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

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).

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Deadline</td>
<td>December 15</td>
</tr>
<tr>
<td>Spring Deadline</td>
<td>The program does not admit in the spring.</td>
</tr>
<tr>
<td>Summer Deadline</td>
<td>The program does not admit in the summer.</td>
</tr>
<tr>
<td>GRE (Graduate Record</td>
<td>Required.</td>
</tr>
<tr>
<td>Examinations)</td>
<td></td>
</tr>
</tbody>
</table>

English Proficiency Test
Every applicant whose native language is not English or whose undergraduate instruction was not in English must provide an English proficiency test score and meet the Graduate School minimum requirements (https://grad.wisc.edu/apply/requirements/#english-proficiency).

Other Test(s) (e.g., GMAT, MCAT) n/a

Letters of Recommendation Required 3

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.

FUNDING

GRADUATE SCHOOL RESOURCES

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 to Face</th>
<th>Evening/Weekend</th>
<th>Online</th>
<th>Hybrid</th>
<th>Accelerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</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

**Requirements Detail**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credit</th>
<th>Minimum</th>
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</thead>
<tbody>
<tr>
<td>Graduate Credit</td>
<td></td>
<td>51</td>
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<tr>
<td>Residence Credit</td>
<td></td>
<td>32</td>
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### REQUIRED COURSES

#### Analytical Chemistry Track

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

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

Select two of the following:

- 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 dissertator 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.

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.

Chemical Biology Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM/</td>
<td>Chemical Biology</td>
<td>3</td>
</tr>
<tr>
<td>BIOCHEM</td>
<td></td>
<td></td>
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</tbody>
</table>

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

- CHEM 606 Physical Methods for Structure Determination
- CHEM 621 Instrumental Analysis
- CHEM 622 Organic Analysis
- CHEM/ BMOLCHEM 627 Methods and Technologies for Protein Characterization
- CHEM 630 Selected Topics in Analytical Chemistry
- CHEM/ BIOCHEM 665 Biophysical Chemistry
- CHEM 668 Biophysical Spectroscopy

• 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.

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Chemical Biology Track

<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>
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</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>

• 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.

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Materials Chemistry Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>CHEM 613</td>
<td>Chemical Crystallography</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 624</td>
<td>Electrochemistry</td>
<td>2-3</td>
</tr>
<tr>
<td>CHEM 630</td>
<td>Selected Topics in Analytical Chemistry</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 652</td>
<td>Chemistry of Inorganic Materials</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 653</td>
<td>Chemistry of Nanoscale Materials</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 654</td>
<td>Materials Chemistry of Polymers</td>
<td>2-3</td>
</tr>
<tr>
<td>CHEM 664</td>
<td>Physical Chemistry of Macromolecules</td>
<td>2-3</td>
</tr>
<tr>
<td>CHEM 842</td>
<td>Advanced Organic Chemistry</td>
<td>1-3</td>
</tr>
</tbody>
</table>

• Every semester until you reach dissertator status, enroll in and attend Materials seminars
• During the Spring semester of the second year, complete the written Thesis Preliminary Exam and the oral defense.
• During the Spring semester of the third year, complete the written Research Proposal and the oral defense.
• About 1 year before you are planning on completing the PhD, schedule a thesis planning meeting with your committee.

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Materials Chemistry Track

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<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>
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</table>

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

- CHEM 606 Physical Methods for Structure Determination
- CHEM 613 Chemical Crystallography
- CHEM 630 Selected Topics in Analytical Chemistry (Chemistry of Inorganic Materials)

Organic Chemistry Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 641</td>
<td>Advanced Organic Chemistry</td>
<td>3</td>
</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:

CHEM 714 Organometallic Chemistry of the Transition Elements
CHEM 801 Selected Topics in Inorganic Chemistry
Complete at least 2 credits from the following:

- CHEM 960 Seminar-Physical Chemistry
- CHEM 675 Topics in Chemical Instrumentation: Introduction to NMR
- CHEM 661 Chemical and Statistical Thermodynamics
- CHEM 675 Introductory Quantum Chemistry
- CHEM 960 Seminar-Physical Chemistry

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.

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### Physical Chemistry Track 1

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<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>
<tr>
<td>CHEM 654</td>
<td>Materials Chemistry of Polymers</td>
<td></td>
</tr>
<tr>
<td>CHEM 664</td>
<td>Physical Chemistry of Macromolecules</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>
<tr>
<td>CHEM 762</td>
<td>Molecular Reaction Dynamics</td>
<td></td>
</tr>
<tr>
<td>CHEM 763</td>
<td>Introduction to Molecular Spectroscopy</td>
<td></td>
</tr>
<tr>
<td>CHEM 775</td>
<td>Electronic Structure of Molecules</td>
<td></td>
</tr>
<tr>
<td>CHEM 777</td>
<td>Physical Chemistry of Surfaces</td>
<td></td>
</tr>
<tr>
<td>CHEM 860</td>
<td>Selected Topics in Physical Chemistry</td>
<td></td>
</tr>
<tr>
<td>CHEM 864</td>
<td>Statistical Mechanics</td>
<td></td>
</tr>
<tr>
<td>CHEM/ BIOCHEM 872</td>
<td>Selected Topics in Macromolecular Biophysical Chemistry</td>
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</tr>
</tbody>
</table>

- 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.

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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.

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

Bertram, Timothy
Blackwell, Helen
Brunold, Thomas
Burke, Steven
Burstyn, Judith (Chair)
Cavagnero, Silvia
Choi, Kyoung-Shin
Coon, Joshua
Ediger, Mark
Fredrickson, Daniel
Gellman, Samuel
Hamers, Robert
Hermans, Ivo
Jin, Song
Landis, Clark
McMahon, Robert
Moore, John
Nathanson, Gilbert
Record, Thomas
Schmidt, Jordan
Schomaker, Jennifer
Schwartz, David
Shakhashiri, Bassam
Sibert, Edwin (Associate Chair)
Smith, Lloyd
Stahl, Shannon
Weisshaar, James
Weix, Daniel
Woods, Claude
Wright, John
Yethiraj, Arun
Yoon, Tehshik
Zanni, Martin

**ASSOCIATE PROFESSORS**

Boydston, Andrew
Garand, Etienne
Goldsmith, Randall

**ASSISTANT PROFESSORS**

Buller, Andrew
Martell, Jeffrey
Wickens, Zachary

**AFFILIATE PROFESSORS**

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)
Gong, Shaoqin Sarah (professor of Biomedical Engineering)
Gopalan, Padma (Professor of Materials Science and Engineering)
Hoskins, Aaron (Associate Professor of Biochemistry)
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 (Professor of Pharmacy)
Middlecamp, Catherine (Professor, Nelson Institute for Environmental Studies)
Pedersen, Joel (Professor of Soil Science)
Tang, Weiping (Professor of Pharmacy)
Yu, Lian (Professor of Pharmacy)

**CHEMISTRY ELECTRONICS SHOP**
Thompson, Blaise (Instrument Tech)

**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 (Associate Director of the NMR Laboratory)
Shanks, Robert (Senior Instrument Technologist)
Vestling, Martha (Director of the Mass Spectrometry Laboratory)

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