

Chemistry and Biochemistry

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Undergraduate Advisors:

Faculty advisors in the Department of Chemistry and Biochemistry are as follows:

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Degrees Offered: Bachelor of Science (BS), Bachelor of Arts (BA), Master of Science (MS), Doctor of Philosophy (PhD) in Chemistry; MS and PhD in Biochemistry; BS and BA in Chemistry Teaching; BS and BA in Composite Teaching—Physical Science (Chem)

Undergraduate emphases: BS—Professional Chemistry, Biochemistry, Environmental Chemistry, Chemical Education, Life Science

Graduate specializations: Chemistry—Analytical Chemistry, Inorganic Chemistry, Organic Chemistry, Physical Chemistry

Undergraduate Programs

Objectives

Chemistry is a subject that addresses the properties of materials and the transformations that they undergo. Especially important are aspects of energy and structure related to chemical reactivity. Consequently, students of many disciplines take courses in chemistry to learn about the behavior of the substances they will use or reference. The Department of Chemistry and Biochemistry offers a wide variety of courses for those whose majors and/or anticipated careers require a knowledge of chemistry. These areas of study include nutrition, engineering, biology, agriculture, natural resources, medicine, law, and education, to name a few. Many students also choose chemistry as an elective course to better prepare themselves as citizens in a technological world.

The **Bachelor of Science Degree** entails considerable specialization in chemistry and related areas. The BS emphases require a common core of courses, but allow for a different concentration of advanced work according to the interests and career objectives of the student. The **BS with Professional Chemistry Emphasis**, **BS with Environmental Chemistry Emphasis**, and **BS with Biochemistry Emphasis** degrees meet the requirements for certification by the American Chemical Society (ACS). The certified degree emphases provide excellent preparation for immediate entry into the job market or for graduate school in chemistry, biochemistry, chemical engineering, molecular biology, nutrition, food science, materials science, and a wide variety of other fields. ACS certification in **Chemical Education** is available to students who complete an ACS-certified program, together with the Professional Education program in secondary education. The **BS with Life Science Emphasis** degree is popular for students wishing to go on to medical or dental graduate programs. The life science emphasis is particularly appropriate for **premedical** and **predental** students who want a strong base for understanding the nature of chemical reactions in the body and the behavior of the drugs they will prescribe, or who want an attractive alternative should they decide ultimately not to pursue medical or dental school. The **Chemistry Teaching Major** or the **Composite Teaching Major in Physical Science** are available to those who want a career in secondary education. The BA degree is an excellent choice for students with an interest in studying **law** or **business** and who have an interest in science.

The core of the program utilizes year-long sequences of classes. The first-year sequence introduces the basic principles of chemistry, as well as most of the major concepts of the science. The second year explores in greater depth the characteristics of carbon-based compounds that serve as the backbone for the chemistry of life; for most drugs and medicines; for petroleum; for most fibers, paints, and plastics; and for many other commercial products. The third year examines in greater depth the models, theories, and mathematical interpretation of the structures, rates of change, energetics, and other properties of chemicals. In addition, one-semester courses examining the chemistry of life processes, the behavior of inorganic substances, and the analysis of the composition of substances are required. Many of the sequences have associated laboratory courses where students get hands-on practice. Here they synthesize compounds, measure physical properties, analyze samples, and determine structural features of compounds, using modern techniques and instrumentation. The requirements of the BS and BA degrees in chemistry, along with University and University Studies requirements, are summarized here. The specific requirements for the teaching major and for the composite teaching major in physical science are also included.

Students are also urged to study these requirements and to visit with their advisor on a regular basis about progress toward the completion of their degrees or for any questions regarding complementary courses and career goals.

General Requirements

Admission Requirements. First-year students admitted to USU in good standing qualify for admission to this major. Transfer students from other institutions need a 2.2 transfer GPA, and students transferring from other USU programs need a 2.0 total GPA for admission to this major in good standing.

Students interested in studying chemistry should take high school mathematics courses that will enable them to start calculus during their first semester at USU. High school coursework in chemistry and physics is also desirable. AP credit in chemistry may be counted toward the degree. For details, contact the departmental advising faculty.

No CHEM prefix course may be applied toward graduation with any major or minor in chemistry with an earned grade of less than C-. Except for CHEM 4800 and 4990, no CHEM prefix course may be taken on a *Pass/Fail* basis. No CHEM prefix course may be repeated more than one time to improve the grade to a C- or better. A student dropped from the chemistry program for failure to meet this standard may appeal to the departmental Curriculum Committee for readmission.

Chemistry Core Curriculum

In addition to the University Studies requirements for graduation, chemistry majors take a series of core courses spread across a traditional four-year period. The completion of the chemistry core also covers the College of Science requirements for graduation.

First Year: CHEM 1210, 1220, 1230, 1240; MATH 1210, 1220.

Second Year: CHEM 2310, 2320, 2330, 2340, 3510, 3520, 3600, 3610; PHYX 2210, 2220; MATH 2210.

Third Year: CHEM 3060, 3070, 3080, 3090, 5640, 5650, 5700; MATH 2250 *or* STAT 3000 (optional for Chemistry Teaching Major).

Fourth Year: CHEM 4990.

Chemistry Requirements

Professional Chemistry Emphasis (ACS Certified). In addition to the chemistry core, CHEM 5520, 5530; and 6 advanced electives, as approved by the department, are required.

Biochemistry Emphasis (ACS Certified). In addition to the chemistry core, CHEM 5710, 5720; BIOL 1210 and four advanced Biology elective courses, as approved by the department, are required.

Environmental Chemistry Emphasis (ACS Certified). In addition to the chemistry core, CHEM 5670, 5680; and 9 credits of approved environmental courses from outside the department are required.

Chemical Education Emphasis (ACS Certified). In addition to the chemistry core, teaching licensure courses as specified by the Department of Secondary Education (35 cr.); and teaching minor from outside the Department of Chemistry and Biochemistry (12-16 cr.) are required.

BS Degree with Honors. This option can be met by completing any ACS certified program and by meeting the following requirements: Minimum GPA of 3.50 in chemistry courses; overall GPA of 3.30; 13 credits of honors work as follows: 3-6 credits of CHEM 4800H (Research Problems), 3 credits chosen from CHEM 2320H, 3070H, 5640H, or 5700H, 1 credit of CHEM 4990H (Undergraduate Seminar), and 3-6 credits selected from Honors courses numbered 3000 or above in chemistry or related subjects, as appropriate. Three credits may be selected from chemistry courses numbered 6010 or above. Students must be admitted to Honors through the Honors Program Office.

BS in Chemistry, Life Science Emphasis. In addition to the chemistry core (with the exception of CHEM 5640, 5650), BIOL 1210; BIOL 1220 or 2000; BIOL 3200 or 3300; and CHEM 5710, 5720 are required.

BA in Chemistry: In addition to the chemistry core (with the exception of CHEM 5640, 5650), CHEM 5520 or 5640; and two years of foreign language are required.

Chemistry Teaching Major: In addition to the chemistry core (minus the MATH 2250 or STAT 3000 courses), SCI 4300, teacher licensure courses offered by Secondary Education (35 cr.), and a teaching minor from outside the Department of Chemistry and Biochemistry (12-16 cr) are required. An overall 2.75 GPA in a minimum of 60 semester credits of approved University coursework is required for admission into the Secondary Teacher Education Program (STEP). A minimum overall GPA of 2.75 is required for graduation. Specific for admission to this program, a student must have at least a 2.75 GPA in CHEM 1210, 1220, 1230, and 1240.

Composite Teaching Major in the Physical Sciences. This degree is available through the Chemistry and Biochemistry or Physics departments. Students with a Composite Teaching Major in Physical Sciences should plan their programs carefully in order to meet the upper-division requirement for graduation. An overall 2.75 GPA in a minimum of 60 semester credits of approved University coursework is required for admission into the Secondary Teacher Education Program (STEP). A minimum overall GPA of 2.75 is required for graduation.

Specific for admission to this program, a student must have at least a 2.75 GPA in the following chemistry and physics courses: CHEM 1210, 1220, 1230, 1240; PHYX 2110, 2120, *or* PHYX 2210, 2220 (preferred). *This program does not include many aspects of the Chemistry Core.*

Required Courses: CHEM 1210, 1220, 1230, 1240; CHEM 2300 or 2310; CHEM 2330; PHYX 1000; PHYX 1030 or 3030; PHYX 2110 and 2120, *or* PHYX 2210 and 2220; MATH 1210, 1220; STAT 3000; SCI 4300; BIOL 1010; GEOL 1150; BMET 2000; and teacher licensure courses from Secondary Education (35 cr.). A teaching minor is optional for the Composite Teaching Major in the Physical Sciences.

Chemistry Minor. In addition to CHEM 1210, 1220, 1230, and 1240, 10 additional credits in Chemistry prefix courses at the 2000 level or higher are required (either CHEM 2300 or 2310 may be included).

Chemistry Teaching Minor. In addition to CHEM 1210, 1220, 1230, 1240, CHEM 2300 or 2310, and CHEM 2330, 3 additional credits selected from the following are required: CHEM 2320 (if CHEM 2310 has been previously selected), CHEM 3060, *both* CHEM 3510 and 3520, CHEM 3600, CHEM 3650, or CHEM 3700.

Career Opportunities

Chemistry degree holders work in a wide variety of professions, from physicians, lawyers, and professors to research/development, sales, or production in the chemical, oil, pharmaceutical, metals, electronic, and biochemical industries. Government at all levels employs chemists, including the federal Departments of Defense, Health and Human Services, Agriculture, and Interior. A graduate with a bachelor's degree often begins work in chemical

analysis or sales or may assist senior chemists in research and development. A graduate with a teaching major or chemistry education emphasis may teach in public schools. A graduate degree is usually needed to direct research or teach at the university level. Degree holders from the Department of Chemistry and Biochemistry have had excellent success in obtaining support for graduate studies, often at very prestigious institutions, and in obtaining employment directly following graduation. For further information, students should contact their advisor.

Graduate Programs

Admissions Requirements

See the general admission requirements for the School of Graduate Studies (pages 90-91). All applicants should have a bachelor's degree or master's degree in chemistry or biochemistry from an accredited institution. Appropriate undergraduate preparation is expected; applicants not fully prepared may be admitted with the condition that appropriate undergraduate courses are taken as necessary.

Applications are especially encouraged during the spring semester for expected admission in the following fall semester. However, the Graduate Recruiting and Admissions Committee screens applications throughout the year. Detailed information about the graduate programs and faculty research activities can be found on the Internet at <http://www.chem.usu.edu>.

Degree Programs

Master of Science. To earn an MS in chemistry or biochemistry, a student must meet the general requirements of the School of Graduate Studies (see pages 94-95), conduct research under the direction of a major professor and write a thesis acceptable to a supervisory committee (Plan A) or write a review-of-literature paper (Plan B), and pass an oral examination that is principally a defense of the thesis or the Plan B paper.

Qualified undergraduate chemistry majors at USU may apply in the third year for admission to the MS program. Students may be admitted to this MS program if they have a *B* average in chemistry, physics, and mathematics courses, and have completed the one-year sequences in general, organic, and physical chemistry (including labs), two courses in analytical or inorganic chemistry, two semesters of physics, math through MATH 2210, and at least 15 credits of their University Studies requirements.

Students should consult with the chairman of the Graduate Recruiting and Admissions Committee to be certain of their eligibility for this program. The chairman will then submit an application to the department head and to the School of Graduate Studies for approval. Students must earn a satisfactory grade on the GRE exam before the completion of the MS degree. All requirements for the BS degree must be completed within two semesters of admission. The MS coursework cannot include coursework counted toward the BS degree.

Doctor of Philosophy. To earn the PhD in chemistry or biochemistry, a student must successfully complete a core curriculum of courses and other courses as approved by a supervisory committee. In addition, preliminary examinations (both oral and written) must be passed and research in a field of specialization must

be conducted. The final requirement is the writing and defense of a dissertation before the student's supervisory committee.

Biochemistry Course Requirements. Every MS and PhD student in the biochemistry program must complete CHEM 6730, 6740, 6750, and 6760. In addition, all students must register for at least 2 credits of CHEM 6720 in the first semester of residence to participate in research training. Both MS and PhD students must complete a total of at least 15 credits in coursework, exclusive of seminar and research credit. The Program of Study is approved by the student's supervisory committee. A total of 30 credits is required for the MS degree, and a total of 90 credits is required for the PhD. Beginning students who already hold an MS degree need 60 credits to complete the PhD program.

Chemistry Course Requirements. Every MS and PhD student in the chemistry program must complete the courses required for their specialization: *Analytical*—CHEM 7600, 7610; *Inorganic*—CHEM 6500, 6510; *Organic*—CHEM 6300, 7300, 7310; or *Physical Chemistry*—CHEM 6010, 6020, 7020. Both MS and PhD students must complete a total of at least 15 credits in coursework, exclusive of seminar and research credit. The Program of Study is approved by the student's supervisory committee. A total of 30 credits is required for the MS degree and a total of 90 credits is required for the PhD. Beginning students who already hold an MS degree need 60 credits to complete the PhD program.

Financial Assistance

The department offers financial support to students in the form of teaching assistantships, research assistantships, and fellowships. All applications for admission to the School of Graduate Studies constitute an application for financial assistance; it is not necessary to file a separate request. Teaching assistantships are the principal means of support for first-year students. Inquiries about current support levels should be directed to the department main office. The department is responsible for the first nine months of stipend and tuition, with the remaining summer stipend and tuition usually being paid from faculty research funds. Teaching assistants devote no more than 12 contact hours per week directing undergraduate laboratories, leading recitation sections, and assisting students with questions during the regular fall and spring semesters. Research assistantships, funded from individual faculty research grants, support students conducting research related to the grant projects. Although first-year students are not normally supported as research assistants, well-prepared students may be eligible for research support at the discretion of their major professor.

Fellowships are awarded by the University to outstanding students solely on the basis of merit. The department encourages students with strong academic records to apply for the University fellowships and national awards, and will provide assistance in obtaining and submitting the appropriate forms. Additionally, several graduate awards are given each year to honor exemplary performance in research and teaching.

The College of Science recently established the Willard L. Eccles Foundation Science Fellowship. The \$15,000 per year, three-year stipend is competitively awarded to highly qualified science applicants. Students applying to the graduate program will be considered for this fellowship, and will be sent the necessary information. Application deadline for this fellowship is March 1.

Chemistry and Biochemistry Faculty

Trustee Professor

Ann E. Aust, biochemistry

Professors

Steven D. Aust, biochemistry

Stephen E. Bialkowski, analytical chemistry

Scott A. Ensign, biochemistry

David Farrelly, physical chemistry

Richard C. Holz, bioinorganic chemistry

Vernon D. Parker, physical organic chemistry

Steve Scheiner, computational chemistry

Lance C. Seefeldt, biochemistry

Professors Emeritus

William M. Moore, physical chemistry

Richard K. Olsen, organic chemistry

Grant G. Smith, organic chemistry

Jack T. Spence, inorganic chemistry

Associate Professors

Alexander I. Boldyrev, physical chemistry

Robert S. Brown, analytical chemistry

Bradley S. Davidson, organic chemistry

Alvan C. Hengge, organic chemistry

John L. Hubbard, inorganic chemistry

Assistant Professors

Lisa M. Berreau, inorganic chemistry

Cheng-Wei Tom Chang, organic chemistry

Joan M. Hevel, biochemistry

Philip J. Silva, analytical chemistry

Research Assistant Professors

Tapas Kar, physical chemistry

Yun Lu, organic chemistry

Lecturer

Douglas G. Harris

Course Descriptions

Chemistry and Biochemistry (CHEM), pages 365-367