/6]
	Physics 207 (5 cr) [3/2/3]	CHEM 345 (3 cr) [3/0/0]
		Physics 208 (5 cr) [3/2/3]
Year 3	CHEM 346 (1-2 cr) [0/2/8]	CHEM 311 (4 cr) [3/1/3]
		CHEM 561 or 565 (3 or 4 cr) [3-4/1/0]
Year 4	CHEM 562 (3 cr) [3/1/0]	CHEM 564 (1 cr) [0/0/4]
	CHEM 563 (1 cr) [0/0/4]	CHEM Electives

A student interested in inorganic chemistry could take CHEM 311 before taking the organic and analytical courses by following pathway 2b.

Pathway 2b	Semester I	Semester II
Year 1	CHEM 109 (5 cr) [3/1/3]	CHEM 311 (4 cr) [3/1/3]
	MATH 221 (5 cr) [3/2/0]	MATH 222 (4 cr) [3/2/0]
Year 2	CHEM 329 (4cr) [2/1/8]	CHEM 343 (3 cr) [3/0/0]
	Physics 207 (5 cr) [3/2/3]	Physics 208 (5 cr) [3/2/3]
Year 3	CHEM 344 (2 cr) [0/2/6]	CHEM 561 or 565 (3 or 4 cr) [3-4/1/0]
	CHEM 345 (3 cr) [3/0/0]	CHEM 511 (3 cr) [3/0/0]
Year 4	CHEM 562 (3 cr) [3/1/0]	CHEM 564 (1 cr) [0/0/4]
	CHEM 563 (1 cr) [0/0/4]	CHEM Electives

A student may also choose to take the analytical course CHEM 329 before taking the organic and inorganic courses by following pathway 2c.

Pathway 2c	Semester I	Semester II
Year 1	CHEM 109 (5 cr) [3/1/3]	CHEM 329 (4 cr) [2/1/8]
	MATH 221 (5 cr) [3/2/0]	MATH 222 (4 cr) [3/2/0]
Year 2	CHEM 311 (4 cr) [3/1/3]	CHEM 343 (3 cr) [3/0/0]
	Physics 207 (5 cr) [3/2/3]	Physics 208 (5 cr) [3/2/3]
Year 3	CHEM 344 (2 cr) [0/2/6]	CHEM 561 or 565 (3 or 4 cr) [3-4/1/0]
	CHEM 345 (3 cr) [3/0/0]	
Year 4	CHEM 562 (3 cr) [3/2/0]	CHEM 564 (1 cr) [0/0/4]
	CHEM 563 (1 cr) [0/0/4]	CHEM Electives

Pathway 3 - For Students Pursuing Careers in Synthetic Chemistry

Possible course schedule for students with interests in synthetic chemistry or biological chemistry would accelerate the organic courses. Pathway 3 would be suitable for students interested in synthetic chemistry (Organic or Inorganic).

Pathway 3	Semester I	Semester II
Year 1	CHEM 109 (5 cr) [3/1/3]	CHEM 311 (4 cr) [3/1/3]
	MATH 221 (5 cr) [3/2/0]	CHEM 343 (3 cr) [3/0/0]
		MATH 222 (4 cr) [3/2/0]
Year 2	CHEM 345(3 cr) [3/0/0]	CHEM 329 (4 cr) [2/1/8]
	CHEM 344 (2 cr) [0/2/6]	Physics 208 (5 cr) [3/2/3]
	Physics 207 (5 cr) [3/2/3]	
Year 3	CHEM 346 (1 or 2 cr) [0/2/8]	CHEM 561 or 565 (3 or 4 cr) [3-4/1/0]
	CHEM 547 (3 cr) [3/0/0]	
Year 4	CHEM 562 (3 cr) [3/1/0]	CHEM 564 (1 cr) [0/0/4]
	CHEM 563 (1 cr) [0/0/4]	CHEM Electives

Pathway 4 - For Students Pursuing Careers in Chemistry with Biological Emphasis

Pathway 4	Semester I	Semester II
Year 1	CHEM 109 (5 cr) [3/1/3]	CHEM 343 (3 cr) [3/1/0]
	MATH 221 (5 cr) [3/2/0]	MATH 222 (4 cr) [3/2/0]
Year 2	CHEM 345 (3 cr) [3/0/0]	CHEM 311 (4 cr) [3/1/3]
	CHEM 344 (2 cr) [0/2/6]	Bio 152 (5 cr) [3/1/3]
	Bio 151 (5 cr) [3/1/3]	
Year 3	CHEM 329 (4 cr) [2/1/8]	Physics 208 (5 cr) [3/2/3]
	Physics 207 (5 cr) [3/2/3]	Biochem 508 (3 cr) [3/0/0]
	Biochem 507 (3 cr) [3/0/0]	
Year 4	CHEM 565 (4 cr) [4/1/0]	CHEM 562 (3 cr) [3/1/0]
	CHEM 563 (1 cr) [0/0/4]	CHEM 564 (1 cr) [0/0/4]

Pathway 5 - For Students Pursuing Careers in Physical-Analytical Chemistry

Pathway 5	Semester I	Semester II
Year 1	CHEM 109 (5cr) [3/1/3]	CHEM 329 (4 cr) [2/1/8]
	MATH 221 (5 cr) [3/2/0]	MATH 222 (4 cr) [3/2/0]
	Physics 207 (5 cr) [3/2/3]	Physics 208 (5 cr) [3/2/3]
Year 2	CHEM 561 (3 cr) [3/1/0]	CHEM 311 (4 cr) [3/1/3]
	MATH 320 or 340 (3 cr) [3/1/0]	CHEM 562 (3 cr) [3/1/0]
		CHEM 563 (1 cr) [0/0/4]
Year 3	CHEM 343 (3 cr) [3/0/0]	CHEM 344 (2 cr) [0/2/6]
	CHEM 564 (1 cr) [0/0/4]	CHEM 345 (3 cr) [3/0/0]
Year 4	CHEM Electives	CHEM Electives

COLLEGE OF LETTERS & SCIENCE
B.A. and B.S. Degree Requirements, at a glance

Requirements efective for students matriculating to any post-secondary institution May 21, 2007 and later

TOOLS for Learning and Communication

University General Education Requirements

One Quantitative Reasoning A course (q)
One Quantitative Reasoning B course (r)
One Communication A course (a)
One Communication B course (b)
One 3+ credit Ethnic Studies course (e)

Mathematics

Bachelor of Arts
Met with GER Quantitative A & B (above)

Bachelor of Science
Two 3+credit courses at I/A level (MATH, COMP SCI, STAT)
(Limit one each: COMP SCI, STAT)

Minimum Math Competency demonstrated by placement score or course is required for all students

Foreign Language

Bachelor of Arts
Fourth level of a language***, or***
Third level of a language ***and*** Second level of another language

Bachelor of Science
Third level of a language

BREADTH of Exploration in the Liberal Arts & Sciences

Humanities: 12 credits (L,H,X,Z)
6 credits Literature (L)

Social Science: 12 credits (S,W,Y,Z)

Natural Science: 12 credits (B,P,N,W,X,Y)

Bachelor of Arts
One 3+ credit Biological science course (B)
One 3+ credit Physical Science course (P)

Bachelor of Science
6 credits Physical Science (P)
6 credits Biological Science (B)

108 Liberal Arts & Sciences credits (C)

DEPTH of inquiry in the Liberal Arts & Sciences

Mastery of Intermediate/ Advanced Work: 60 credits (I,A,D)

Major: Declare at least one major (and complete all declared majors)

QUANTITY & QUALITY of Work

There are limits on credits for certain courses. Consult this Catalog and your DARS for more information

120 Total Credits

UW-Madison Experience

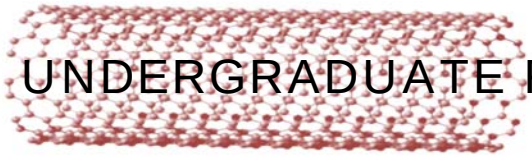
30 credits **in residence** overall
30 credits **in residence** after the 90th credit
15 upper-level credits **in residence** in each major
15 credits **on campus** in each major/Department

Minimum GPAs

2.0 in all courses at UW-Madison
2.0 in I/A/D Level work at UW-Madison
2.0 in all major &major department courses
2.0 in upper-level major &major courses

In all categories, requirements listed are minimums. Further study, especially in Breadth and Depth, is encouraged.

CHEMISTRY UNDERGRADUATE RESEARCH



The chemistry department highly encourages students pursuing a chemistry degree to get involved in research. Research projects give students the opportunity to experience the most up-to-date research equipment and techniques, and the opportunity to apply what they have learned in class to 'real-life' situations. Many undergraduates become co-authors on research publications in the scientific literature and have the opportunity to present their work at professional conferences around the world. Participation in undergraduate research also gives you invaluable marketable skills that become crucial when applying to graduate programs, industrial jobs, and/or professional schools.

How to get involved:

There are many ways to get involved in research; you may do research for course credit, pay or as a volunteer. Regardless, several blocks of time (*at least* 4-5 hours) are usually required each week to carry out your project.

CHEM 260: 1-credit seminar course designed to help undergraduates find a research mentor, learn how to effectively define an independent research project, learn about the roles and responsibilities of a researcher, and learn how to effectively communicate your research to the greater scientific community. This course is designed to be taken concurrently with 1-3 independent research credits and is offered both in the Fall and Spring semesters.

Laboratory credit: Every chemistry major is required to complete 3 credits of additional laboratory work. One way to satisfy this requirement is to get involved in independent research and enroll in CHEM 699, CHEM 681/682, or CHEM 691/692. To enroll for research credits, you must first find a research advisor who will sponsor you in his/her lab for the semester. Both the professor and student should agree on a study plan and determine the number of credits to be earned. Finally, you must complete a chemistry research authorization form and return it to Dr. Cheri Barta in Chemistry, Room 2110. The form can be found on the UW chemistry website (http://chem.wisc.edu/content/get-started).

CHEM 299: Directed Study (1-4 credits). Open to freshmen and sophomores at the consent of the instructor. *This course does not count towards the 3 credits of additional laboratory work.*

CHEM 699: Directed Study (1-6 credits). Open to students who have completed at least one semester of research or students that have junior or senior standing (54 credits or more). Must also have consent of the instructor.

CHEM 681/682: Senior Honors Thesis (2-4 credits/semester). Must be a senior honors candidate, have consent of the instructor, enroll in both CHEM 681 and CHEM 682 for consecutive semesters for a total of 6 credits, and complete a research thesis at the end of CHEM 682.

CHEM 691/692: Senior Thesis (2-6 credits/semester). Recommended for seniors; must have consent of the instructor, enroll in both CHEM 691 and CHEM 692 for consecutive semesters for a minimum of 4 credits total, and complete a research thesis at the end of the CHEM 692.

---

[7] One credit hour in research corresponds to 3 to 4 hours of research per week for 15 weeks (45-60 hours per semester).

Finding a mentor:

The hardest part of getting involved in research is finding a research mentor. You may be lucky and find a research mentor immediately. Most often, however, you will need to contact several people multiple times before finding a research lab that is taking undergraduate students. Don't get discouraged though—if you are having a hard time finding an advisor, come talk to the chemistry undergraduate research coordinator (Dr. Barta, email: cbarta@chem.wisc.edu, Office: Chemistry RM #2110, Phone: 608-262-6533) or check out other helpful hints on the UW chemistry website (http://chem.wisc.edu/content/get-started). Just remember...although getting involved in research can be the most valuable experience in your scientific career, it also takes a lot of patience, perseverance and commitment.

1) Decide what interests you.
Think back to what chemistry classes and labs you particularly enjoyed. Was the content of the class/lab more chemical biology, inorganic, chemical education, analytical, organic, materials, physical/theoretical or environmental focused? Attending departmental, college, and university research forums/seminars can also help you to figure out what you might like to do. Don't forget to also use your fellow classmates, your TA's and your professors as resources.

2) Identify Potential Faculty that you want to work with.
After deciding what type of chemistry interests you, go to the UW Chemistry website (www.chem.wisc.edu) and identify seven or eight different professors that are doing projects you would like to work on. Best advice is to stay flexible--Professors sometimes aren't able to take research students due to insufficient funding, limited lab space, limited personnel, etc. Don't take this rejection personally—just move on to your next choice.

3) Contact potential faculty.
Write a compelling, concise email. HINT: if you write an email, DO NOT write a generic email saying, "Hi! My name is ____ and I'm interested in doing research with you. When can I start?" You'll almost always get NO response. You must put some time into this if you are serious about doing research. You can think of this process as being very similar to finding a job--It is a good idea to have a resume ready in case you are asked for it, and you must always be on your best behavior (make sure you don't have spelling errors in your emails, etc.) For hints on how to write a good email, go to chem.wisc.edu/content/get-started.

4) Wait.
If you don't hear anything back in a week, try emailing again. If you still don't hear back, stop by their office and ask if you can set-up a meeting to discuss their research. Remember that professors are busy—if you really want to work in their research group, you must make a concerted effort.

5) Fill out a *Chemistry Research Authorization Form* and return it to Dr. Barta.
Once you have found a research advisor, you must fill out the *Chemistry Research Authorization Form*. This form needs to be filled out every semester regardless if you are doing research for class credit, for pay, or as a volunteer.

The earlier the better:

We highly encourage freshman to start thinking about research during their first year on campus in hopes that you will get involved in undergraduate research during your second year. If you start early in your academic career, you will have more chances to explore different research possibilities, more opportunities to develop your scientific knowledge, and more experiences to prepare you for your future career.

CHEMISTRY HONORS IN THE MAJOR

Students may declare Honors in the Chemistry Major in consultation with the chemistry major advisor (http://chem.wisc.edu/content/undergraduate-advising). To be admitted to the Honors Program in Chemistry, students must have declared a major in chemistry and achieved a 3.200 overall GPA. They must also have achieved a 3.200 GPA.in all CHEM courses taken and courses accepted for the major.

Once admitted, honors candidates should select a faculty research mentor by the fall semester of their junior year. Mentors may come either from chemistry or from a related department such as chemical engineering, pharmacology, or biochemistry. Students who choose a mentor from outside the chemistry department are responsible for providing the mentor with the requirements for the honors major in chemistry.

To earn a B.A. or B.S. with Honors in the Major in Chemistry, students must satisfy both the requirements for the regular major and the following additional requirements:

- Earn a 3.300 overall university GPA.
- Earn a 3.300 GPA for all CHEM courses and all courses accepted for the major.
- Complete at least 3 credits of advanced work beyond those already required for the major. This requirement may be met in one of three ways:
    - With additional 500-level or higher courses in chemistry or biochemistry;
    - With additional research credits, beyond credits for the Senior Honors Thesis and beyond any credits that are being used to satisfy the 3 additional laboratory credits required for the major; or
    - With additional breadth courses in other related disciplines
- Complete a two-semester Senior Honors Thesis in CHEM 681 Senior Honors Thesis and CHEM 682 Senior Honors Thesis, for a total of 6 credits.
- Present their work to their peers in a symposium

Additional breadth courses for advanced work may come (for example) from engineering, physics, molecular biology, computer science, water chemistry, and business. Advanced level courses should be chosen in consultation with the student's research mentor. Courses required for the chemistry major cannot be used to simultaneously satisfy the advanced course requirement for honors in the major.

Several opportunities for students to present their work at a symposium are available near the end of the spring semester every year. These opportunities include the Chemistry Undergraduate Poster Session held every May, the campus-wide Undergraduate Symposium in April, and the L&S Senior Honors Thesis Symposium also in April.

CHEMISTRY DEPARTMENT UNDERGRADUATE SCHOLARSHIPS AND AWARDS

Academic Year and Summer Research Scholarships

Through the generosity of alumni and other friends of the department, the Department of Chemistry is able to offer scholarships and summer research support. In 2017, the Department awarded 36 undergraduate awards totaling over $150,000. Any student who will be enrolled as an undergraduate at UW-Madison during the next academic year and is a chemistry major or is conducting research with a chemistry faculty member is eligible to apply for the scholarships. An overall GPA of at least 3.0 is required for application; awards are based on both merit and financial need. Scholarships to students with GPAs much below 3.5 are less likely to be awarded, unless strongly supported by an undergraduate research supervisor.

Students may apply for academic year scholarships and/or summer research support. The academic year scholarships range from $500 to $6,000. The summer research scholarship amount was $4000 to $5000 in 2017. Recipients of the summer research scholarships must enroll in at least one credit of research for the summer term. Students cannot receive both the Hilldale Research Fellowship and a chemistry summer research scholarship for the same summer. More information about chemistry scholarships can be found at: http://chem.wisc.edu/content/chemistry-scholarships.

Other Undergraduate Chemistry Awards

The James C. Krauskopf Award and John and Elizabeth Moore Award are given annually to the students with the most outstanding record in General Chemistry.

The ACS Wisconsin Section gives awards to the best students in Analytical Chemistry, Inorganic Chemistry, Organic Chemistry, and Physical Chemistry.

Additional Information

For additional information about scholarships offered at UW-Madison, visit Scholarships@UW: http://scholarships.wisc.edu/Scholarships/.

For information about all aspects of financial aid, visit the Office of Student Financial Aid: http://finaid.wisc.edu/ .