CHEMISTRY, PH.D.

The mission of the Department of Chemistry at the University of Wisconsin–Madison is to conduct world-class, groundbreaking research in the chemical sciences while offering the highest quality of education to undergraduate students, graduate students, and postdoctoral associates. Our leadership in research includes the traditional areas of physical, analytical, inorganic, and organic chemistry, and has rapidly evolved to encompass environmental chemistry, chemical biology, biophysical chemistry, soft and hard materials chemistry, and nanotechnology. We pride ourselves on our highly interactive, diverse, and collegial scientific environment. Our emphasis on collaboration connects us to colleagues across campus, around the country, and throughout the world.

The Department of Chemistry is ranked very highly in all recent national rankings of graduate programs. We offer a doctor of philosophy in chemistry. Specializations within the program are analytical, inorganic, materials, organic, and physical chemistry as well as chemical biology. Breadth coursework may be taken in other departments including physics, mathematics, computer sciences, biochemistry, chemical engineering, and in fields other than the student’s specialization within the Department of Chemistry.

Excellent facilities are available for research in a wide variety of specialized fields including synthetic and structural chemistry; natural product and bio-organic chemistry; molecular dynamics and photochemistry; biophysical, bioanalytical, and bioinorganic chemistry; spectroscopy (including magnetic resonance and microwave), theoretical and experimental chemical physics, chemical dynamics, quantum and statistical mechanics; macromolecular and polymer chemistry, materials science, surface and solid-state chemistry; x-ray crystallography, lasers, and light scattering; and chemical education. Programs are assisted by department computing and instrument centers and by other facilities on campus including those of the Division of Information Technology (DoIT).

Information on the research fields of faculty members is available on the chemistry website (http://www.chem.wisc.edu).

The department offers opportunities for graduate students to obtain teaching experience. Financial assistance is available to most graduate students in the form of teaching or research assistantships, fellowships, or traineeships.

ADMISSIONS

Prospective graduate students are expected to have satisfactorily completed the equivalent in class and lab of the fundamental courses in chemistry offered at UW–Madison, one year of physics, and mathematics through calculus. Students who have not completed all the prerequisites may be admitted in exceptional cases, but any deficiencies must be made up in the first year of graduate study.

A grade point average of 3.0 (on a 4.0 scale) in the last 60 hours of undergraduate work is the minimum required for admission to graduate studies. The Graduate Record Exam (GRE) is also required. The subject test is required for international applicants, and strongly recommended for domestic students. Students for whom English is not the native language are required to present scores from the Test of English as a Foreign Language (TOEFL) or International English Language Testing System (IELTS). Before teaching assistant appointments can be finalized, students for whom English is a second language must participate in the SPEAK Test, the institutional version of the Test of Spoken English (TSE).

Admission deadline for the fall semester is December 15. Although some exam scores or recommendation letters might not have been received at that time, the application should be substantially complete by then to be considered for admission in the following fall.

Admission for the spring semester is not the norm, and applications for spring should only be submitted following discussion with a faculty member and/or the director of graduate study. Most summer admissions are applicants who were already admitted for the fall semester, and decided to start earlier so they could serve as a teaching assistant or research assistant.

GRADUATE SCHOOL ADMISSIONS

Graduate admissions is a two-step process between academic degree programs and the Graduate School. Applicants must meet requirements of both the program(s) and the Graduate School. Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/admissions).

FUNDING

Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding) is available from the Graduate School. Be sure to check with your program for individual policies and processes related to funding.

PROGRAM RESOURCES

With few exceptions, students admitted to the Ph.D. program in the Department of Chemistry are guaranteed support for five continuous academic years. The support will be at the level of at least 50% time, and may come from a variety of sources—teaching assistantships, research assistantships, project assistantships, traineeships, and fellowships. This guarantee requires that you remain a graduate student in good standing in the Ph.D. program in the Department of Chemistry, and that your teaching or other assigned responsibilities are satisfactory.

Currently, graduate students who have at least a 33.4% appointment for a fall or spring term are eligible to receive a full tuition (but not segregated fee) waiver.

Although serving as a teaching assistant is not a requirement of the chemistry department at this time, teaching can be an important part of the graduate training you receive. Most students will serve at least two semesters as a teaching assistant, and many will serve for two years. Whether or not an individual student will be appointed as a teaching assistant, research assistant, trainee or fellow depends on the availability of funding from the major professor, and eligibility for traineeships and fellowships from other sources.
REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/#policiesandrequirementstext), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION

<table>
<thead>
<tr>
<th>Mode of Instruction Definitions</th>
<th>Face to Face</th>
<th>Evening/Weekend</th>
<th>Online</th>
<th>Hybrid</th>
<th>Accelerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face to Face</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Evening/Weekend</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Online</td>
<td>No</td>
<td>No</td>
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<td>No</td>
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<tr>
<td>Hybrid</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Accelerated</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Mode of Instruction Definitions

Evening/Weekend: These programs are offered in an evening and/or weekend format to accommodate working schedules. Enjoy the advantages of on-campus courses and personal connections, while keeping your day job. For more information about the meeting schedule of a specific program, contact the program.

Online: These programs are offered primarily online. Many available online programs can be completed almost entirely online with all online programs offering at least 50 percent or more of the program work online. Some online programs have an on-campus component that is often designed to accommodate working schedules. Take advantage of the convenience of online learning while participating in a rich, interactive learning environment. For more information about the online nature of a specific program, contact the program.

Hybrid: These programs have innovative curricula that combine on-campus and online formats. Most hybrid programs are completed on-campus with a partial or completely online semester. For more information about the hybrid schedule of a specific program, contact the program.

Accelerated: These on-campus programs are offered in an accelerated format that allows you to complete your program in a condensed time-frame. Enjoy the advantages of on-campus courses with minimal disruption to your career. For more information about the accelerated nature of a specific program, contact the program.

CURRICULAR REQUIREMENTS

Minimum Credit Requirement

51 credits

Minimum Residence Credit Requirement

32 credits

Minimum Graduate Coursework Requirement

Half of degree coursework (26 credits out of 51 total credits) must be completed graduate-level coursework; courses with the Graduate Level Coursework attribute are identified and searchable in the university’s Course Guide.

Overall Graduate GPA Requirement

3.00 GPA required.

Other Grade Requirements

The Graduate School requires an average grade of B or better in all coursework (300 or above, not including research credits) taken as a graduate student unless conditions for probationary status require higher grades. Grades of Incomplete are considered to be unsatisfactory if they are not removed during the next enrolled semester.

Assessments and Examinations

Doctoral students are required to take a comprehensive preliminary/oral examination after they have cleared their record of all Incomplete and Progress grades (other than research and thesis). Deposit of the doctoral dissertation in the Graduate School is required.

Language

There are currently no language requirements to obtain Requirements the Ph.D. in Chemistry.

Doctoral Minor/Breadth Requirements

Doctoral students must complete a doctoral minor.

REQUIRED COURSES

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 901</td>
<td>Seminar-Teaching of Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 607</td>
<td>Laboratory Safety</td>
<td>1</td>
</tr>
</tbody>
</table>

Each student must complete CHEM 901 Seminar-Teaching of Chemistry in the fall of their first year, and CHEM 607 Laboratory Safety in the spring of their first year.

The Department of Chemistry recognizes 6 paths to the Ph.D. in Chemistry; each path has specific required courses, called their core courses, and other path-specific requirements.

Analytical Chemistry Track

Select two of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 621</td>
<td>Instrumental Analysis</td>
<td>3-4</td>
</tr>
<tr>
<td>CHEM 920</td>
<td>Seminar-Analytical Chemistry</td>
<td>0</td>
</tr>
</tbody>
</table>

CHEM 622 Organic Analysis

CHEM 623 Experimental Spectroscopy

CHEM 624 Electrochemistry

CHEM 625 Separations in Chemical Analysis

CHEM/GENETICS 626 Genomic Science

CHEM/BMOLCHEM 627 Methods and Technologies for Protein Characterization

CHEM 628 Chemical Instrumentation: Design and Control Applications

CHEM 630 Selected Topics in Analytical Chemistry

- Every semester until you reach dissertation status, enroll in and attend CHEM 920 Seminar-Analytical Chemistry
- During the spring semester of the second year, complete the written Thesis Background Oral (TBO) and oral defense.
- During the spring semester of the third year, complete the written Research Proposal (RP) and oral defense.
- By May of the fourth year, complete an oral presentation to your thesis committee.
These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

**Chemical Biology Track**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CHEM/BIOCHEM 704</td>
<td>Chemical Biology</td>
<td>2</td>
</tr>
</tbody>
</table>

Select any one of the following for the maximum credits offered:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 606</td>
<td>Physical Methods for Structure Determination</td>
<td></td>
</tr>
<tr>
<td>CHEM 621</td>
<td>Instrumental Analysis</td>
<td></td>
</tr>
<tr>
<td>CHEM 622</td>
<td>Organic Analysis</td>
<td></td>
</tr>
<tr>
<td>CHEM/BMOLCHEM 627</td>
<td>Methods and Technologies for Protein Characterization</td>
<td></td>
</tr>
<tr>
<td>CHEM 630</td>
<td>Selected Topics in Analytical Chemistry</td>
<td></td>
</tr>
<tr>
<td>CHEM/BIOCHEM 665</td>
<td>Biophysical Chemistry</td>
<td></td>
</tr>
<tr>
<td>CHEM 668</td>
<td>Biophysical Spectroscopy</td>
<td></td>
</tr>
</tbody>
</table>

• Before January 30 of the second year, submit the written Thesis Preliminary Report; before April 30, present the oral defense.

• At the end of the fall semester of the third year, complete the written Research Proposal; in the first two weeks of January, do the oral defense.

• In May of the fourth year, complete an oral presentation to the thesis committee.

These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

**Inorganic Chemistry Track**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 608</td>
<td>Symmetry, Bonding, and Molecular Shapes</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 713</td>
<td>Inorganic and Organometallic Chemistry of the Main Group Elements</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 900</td>
<td>Seminar-Inorganic Chemistry</td>
<td>0</td>
</tr>
</tbody>
</table>

Fulfill the minor requirements and at least 2 of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 606</td>
<td>Physical Methods for Structure Determination</td>
<td></td>
</tr>
<tr>
<td>CHEM 613</td>
<td>Chemical Crystallography</td>
<td></td>
</tr>
<tr>
<td>CHEM 630</td>
<td>Selected Topics in Analytical Chemistry (Chemistry of Inorganic Materials)</td>
<td></td>
</tr>
<tr>
<td>CHEM 714</td>
<td>Organometallic Chemistry of the Transition Elements</td>
<td></td>
</tr>
<tr>
<td>CHEM 801</td>
<td>Selected Topics in Inorganic Chemistry</td>
<td></td>
</tr>
</tbody>
</table>

• Every semester until you reach dissertator status, enroll in and attend CHEM 900 Seminar-Inorganic Chemistry

• By January 31 of the second year, complete the written Thesis Background Exam (TBE); complete the oral defense by the end of the spring semester.

• By January 31 of the third year, complete the written Research Proposal (RP); complete the oral defense by the end of the spring semester.

• During spring of the fourth year, complete an oral presentation at the weekly seminar series.

These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

**Organic Chemistry Track**

<table>
<thead>
<tr>
<th>Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>CHEM 641</td>
<td>Advanced Organic Chemistry</td>
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</tr>
<tr>
<td>CHEM 841</td>
<td>Advanced Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 940</td>
<td>Seminar-Organic Chemistry</td>
<td>0</td>
</tr>
</tbody>
</table>

Recommended courses, which may be taken as part of the minor:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>CHEM 843</td>
<td>Advanced Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 605</td>
<td>Spectrochemical Measurements</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 636</td>
<td>Topics in Chemical Instrumentation: Introduction to NMR</td>
<td></td>
</tr>
</tbody>
</table>

• Every semester until you reach dissertator status, enroll in and attend CHEM 940 Seminar-Organic Chemistry
• By January 31 of the second year, complete the written Thesis Background Oral (TBO); complete the oral defense by April 30.
• Complete the written Research Proposal (RP) by mid-December; complete the oral defense by mid-January.
• By May of the fourth year, complete an oral presentation to the thesis committee.

These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

### Physical Chemistry Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 661</td>
<td>Chemical and Statistical Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 675</td>
<td>Introductory Quantum Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 960</td>
<td>Seminar-Physical Chemistry</td>
<td>2</td>
</tr>
</tbody>
</table>

Complete at least 2 credits from the following:

- CHEM 654 Materials Chemistry of Polymers
- CHEM 664 Physical Chemistry of Macromolecules
- CHEM/BIOCHEM 665 Biophysical Chemistry
- CHEM 668 Biophysical Spectroscopy
- CHEM 762 Molecular Reaction Dynamics
- CHEM 763 Introduction to Molecular Spectroscopy
- CHEM 775 Electronic Structure of Molecules
- CHEM 777 Physical Chemistry of Surfaces
- CHEM 860 Selected Topics in Physical Chemistry
- CHEM 864 Statistical Mechanics
- CHEM/BIOCHEM 872 Selected Topics in Macromolecular and Biophysical Chemistry

• Every semester until you reach dissertator status, enroll in and attend CHEM 960 Seminar-Physical Chemistry
• During the Spring semester of the second year, complete the written Thesis Background Oral (TBO) and the oral defense.
• During the Spring semester of the third year, complete the written Research Proposal and oral defense.
• By May of the fourth year, complete an oral presentation to the thesis committee.

These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

### MAJOR-SPECIFIC POLICIES

**GRADUATE PROGRAM HANDBOOK**

The Graduate Program Handbook (http://chem.wisc.edu/content/graduate) is the repository for all of the program's policies and requirements.

### PRIOR COURSEWORK

**Graduate Work from Other Institutions**

With program approval, students are allowed to count no more than 12 credits of graduate coursework from other institutions. Coursework earned ten years or more prior to admission to a doctoral degree is not allowed to satisfy requirements.

**UW–Madison Undergraduate**

Up to 7 credits numbered 300 or above from a UW–Madison undergraduate career are allowed to count toward the minimum graduate degree credit requirement; if those 7 credits are numbered 700 or above from a UW–Madison undergraduate career, they are allowed to count toward the minimum graduate coursework requirement. **All credits so counted** must be over and above the minimum credits that were required by the original undergraduate degree. Coursework earned ten years or more prior to admission to a doctoral degree is not allowed to satisfy requirements.

**UW–Madison University Special**

With program approval, students are allowed to count no more than 15 credits of coursework numbered 300 or above taken as a UW–Madison special student toward the residence and degree credit requirements; if those 15 credits of coursework taken as a UW–Madison Special student are numbered 700 or above, they are allowed to count toward the minimum graduate coursework requirement. Coursework earned ten or more years prior to admission to a doctoral degree is not allowed to satisfy requirements.

### PROBATION

The Graduate School regularly reviews the record of any student who earned grades of BC, C, D, F, or Incomplete in a graduate course (300 or above), or grade of U in research credits. This review could result in academic probation with a hold on future enrollment or in being suspended from the Graduate School.

### ADVISOR / COMMITTEE

Every graduate student is required to have an advisor. An advisor is a faculty member, or sometimes a committee, from the major department responsible for providing advice regarding graduate studies. An advisor generally serves as the thesis advisor. In many cases, an advisor is assigned to incoming students. Students can be suspended from the Graduate School if they do not have an advisor.

To ensure that students are making satisfactory progress toward a degree, the Graduate School expects them to meet with their advisor on a regular basis.

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1 These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do not appear in the Graduate School admissions application, and they will not appear on the transcript.
A committee often accomplishes advising for the students in the early stages of their studies.

**CREDITS PER TERM ALLOWED**
15 credits

**TIME CONSTRAINTS**
Doctoral degree students who have been absent for ten or more consecutive years lose all credits that they have earned before their absence. Individual programs may count the coursework students completed prior to their absence for meeting program requirements; that coursework may not count toward Graduate School credit requirements.

A candidate for a doctoral degree who fails to take the final oral examination and deposit the dissertation within five years after passing the preliminary examination may be required to take another preliminary examination and to be admitted to candidacy a second time.

**OTHER**
All admitted Ph.D. graduate students receive tuition remission and a stipend, guaranteed for 10 semesters, as long as progress to the degree is made.

**PROFESSIONAL DEVELOPMENT**

**GRADUATE SCHOOL RESOURCES**
Take advantage of the Graduate School’s professional development resources (https://grad.wisc.edu/pd) to build skills, thrive academically, and launch your career.

**LEARNING OUTCOMES**

1. Articulates research problems, potentials, and limits with respect to theory, knowledge, and practice within an area of chemistry.

2. Formulates ideas, concepts, designs, and techniques beyond the current boundaries of knowledge within an area of chemistry.

3. Creates research and scholarship that makes a substantive contribution to an area of chemistry.

4. Demonstrates breadth within their learning experiences.

5. Advances the beneficial societal impacts of research in chemistry.

6. Communicates complex scientific ideas in a clear and understandable manner.

7. Fosters safe, ethical, and professional conduct.

**PEOPLE**

**PROFESSORS**
Berry, John
Blackwell, Helen
Brunold, Thomas
Burke, Steven
Burstyn, Judith (Chair)

Cavagnero, Silvia
Choi, Kyong-Shin
Coon, Joshua
Cui, Qiang
Ediger, Mark
Gellman, Samuel
Hamers, Robert
Hermans, Ivo
Jin, Song
Landis, Clark
McMahon, Robert
Moore, John
Nathanson, Gilbert
Record, Thomas
Schwartz, David
Shakhashiri, Bassam
Sibert, Edwin (Associate Chair)
Smith, Lloyd
Stahl, Shannon
Weisshaar, James
Woods, Claude
Wright, John
Yethiraj, Arun
Yoon, Tehshik
Zanni, Martin

**ASSOCIATE PROFESSORS**
Bertram, Timothy
Fredrickson, Daniel
Schmidt, Jordan
Schomaker, Jennifer

**ASSISTANT PROFESSORS**
Buller, Andrew
Garand, Etienne
Goldsmith, Randall
Wickens, Zachary

**AFFILIATE PROFESSORS**
Abbott, Nicholas (Professor of Chemical and Biological Engineering)
Forest, Katrina (Professor of Bacteriology)
Ge, Ying (Associate Professor of Cell and Regenerative Biology)
Gilbert, Pupa (Professor of Physics)
Golden, Jennifer (Assistant Professor of Pharmacy)
Gopalan, Padma (Professor of Materials Science and Engineering)
Jackson, Catherine (Assistant Professor of History of Science)
Kuech, Thomas (Professor of Chemical and Biological Engineering)
Li, Lingjun (Professor of Pharmacy)
Lynn, David (Professor of Chemical and Biological Engineering)
Mecozzi, Sandro (Associate Professor of Pharmacy)
Middlecamp, Catherine (Professor, Nelson Institute for Environmental Studies)
Pedersen, Joel (Professor of Soil Science)
Tang, Weiping (Associate Professor of Pharmacy)
Weibel, Douglas (Professor of Biochemistry)
Yu, Lian (Professor of Pharmacy)

**CHEMISTRY ELECTRONICS SHOP**
Goebel, William (Electronics Technician)
CHEMISTRY MACHINE SHOP
Martin, Mathew (Instrument Maker - Advanced)
Mullarkey, James (Instrument Maker - Advanced)
Myers, Steven (Machine Shop Supervisor)
Schneider, Kendall (Instrument Maker - Advanced)

PAUL BENDER CHEMISTRY INSTRUMENTATION CENTER (CIC)
Fry, Charles (Director of the NMR Laboratory)
Guzei, Ilia (Director of the X-Ray Laboratory)
Hofstetter, Heike (Assistant Director of the NMR Laboratory)
Shanks, Robert (Senior Instrument Technologist)
Vestling, Martha (Director of the Mass Spectrometry Laboratory)
Zhu, Lingchao (Instrument Technologist)

RESEARCH SUPPORT STAFF
Bates, Desiree (Computational Chemistry Leader)
Drier, Tracy (Master Glassblower)
McGuire, Paul (High Performance Computing Systems Administrator)
Silver, Alan (Computer Systems Administrator)