

CHEMISTRY - BACHELOR OF ARTS (BA)

Chemistry major students are prepared for many different careers after graduation. About 50 percent of chemistry majors enter directly into industry or government positions that require scientific expertise, such as chemical, oil, electronics, mining and manufacturing industries, water districts, crime laboratories, biotechnology, health and safety, atmospheric science and environmental quality.

Approximately 25 percent of chemistry graduates are attracted by specialized graduate education in chemistry or biochemistry. Graduate work is often in one of the traditional areas of analytical, inorganic, organic or physical chemistry and, increasingly, in interdisciplinary areas such as atmospheric, bio-organic or organo-metallic chemistry, molecular biology, biotechnology and chemical physics for their advanced work. Another 25 percent of a typical graduating class goes on to professional school, pursuing advanced degrees in medicine, dentistry, pharmacy, law, business, engineering and computer science.

Career Services (<http://www.colorado.edu/careerservices/>) offers a number of programs and services designed to help students plan their career, including workshops, internships, and placement services after graduation. For an appointment with a career counselor or for more information call 303 492 6541, or stop by Center for Community, S440.

Announcements

See the undergraduate blog (<http://www.colorado.edu/chembio/undergraduate-blog/>) and second-floor Ekeley bulletin board for announcements and postings. Some examples of the information posted are:

- Main page: contact information and general announcements.
- Student opportunities: internship/job announcements, summer programs, events/programs offered by other campus offices and departments that may be of interest.
- Scholarship announcements: announcements of scholarships opportunities and information meetings.
- Seminars and conferences: seminar and conference announcements.
- Academic support: SASC workshop schedule, tutors, and other academic support opportunities.
- Career services: schedule of events offered by this office.
- Education abroad: announcements from education abroad about their programs and information meetings.
- Courses: information about new and/or interesting courses for core and elective credit.

Chemistry Honors Program

Opportunity is provided for qualified chemistry and chemistry/biochemistry double majors to participate in the departmental honors program and graduate with honors (*cum laude*, *magna cum laude*, or *summa cum laude*) in chemistry. Students interested in the honors program should contact the departmental honors advisor during their junior year.

American Chemical Society Certified Degree

The American Chemical Society maintains a certification program in which a student graduating with a specified minimum program is certified to the society upon graduation. To be certified, a graduate must satisfy requirements in addition to the minimum for graduation. The department offers this certificate for chemistry or chemistry/biochemistry double majors only. More information can be found in *J. Chem. ED.*, Vol. 92, pp. 965-968 (2015). Specific course requirements can be obtained in the Undergraduate Office, EKLC M199.

Research Opportunities Undergraduate Research Opportunities Program

The Undergraduate Research Opportunities Program (UROP) offers students a chance to work alongside a faculty sponsor on original research. Learn to write proposals, conduct research, pursue creative work, analyze data, and present the results. For more information please visit the Undergraduate Research Opportunities Program (<http://www.colorado.edu/suep/about-urop/>) website. Visit Other Funding Opportunities (<http://www.colorado.edu/suep/urop/other-funding/>) for a list of other funding opportunities for undergraduate students.

Independent Study

Independent study (CHEM 4901), provides an opportunity for a student to work on a research project with an individual faculty member outside of the regular class structure. This generally provides an experience much more like real-life chemistry or biochemistry, where new results are being sought and the outcome of the research is not known in advance. The student may have a totally independent project or may become part of a research team working at the forefront of science. In favorable cases the project may result in publication of the results of the independent study in the scientific literature. As part of the research team in a particular group the student will usually participate in group seminars and informal discussions with other members of the group.

Education Abroad

The experience of studying abroad can prove invaluable. For information about study abroad programs, visit the Education Abroad (<http://studyabroad.colorado.edu/>) website.

Teaching Certification

Chemistry majors can also earn certification as teachers through the School of Education. The program for a secondary school science-teaching certificate is challenging requiring a broad, strong background in science, as well as coursework in education and practice teaching. It usually requires at least five years of study. Students interested in teacher certification are encouraged to contact the School of Education (<http://www.colorado.edu/education/>).

Requirements Program Requirements

The chemistry major requires 30 credits of upper-division chemistry coursework, including courses in general, organic, physical and analytical/instrumental chemistry, as well as an introductory general chemistry sequence and ancillary work in calculus and physics.

Students must complete the general requirements of the College of Arts and Sciences and the required courses listed below. No more than 45

credits of CHEM and BCHM courses can be applied to the 120-credit minimum to graduate. All courses counted towards the major must be completed with a grade of C- or better and none of the courses may be taken for a pass/fail grade. The cumulative Grade Point Average (GPA) in courses that can count toward the major must be at least 2.0.

Transfer students who plan to take a chemistry major must complete at the Boulder campus a minimum of 12 credits of upper-division work covering at least two subdisciplines: organic, physical, analytical and inorganic for chemistry majors.

Students may want to consult each semester's Registration Handbook and Schedule of Courses (<http://www.colorado.edu/registrar/>) as well as the Professor Performance Guide (<http://www.colorado.edu/pba/fcq/>) for further information about course offerings and faculty.

Required Courses and Credits

| Code | Title | Credit Hours |
|------|-------|--------------|
|------|-------|--------------|

General Chemistry

Select one of the following general chemistry sequence options: 10

Option 1

| | |
|--------------------------|---|
| CHEM 1400 & CHEM 1401 | Foundations of Chemistry and Foundations of Chemistry Lab |
| CHEM 2100 & CHEM 2101 | Foundations of Chemistry 2 and Laboratory in Foundations of Chemistry 2 |

Option 2

| | |
|--------------------------|--|
| CHEM 1113 & CHEM 1114 | General Chemistry 1 and Laboratory in General Chemistry 1 |
| CHEM 1133 & CHEM 1134 | General Chemistry 2 and Laboratory in General Chemistry 2 |

Organic Chemistry

Organic Chemistry 1 Lecture

Choose one of the following lectures: 4

| | |
|---------------------------|---|
| CHEM 3451 or CHEM 3311 | Organic Chemistry 1 for Chemistry and Biochemistry Majors Organic Chemistry 1 |
|---------------------------|---|

Organic Chemistry 2 Lecture

Choose one of the following lectures: 4

| | |
|---|---|
| CHEM 3471 or BCHM 3491 or CHEM 3331 | Organic Chemistry 2 for Chemistry Majors Organic Chemistry 2 for Biochemistry Majors Organic Chemistry 2 |
|---|---|

Organic Chemistry Labs ¹

| | |
|--------------------------|--|
| CHEM 3321 & CHEM 3341 | Laboratory in Organic Chemistry 1 and Laboratory in Organic Chemistry 2 |
|--------------------------|--|

In addition, choose one or more of the following to satisfy the organic chemistry lab requirement:

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|---|---|
| CHEM 3381 or CHEM 4021 or CHEM 4901 | Laboratory in Advanced Organic Chemistry Inorganic Laboratory Independent Study in Chemistry |
|---|---|

Required Advanced CHEM Coursework

| | | |
|-----------|----------------------------|---|
| CHEM 4011 | Modern Inorganic Chemistry | 3 |
|-----------|----------------------------|---|

| | | |
|---------------------------|--|-----------|
| CHEM 4171 | Instrumental Analysis - Lecture and Laboratory 1 | 3 |
| CHEM 4181 | Instrumental Analysis - Lecture and Laboratory 2 | 3 |
| CHEM 4511 & CHEM 4581 | Physical Chemistry 1 and Physical Chemistry Lab 1 | 4 |
| CHEM 4531 & CHEM 4591 | Physical Chemistry 2 and Physical Chemistry Lab 2 | 5 |
| Total Credit Hours | | 40 |

Required Ancillary Coursework from Outside Chemistry

| Code | Title | Credit Hours |
|------|-------|--------------|
|------|-------|--------------|

Required Physics Courses

| | | |
|--------------------------|--|---|
| PHYS 1110 & PHYS 1120 | General Physics 1 and General Physics 2 | 8 |
| PHYS 1140 | Experimental Physics 1 | 1 |

Calculus 12-15

Complete three semesters of calculus (through Calculus 3):

| | |
|---------------------------|--|
| MATH 1300 or APPM 1350 | Calculus 1 Calculus 1 for Engineers |
| MATH 2300 or APPM 1360 | Calculus 2 Calculus 2 for Engineers |
| MATH 2400 or APPM 2350 | Calculus 3 Calculus 3 for Engineers |

Total Credit Hours 21-24

Recommended Chemistry Electives

All students, and especially those intending to go on to graduate school in chemistry, will benefit from additional advanced courses. Recommended electives include the following:

| Code | Title | Credit Hours |
|---|---|--------------|
| CHEM 3151 | Air Chemistry and Pollution | |
| CHEM 3251 | Sustainable Energy from a Chemistry Perspective | |
| CHEM 4021 | Inorganic Laboratory | |
| CHEM 4141 | Environmental Water and Soil Chemistry | |
| CHEM 4251 | Materials Chemistry and Properties | |
| CHEM 4261 | Organic Materials: Structures and Functions | |
| CHEM 4271 | Chemistry of Solar Energy | |
| BCHM 4611 | Principles of Biochemistry | |
| BCHM 4720 | Metabolic Pathways and Human Disease | |
| BCHM 4740 | Biochemistry of Gene Transmission, Expression and Regulation | |
| CHEM 4901 | Independent Study in Chemistry | |
| Graduate courses in various fields of chemistry | | |
| Advanced courses in mathematics or physics | | |

Graduating in Four Years

Consult the Four-Year Guarantee Requirements for information on eligibility. The concept of "adequate progress" as it is used here only refers to maintaining eligibility for the four-year guarantee; it is not a

requirement for the major. To maintain progress in chemistry students should declare the chemistry major in the first semester.

Students must consult with a major advisor to determine adequate progress toward completion of the major.

Recommended Four-Year Plan of Study

Through the required coursework for the major, students will fulfill all 12 credits of the Natural Sciences area of the Gen Ed Distribution Requirement, including the lab component, and the QRMS component of the Gen Ed Skills Requirement.

Year One

| Fall Semester | | Credit Hours |
|--|------------------------------|--------------|
| CHEM 1400 | Foundations of Chemistry | 4 |
| CHEM 1401 | Foundations of Chemistry Lab | 1 |
| MATH 1300 | Calculus 1 | 4-5 |
| or APPM 1350 | or Calculus 1 for Engineers | |
| Gen. Ed. Distribution course (example: Arts & Humanities) | | 3 |
| Gen. Ed. Skills course (example: Lower-division Written Communication) | | 3 |
| Credit Hours | | 15-16 |

Spring Semester

| | | |
|--|---|--------------|
| CHEM 3451 | Organic Chemistry 1 for Chemistry and Biochemistry Majors | 4 |
| CHEM 3381 | Laboratory in Advanced Organic Chemistry | 2 |
| MATH 2300 | Calculus 2 | 4-5 |
| or APPM 1360 | or Calculus 2 for Engineers | |
| Gen. Ed. Distribution/Diversity course (example: Social Sciences/US Perspective) | | 3 |
| Credit Hours | | 13-14 |

Year Two

| Fall Semester | | Credit Hours |
|---|--|--------------|
| CHEM 3471 | Organic Chemistry 2 for Chemistry Majors | 4 |
| CHEM 3381 | Laboratory in Advanced Organic Chemistry | 2 |
| PHYS 1110 | General Physics 1 ((Calculus-based)) | 4 |
| MATH 2400 | Calculus 3 | 4-5 |
| or APPM 2350 | or Calculus 3 for Engineers | |
| Gen. Ed. Distribution course (example: Arts & Humanities) | | 3 |
| Credit Hours | | 17-18 |

Spring Semester

| | | |
|---|--|-----------|
| CHEM 2100 | Foundations of Chemistry 2 | 4 |
| CHEM 2101 | Laboratory in Foundations of Chemistry 2 | 1 |
| PHYS 1120 | General Physics 2 | 4 |
| PHYS 1140 | Experimental Physics 1 | 1 |
| Gen. Ed. Distribution course (example: Arts & Humanities) | | 3 |
| Elective | | 3 |
| Credit Hours | | 16 |

Year Three

| Fall Semester | | Credit Hours |
|---------------|----------------------|--------------|
| CHEM 4511 | Physical Chemistry 1 | 3 |

| | | |
|--|--------------------------|-----|
| CHEM 4581 | Physical Chemistry Lab 1 | 1 |
| Gen. Ed. Distribution/Diversity course (example: Social Sciences/Global Perspective) | | 3 |
| Elective | | 3 |
| Elective | | 3 |
| Elective | | 3-0 |

Credit Hours 16-13

Spring Semester

| | | |
|--|--------------------------|---|
| CHEM 4531 | Physical Chemistry 2 | 3 |
| CHEM 4591 | Physical Chemistry Lab 2 | 2 |
| Gen. Ed. Distribution course (example: Arts & Humanities) | | 3 |
| Gen. Ed. Skills course (example: Upper-division Written Communication) | | 3 |
| Elective | | 3 |

Credit Hours 14

Year Four

Fall Semester

| | | |
|---|--|---|
| CHEM 4011 | Modern Inorganic Chemistry | 3 |
| CHEM 4171 | Instrumental Analysis - Lecture and Laboratory 1 | 3 |
| Gen. Ed. Distribution course (example: Social Sciences) | | 3 |
| Upper-division Elective | | 3 |
| Elective | | 3 |

Credit Hours 15

Spring Semester

| | | |
|---|--|---|
| CHEM 4181 | Instrumental Analysis - Lecture and Laboratory 2 | 3 |
| Gen. Ed. Distribution course (example: Social Sciences) | | 3 |
| Upper-division Elective | | 3 |
| Upper-division Elective | | 3 |
| Upper-division Elective | | 3 |

Credit Hours 15

Total Credit Hours 121

Learning Outcomes

After completing the requirements for the chemistry major, students will be able to:

- Use chemical models to describe the behavior of matter and analyze chemical problems.
- Make quantitative predictions based on chemical models.
- Know and demonstrate appropriate safety practices in the laboratory.
- Develop a scientific hypothesis and conduct an appropriate investigation using a safe and technically sound approach.
- Communicate chemical knowledge and research results clearly in both written and oral format.
- Utilize a range of scientific apparatus and instruments to synthesize molecules, measure their properties and quantify the amount of a substance.
- Demonstrate critical thinking skills and logical approaches to problem solving