Chemistry

The Wiess School of Natural Sciences

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Distinguished Faculty Fellows
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Ken A. Smith

Senior Faculty Fellow
Bruce R. Johnson

Faculty Fellow
Daniel Colbert

Visiting Professor
Raphael Levine

Degrees Offered: B.A., B.S., M.A., Ph.D.

Recognizing the wide range of studies encompassed by chemistry, the department encourages undergraduates to explore offerings in other departments such as mathematics, computational and applied mathematics, biochemistry, and physics as well as upper-level courses in chemistry. An interdepartmental major is offered in chemical physics. Taking advantage of the department's extensive facilities, each B.S. degree candidate carries out a program of individual research under the supervision of a faculty member.

Graduate studies emphasize individual research, together with a fundamental understanding of chemistry beyond the students' specific interests. Faculty research interests include the synthesis and biosynthesis of organic natural products; the synthesis of small cycloalkanes, molecular recognition, and biological catalysis; bioinorganic and organometallic chemistry; main group element and transition metal chemistry; the chemistry of group 13 (III) elements; high-pressure and high-temperature chemistry; fluorine chemistry; chemical vapor deposition; the design of nanophase solids; molecular photochemistry and photophysics; infrared kinetic spectroscopy, laser and NMR spectroscopy; the study of oriented molecular beams; theoretical and computational

chemistry; and the study of giant fullerene molecules carbon nanotubes and their derivatives, polymer synthesis and characterization, molecular electronics, and molecular machines.

Degree Requirements for B.A. in Chemistry

For general university requirements, see Graduation Requirements (pages 16–18). Students choosing to receive a B.A. in Chemistry must have a total of at least 120 semester hours at graduation, including the following courses required of all majors.

Core Courses

Chemistry

CHEM 121/122 *General Chemistry* with Laboratory
(or CHEM 151/152 *Honors Chemistry* with Laboratory*)*
CHEM 211/212 *Organic Chemistry*
CHEM 215 *Organic Chemistry Lab*
CHEM 311/312 *Physical Chemistry*
CHEM 351 *Introductory Module in Experimental Chemistry I*
CHEM 352 *Introductory Module in Experimental Chemistry II*
CHEM 353 *Introductory Module in Analytical Methods*
CHEM 360 *Inorganic Chemistry*

Mathematics

MATH 101/102 *Single Variable Calculus I* and *II*
(or MATH 121/122)
MATH 211 *Ordinary Differential Equations and Linear Algebra*
MATH 212 *Multivariable Calculus*
(or MATH 221/222 *Honors Calculus III* and *IV)*

Physics

PHYS 101 or 111 *Mechanics*
PHYS 102 or 112 *Electricity and Magnetism*

Other

NSCI 230 *Computation in the Natural Sciences* (or equivalent)

Additional Lecture Courses

At least 1 course from the following:

CHEM 401 *Advanced Organic Chemistry*
CHEM 430 *Quantum Chemistry*
CHEM 495 *Transition Metal Chemistry*

Additional Laboratory Courses

At least 3 advanced laboratory module credit hours from the following list:

CHEM 373 *Advanced Module in Fullerence Chemistry*
CHEM 374 *Advanced Module in Synthetic Chemistry*
CHEM 375 *Advanced Module in Inorganic Chemistry*
CHEM 376 *Advanced Module in Materials Chemistry*
CHEM 377 *Advanced Module in Catalysis*
CHEM 381 *Advanced Module in Physical Chemistry, A*
CHEM 382 *Advanced Module in Physical Chemistry, B*
CHEM 383 *Advanced Module in Instrumental Analysis, A*
CHEM 385 *Advanced Module in Polymer Chemistry*
CHEM 391 *Advanced Module in Catalysis*

To ensure that students receive suitable breadth in their laboratory experience, advanced module selections must be approved by the student's major committee. Other advanced laboratory courses from chemically related disciplines (biochemistry, materials science, environmental engineering, etc.) may be substituted for these advanced modules, with approval of the committee. Chemistry majors may also substitute 2 advanced organic laboratory module credit hours for CHEM 215, with approval of the committee. Three hours of CHEM 491 (taken for one entire semester) may

be substituted for 1 advanced laboratory module if no other CHEM 491 credit is taken in the same semester.

Students in the chemistry B.A. major must satisfy the university distribution requirements and complete no fewer than 64 semester hours in addition to the departmental requirements for the chemistry major, giving a minimum total of 120 hours for graduation.

Degree Requirements for B.S. in Chemistry

The core, math, physics, and NSCI 230 requirements for the B.S. degree are the same as those for the B.A. degree. PHYS 201 Waves and Optics and PHYS 202 Modern Physics are recommended but not required.

In addition, the B.S. degree requires the following additional course and laboratory work:

- 2 courses from the **Additional Lecture Courses** list
- 3 advanced modules from the **Additional Laboratory Courses list**. As with the B.A. degree, 2 advanced laboratory modules may be substituted for CHEM 215 with departmental approval.
- At least 3 semester hours in undergraduate research (CHEM 491) in no less than 2-hour segments. With departmental approval, students may satisfy this requirement with HONS 470/471, which requires participation in CHEM 491 meetings. Students may also satisfy 3 of the 6 required hours in upper-level courses with additional research.
- 6 hours credit in upper-level courses (300 level or higher) in chemistry, mathematics, computational and applied mathematics, physics, biochemistry, or other subjects with adviser approval.

Students in the chemistry B.S. major must satisfy the distribution requirements and complete no fewer than 60 semester hours in addition to the departmental requirements for the chemistry major, giving a minimum total of 128 hours for graduation.

American Chemical Society Certification. The Rice Department of Chemistry is on the approved list of the Committee on Professional Training of the American Chemical Society and so can certify that graduates have met the appropriate standards. The B.A. degree is not certifiable. For certification, students must complete:

- All degree requirements for the B.S. degree listed above
- CHEM 495 *Transition Metal Chemistry*
- A department-approved course in biochemistry
- 9 hours total in upper-level courses from chemistry, physics, mathematics, computational and applied mathematics, biochemistry, or other courses in science or engineering with the approval of the department. The required course in biochemistry listed above counts toward this total.

A foreign language, preferably German, is recommended.

Chemical Physics Major. The chemical physics major leading to a B.S. degree is offered in conjunction with the Department of Physics; faculty advisers are Professor Hutchinson in chemistry and Professor Stevenson in physics. Students take upper-level courses in both chemistry and physics, focusing on the applications of physics to chemical systems. Students majoring in chemical physics must complete the following courses.

Core Courses

Chemistry

CHEM 121/122 *General Chemistry with Laboratory*
or CHEM 151/152 *Honors Chemistry with Laboratory*
CHEM 211 *Organic Chemistry*
CHEM 311/312 *Physical Chemistry*

Physics

PHYS 101 or 111 *Mechanics*
PHYS 102 or 112 *Electricity and Magnetism*
PHYS 201 *Waves and Optics*
PHYS 202 *Modern Physics*
PHYS 231 *Elementary Physics Lab II*
PHYS 301 *Intermediate Mechanics*
PHYS 302 *Intermediate Electrodynamics*

Mathematics

MATH 101/102 *Single Variable Calculus I* and *II*
or MATH 121/122
MATH 211 *Ordinary Differential Equations and Linear Algebra*
MATH 212 *Multivariable Calculus*
or MATH 221/222 *Honors Calculus III* and *IV*

Additional Courses

1 course from CHEM 212 or CHEM 360
2 courses from PHYS 311, PHYS 312, CHEM 430, or CHEM 415
6 hours from CHEM 215, CHEM 351, CHEM 352, CHEM 373–391, PHYS 331, or PHYS 332
2 courses from NSCI 230, CAAM 211, CAAM 212, or mathematics or computational and applied mathematics at the 300 level or above

Admission Requirements for Accelerated B.S./Ph.D. Program in Chemistry

The high level of training provided in the Rice B.S. program enables certain specially-qualified undergraduates to enter an accelerated program that allows them to complete a Ph.D. degree within two or three years after receiving their B.S. degree. Students electing this option must begin their research during the summer following their junior year and continue the research by taking CHEM 491 during their senior year.

Degree Requirements for M.A. and Ph.D. in Chemistry

For general university requirements, see Graduate Degrees (pages 60–65). Students who have completed course work equivalent to that required for a B.A. or B.S. in chemistry may apply for admission to the Ph.D. program. For more information, see Admission to Graduate Study (pages 65–66).

M.A. Program. Students are NOT normally admitted to study for an M.A. degree. However, this degree is sometimes awarded to students who do not wish to complete the entire Ph.D. program. Candidates for the M.A. degree must:

- Complete 6 one-semester courses
- Produce a thesis that presents the results of a program of research approved by the department
- Pass a final oral examination

Students who are admitted to Ph.D. candidacy may apply for an automatic master's degree.

Ph.D. Program. The Ph.D. is primarily a research degree. Graduate education is aimed at developing each student's ability to conduct independent, creative research and to develop habits of inquiry that will ensure continuing intellectual development throughout their careers. The completion of the Ph.D. program is expected to take no more than five years of full-time study. Ph.D. students must:

- Complete 6 one-semester graduate-level courses. No courses are specified. Courses are chosen with the approval of the student's advisory committee and/or faculty adviser. Courses should be at the 400 level or higher. Certain 300 level courses in other departments may be acceptable with departmental approval.
- Pass an examination involving a written and oral presentation of an original research proposal. The written proposal must conform to the format and guidelines established by the department. The guidelines are available in the department office. The proposal must be given to the committee at least one week before the date of the examination. The examination, including any follow-up work deemed necessary by the committee, must be completed within two months of the end of the student's fourth semester.
- In addition to the course work listed above, the student must participate in CHEM 600, 601, or 602 each semester that the student is in residence.
- The student is required to participate in CHEM 700, Teaching Practicum, for four semesters.
- Submit and defend a publishable thesis that represents an original and significant contribution to the field of chemistry.

See CHEM (pages 287–291) in the Courses of Instruction section.