

# Department of Chemistry and Biochemistry

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

**Undergraduate emphases:** *BS in Chemistry*—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 in Chemistry** 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 **Bachelor of Science Degree in Biochemistry** encompasses the study of the properties and functions of biological macromolecules, the mechanisms of action of enzymes, gene and protein regulation and expression, bioenergetics, and the metabolic pathways and processes that use and generate chemical and light energy. At its core, biochemistry recognizes and explains the unifying chemical principles that lie at the heart of the diverse expressions of life.

The core courses for the major are built around two-semester course sequences in the areas of general, organic, and biological chemistry; general biology; calculus; and general physics, along with associated laboratory courses. Students may choose from two physics tracks: (1) the life sciences track (typically preferred by students with a more biological inclination) and (2) the science-engineering track (typically preferred by students with a more mathematical/physical inclination). One-semester courses in analytical and biophysical chemistry and statistics round out the core of the program. To complete the additional 18 credits of coursework required for the major, students may choose elective courses from within the disciplines of chemistry, biochemistry, and biology. A wide range of advanced courses are available to meet the advanced electives requirement; students are encouraged to meet with their academic advisor to select courses that provide the best preparation for their intended career path. Representative courses (not all encompassing) include those in biology (e.g., human physiology, genetics, ecology, microbiology, plant physiology, cell biology); biochemistry (e.g., enzymology, structured biology, bioenergetics

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and metabolism, protein structure/function); and chemistry (e.g., intermediate and advanced inorganic, advanced organic).

The biochemistry major differs from the “chemistry major with biochemistry emphasis,” which is an American Chemical Society (ACS) certified degree that emphasizes specialization in biochemistry, but has a more chemical and mathematical emphasis than the biochemistry major. The biochemistry major is more biologically inclined (as well as somewhat less physically and mathematically inclined) than the chemistry major and is designed to meet the standards for the curriculum proposed by the American Society for Biochemistry and Molecular Biology (ASBMB).

The requirements of the BS and BA degrees in chemistry and the BS degree in biochemistry, 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 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.

## Assessment

The Department of Chemistry and Biochemistry has implemented a multilayered assessment strategy that defines learning objectives at the following levels: individual courses, divisional levels, and at the overall program level for the chemistry major. Details of this strategy can be found at: <http://www.chem.usu.edu/assessment/>

Learning objectives for the Chemistry Major are specifically outlined in an organized matrix at:  
<http://www.chem.usu.edu/assessment/matrix.pdf>

## 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 the chemistry or biochemistry major in good standing.

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

No CHEM prefix course may be applied toward graduation with any major or minor in chemistry or biochemistry with an earned grade of less than C-. 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 or biochemistry 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.

## Chemistry Major Core Requirements

### Suggested Schedule

#### First Year (30-32 credits)

##### Fall Semester (15-16 credits)

CHEM 1210 Principles of Chemistry I .....	4
CHEM 1215 Chemical Principles Laboratory I .....	1
MATH 1210 (QL) Calculus I .....	4
University Studies courses .....	6-7

##### Spring Semester (15-16 credits)

CHEM 1220 (BPS) Principles of Chemistry II .....	4
CHEM 1225 Chemical Principles Laboratory II .....	1
MATH 1220 (QL) Calculus II .....	4
University Studies courses .....	6-7

#### Second Year (32-33 credits)

##### Fall Semester (16 credits)

CHEM 2310 <sup>2</sup> Organic Chemistry I .....	4
CHEM 2315 <sup>2</sup> Organic Chemistry Laboratory I .....	1
CHEM 3000 (QI) <sup>2</sup> Quantitative Analysis .....	3
CHEM 3005 <sup>2</sup> Quantitative Analysis Laboratory .....	1
PHYS 2210 (QI) General Physics—Science and Engineering I .....	4
MATH 2210 (QI) Multivariable Calculus .....	3

##### Spring Semester (16-17 credits)

CHEM 2320 <sup>3</sup> Organic Chemistry II .....	4
CHEM 2325 <sup>3</sup> Organic Chemistry Laboratory II .....	1
CHEM 3510 <sup>3</sup> Intermediate Inorganic Chemistry .....	2
CHEM 3520 <sup>3</sup> Inorganic Chemistry Laboratory .....	1
PHYS 2220 (QI/BPS) General Physics—Science and Engineering II ..	4
University Studies courses .....	4-5

#### Third Year (29-31 credits)

##### Fall Semester (14-16 credits)

CHEM 3060 (QI) <sup>2</sup> Physical Chemistry .....	3
CHEM 3080 (CI) <sup>2</sup> Physical Chemistry Laboratory I .....	1
CHEM 5700 <sup>2</sup> General Biochemistry I .....	3
MATH 2250 (QI) <sup>1</sup> Linear Algebra and Differential Equations (4 cr) or	
STAT 3000 (QI) <sup>1</sup> Statistics for Scientists (3 cr) .....	3 or 4
University Studies or elective courses .....	4-5

##### Spring Semester (15 credits)

CHEM 3070 (QI) <sup>3</sup> Physical Chemistry .....	3
CHEM 3090 (CI) <sup>3</sup> Physical Chemistry Laboratory II .....	1
CHEM 5640 <sup>3</sup> Instrumental Analysis .....	3
CHEM 5650 <sup>3</sup> Instrumental Analysis Laboratory .....	2
University Studies or elective courses for specific degree emphasis ...	6

#### Fourth Year (31-32 credits)

CHEM 4990 (CI) Undergraduate Seminar .....	2
Upper-division and advanced elective courses for specific degree emphasis .....	29-30

<sup>1</sup> The completion of MATH 2250 or STAT 3000 is optional for the Teaching Major.

## Chemistry Degree Emphases

### Professional Chemistry Emphasis (ACS Certified)

In addition to the chemistry core, students must complete the following:

CHEM 5520 <sup>2</sup> Advanced Inorganic Chemistry (F) .....	2
CHEM 5530 <sup>3</sup> Advanced Synthesis Laboratory (Sp) .....	2
Advanced electives, as approved by department .....	6

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## Biochemistry Emphasis (ACS Certified)

In addition to the chemistry core, students must complete the following:

<b>CHEM 5710<sup>3</sup></b> General Biochemistry II (Sp) .....	3
<b>CHEM 5720<sup>3</sup></b> General Biochemistry Laboratory (Sp) .....	3
<b>BIOL 1610<sup>2</sup></b> Biology I (F) .....	4
Advanced Biology electives, as approved by department .....	4

## Environmental Chemistry Emphasis (ACS Certified)

In addition to the chemistry core, students must complete the following:

<b>CHEM 5670<sup>3</sup></b> Intermediate Environmental Chemistry (Sp).....	3
<b>CHEM 5680<sup>3</sup></b> Environmental Chemistry Laboratory (Sp) .....	2
Introductory environmental electives as approved by department .....	6-7
Advanced environmental electives as approved by department .....	3

## Chemical Education Emphasis (ACS Certified)

In addition to the chemistry core, students must complete the following:

Required courses for the Secondary Teacher Education Program (STEP) (see details on page 199) .....	35
Teaching minor from outside the Department of Chemistry and Biochemistry .....	12-16

<sup>2</sup> Offered fall semester only  
<sup>3</sup> Offered spring semester only

## BS Degree in Chemistry with Honors

This option can be met by completing any ACS certified program and by meeting the following requirements:

1. Minimum GPA of 3.50 in chemistry courses
2. Overall GPA of 3.30
3. Completion of 15 credits of honors work by successfully completing honors contracts in the following courses:

<b>CHEM 4800 (CI)</b> Research Problems (F, Sp, Su) .....	3-6
<b>CHEM 4990 (CI)</b> Undergraduate Seminar (F, Sp) .....	2

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 6000 or above.....3-6

In addition, select two courses from the following:

<b>CHEM 2320</b> Organic Chemistry II (Sp) .....	4
<b>CHEM 3070 (QI)</b> Physical Chemistry (Sp) .....	3
<b>CHEM 5640</b> Instrumental Analysis (Sp) .....	3
<b>CHEM 5700</b> General Biochemistry I (F) .....	3

## BS in Chemistry, Life Science Emphasis

In addition to the Chemistry Core Requirements (with the exception of CHEM 5640, 5650), students must complete the following:

<b>BIOL 1610</b> Biology I (F).....	4
<b>BIOL 1620 (BLS)</b> Biology II (Sp) (4 cr) <b>or</b>	
<b>BIOL 2420</b> Human Physiology (F,Sp,Su) (4 cr).....	4
<b>BIOL 3060 (QI)</b> Principles of Genetics (F,Sp,Su) (4 cr) <b>or</b>	
<b>BIOL 3300 (BLS)</b> General Microbiology (F,Sp) (4 cr) .....	4
<b>CHEM 5710</b> General Biochemistry II (Sp).....	3
<b>CHEM 5720</b> General Biochemistry Laboratory (Sp).....	3

## BA in Chemistry

In addition to the chemistry core (with the exception of CHEM 5640, 5650), students must complete the following:

<b>CHEM 5520</b> Advanced Inorganic Chemistry (F) (2 cr) <b>or</b>	
<b>CHEM 5640</b> Instrumental Analysis (Sp) (3 cr).....	2 or 3
Completion of one foreign language (16 cr) <b>or</b>	
Completion of two foreign languages (20 cr).....	16 or 20

## Chemistry Teaching Major

In addition to the Chemistry Core Requirements (with the exception of MATH 2250 or STAT 3000, and CHEM 5640 and 5650), students must complete the following:

<b>SCI 4300</b> Science in Society (F,Sp).....	2
Required courses for the Secondary Teacher Education Program (STEP) (see details on page 199) .....	35
Teaching minor from outside the Department of Chemistry and Biochemistry .....	12-16

## 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.

Specific for admission to this program, a student must have at least a 2.75 GPA in the following chemistry and physics courses:

<b>CHEM 1210</b> Principles of Chemistry I (F,Sp).....	4
<b>CHEM 1215</b> Chemical Principles Laboratory I (F,Sp).....	1
<b>CHEM 1220 (BPS)</b> Principles of Chemistry II (F,Sp,Su) .....	4
<b>CHEM 1225</b> Chemical Principles Laboratory II (F,Sp).....	1

<b>PHYS 2110</b> General Physics—Life Sciences I (4 cr) <b>and</b>	
<b>PHYS 2120 (BPS)</b> General Physics—Life Sciences II (4 cr) .....	8

**OR**

<b>PHYS 2210 (QI)</b> General Physics—Science and Engineering I (4 cr) <b>and</b>	
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<b>PHYS 2220 (QI/BPS)</b> General Physics—Science and Engineering II (4 cr) .....	8
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(PHYS 2210 and 2220 are preferred.)

*This program does not include many aspects of the Chemistry Core.*

### Required Courses:

<b>CHEM 1210</b> Principles of Chemistry I (F,Sp).....	4
<b>CHEM 1215</b> Chemical Principles Laboratory I (F,Sp).....	1
<b>CHEM 1220 (BPS)</b> Principles of Chemistry II (F,Sp,Su) .....	4
<b>CHEM 1225</b> Chemical Principles Laboratory II (F,Sp).....	1
<b>CHEM 2300</b> Principles of Organic Chemistry (F) (3 cr) <b>or</b>	
<b>CHEM 2310</b> Organic Chemistry I (F) (4 cr) .....	3 or 4
<b>CHEM 2315</b> Organic Chemistry Laboratory I (F) .....	1
<b>PHYS 1040 (BPS)</b> Introductory Astronomy .....	3
<b>PHYS 1080 (BPS)<sup>4</sup></b> Intelligent Life in the Universe (3 cr) <b>or</b>	
<b>PHYS 3030 (DSC/QI)</b> The Universe (3 cr) .....	3

<b>PHYS 2110</b> General Physics—Life Sciences I (4 cr) <b>and</b>	
<b>PHYS 2120 (BPS)</b> General Physics—Life Sciences II (4 cr) .....	8

**OR**

<b>PHYS 2210 (QI)</b> General Physics—Science and Engineering I (4 cr) <b>and</b>	
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<b>PHYS 2220 (QI/BPS)</b> General Physics—Science and Engineering II (4 cr) .....	8
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<b>MATH 1210 (QL)</b> Calculus I (F,Sp,Su) .....	4
<b>MATH 1220 (QL)</b> Calculus II (F,Sp,Su) .....	4
<b>STAT 3000 (QI)</b> Statistics for Scientists (F,Sp,Su) .....	3
<b>SCI 4300</b> Science in Society (F,Sp).....	2
<b>BIOL 1010 (BLS)</b> Biology and the Citizen (F,Sp,Su).....	3
<b>GEO 1110 (BPS)</b> The Dynamic Earth: Physical Geology (F,Sp) .....	4
<b>PSC 2000 (BPS)</b> The Atmosphere and Weather (F).....	3

Teacher licensure courses from Secondary Education (35 cr)  
(see details on page 199)..... 35

A teaching minor is optional for the Composite Teaching Major in the Physical Sciences.

<sup>4</sup>PHYS 1080 is sometimes listed as USU 1360, ST: Intelligent Life in the Universe.

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## Secondary Teacher Education Program (STEP) (35 credits)

Prior to enrolling in these courses, students must be approved for admission to the STEP by the Emma Eccles Jones College of Education and Human Services. The teaching major advisor can assist with this process.

An overall 2.75 GPA in a minimum of 60 semester credits of approved University coursework is required for admission into the STEP. A minimum overall GPA of 2.75 is required for graduation. Specific for admission to any Chemistry Teaching program, a student must have at least a 2.75 GPA in CHEM 1210, 1215, 1220, and 1225.

All USU teacher education candidates will be required to take and pass the content exam approved by the Utah State Office of Education in their major content area prior to student teaching.

Students who may wish to teach Integrated Science at the middle or junior high school level should talk to their advisor about completing the courses necessary for an Integrated Science endorsement.

### Level 1 (11 credits)

INST 3500 Technology Tools for Secondary Teachers (F,Sp,Su)	1
SCED 3100 Motivation and Classroom Management (F,Sp)	3
SCED 3210 (CI/DSS) Educational and Multicultural Foundations (F,Sp)	3
SCED 3300 Clinical Experience I (40 hours minimum) (F,Sp)	1
SCED 3400 Teaching Science I (Sp)	3

### Level 2 (12 credits)

SPED 4000 Education of Exceptional Individuals (may be taken anytime) (F,Sp,Su)	2
SCED 4200 (CI) Reading, Writing, and Technology (F,Sp)	3
SCED 4210 Cognition and Evaluation of Student Learning (F,Sp)	3
SCED 4300 Clinical Experience II (40 hours minimum) (F,Sp)	1
SCED 4400 Teaching Science II (F)	3

### Level 3 (12 credits)

SCED 5500 Student Teaching Seminar (2 weeks) (F,Sp)	2
SCED 5630 Student Teaching in Secondary Schools (13 weeks, full-time) (F,Sp)	10

**Note:** The Teaching Science I and II courses (SCED 3400 and 4400) are *only* taught once per year. Therefore, it is important for students to consult with their advisor to fit these courses in the correct sequence into their plan of study.

**Note:** The courses in nonscience majors may differ from those listed here.

## Biochemistry Major

The following curriculum is required for the BS degree in biochemistry. To complete the degree in eight semesters (four academic years), students must register for an average of 15-16 credits per semester. (**Note:** Biochemistry Majors *cannot* declare a Chemistry Minor.)

**Note:** Students may satisfy the CHEM 1210 requirement with an AP score of 3 or 4. *Both* CHEM 1210 *and* 1220 may be satisfied with an AP score of 5.

### Suggested Schedule

#### First Year (30-32 credits)

##### Fall Semester (15-16 credits)

CHEM 1210 Principles of Chemistry I	4
CHEM 1215 Chemical Principles Laboratory I	1
MATH 1210 (QL) Calculus I	4
University Studies courses	6-7

##### Spring Semester (15-16 credits)

CHEM 1220 (BPS) Principles of Chemistry II	4
CHEM 1225 Chemical Principles Laboratory II	1
MATH 1220 (QL) Calculus II	4
University Studies courses	6-7

#### Second Year (32 credits)

##### Fall Semester (16 credits)

CHEM 2310 <sup>5</sup> Organic Chemistry I	4
CHEM 2315 <sup>5</sup> Organic Chemistry Laboratory I	1
BIOL 1610 <sup>5</sup> Biology I	4
PHYS 2110 General Physics—Life Sciences I (4 cr) or PHYS 2210 (QI) General Physics—Science and Engineering I (4 cr)	4
University Studies course(s)	3

##### Spring Semester (16 credits)

CHEM 2320 <sup>6</sup> Organic Chemistry II	4
CHEM 2325 <sup>6</sup> Organic Chemistry Laboratory II	1
BIOL 1620 (BLS) <sup>6</sup> Biology II	4
PHYS 2120 (BPS) General Physics—Life Sciences II (4 cr) or PHYS 2220 (BPS/QI) General Physics—Science and Engineering II (4 cr)	4
University Studies course(s)	3

#### Third Year (31-37 credits)

##### Fall Semester (15-18 credits)

CHEM 3000 <sup>5</sup> (QI) Quantitative Analysis	3
CHEM 3005 <sup>5</sup> Quantitative Analysis Laboratory	1
CHEM 5700 <sup>5</sup> General Biochemistry I	3
Advanced Biology Electives (2000 level or higher)	3-4
University Studies courses	5-7

##### Spring Semester (16-19 credits)

CHEM 5710 <sup>6</sup> General Biochemistry II	3
CHEM 5720 <sup>6</sup> General Biochemistry Laboratory	3
STAT 3000 (QI) Statistics for Scientists	3
Advanced Biology Electives (2000 level or higher)	3-4
University Studies courses	4-7

#### Fourth Year (29-34 credits)

##### Fall Semester (14-17 credits)

CHEM 4890 (CI) Undergraduate Biochemistry Seminar	2
CHEM 5070 <sup>5</sup> Biophysical Chemistry	3
Advanced elective coursework	6-12
University Studies course(s)	0-3

##### Spring Semester (12-15 credits)

Advanced elective coursework	6-12
University Studies course(s)	0-3

#### Preapproved Course Options for Biochemistry Major Electives (18 credits required for major)

Of the 18 credits required, 14 must be at the 3000 level or higher. Other upper-division courses may be substituted if approved by the department. Prerequisites will *not* be waived. Only courses with a C-grade or better can be applied toward the electives requirement.

ADVS 3020 Biotechnology in Agriculture (F) (Prereq: BIOL 1620, CHEM 2310)	3
ADVS 5350 Introductory Pharmacology and Pharmacokinetics (Sp) (Prereq: BIOL 5600, CHEM 3700, permission of instructor)	3
BIOL 2320 Human Anatomy (Sp,Su)	4
BIOL 2420 Human Physiology (F,Sp,Su)	4
BIOL 3060 (QI) Principles of Genetics (F,Sp,Su) (Prereq: BIOL 1610, CHEM 1210)	4

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<b>BIOL 3065</b> Genetics Laboratory (F) (Prereq: BIOL 3060, which may be taken concurrently).....	2
<b>BIOL 3300</b> General Microbiology (F,Sp) (Prereq: BIOL 1610; CHEM 2310, which may be taken concurrently).....	4
<b>BIOL 4000</b> Human Dissection (F) (Prereq: BIOL 2320).....	1
<b>BIOL 5100</b> Neurobiology (F) (Prereq: BIOL 1620; BIOL 2420, 5600, or 5620; CHEM 1220; and PHYS 2120 or 2220).....	3
<b>BIOL 5150</b> Immunology (Sp) (Prereq: CHEM 1220; BIOL 3060; and BIOL 3300 or 5210).....	3
<b>BIOL 5210</b> Cell Biology (F) (Prereq: BIOL 1620, 3060; CHEM 2300 or 2320; CHEM 5700).....	3
<b>BIOL 5230</b> Developmental Biology (Sp) (Prereq: BIOL 3060 and 5210; CHEM 5700 strongly recommended).....	3
<b>BIOL 5250 (CI)</b> Evolutionary Biology (F,Sp) (Prereq: BIOL 3060 or WILD 4880 or permission of instructor).....	3
<b>BIOL 5330</b> Virology (Sp) (Prereq: BIOL 3060 and 3300).....	3
<b>BIOL 5600</b> Comparative Animal Physiology (Sp) (Prereq: BIOL 1620 and CHEM 1220).....	3
<b>BIOL 5620</b> Medical Physiology (F) (Prereq: BIOL 1620; BIOL 2420 or 5600; CHEM 5710).....	3
<b>CHEM 4800 (CI)</b> Research Problems: Undergraduate Research (F,Sp,Su) (Prereq: Permission of instructor).....	3
<b>CHEM 6730</b> Principles of Enzymology (Sp) (Prereq: CHEM 5700).....	3
<b>CHEM 6740</b> Cellular Communication by Small Molecules and Proteins (Sp) (Prereq: CHEM 5700).....	3
<b>CHEM 6750</b> Principles of Structural Biology (F) (Prereq: CHEM 5700).....	3
<b>CHEM 6760</b> Principles of Bioenergetics (F) (Prereq: CHEM 5700).....	3

<sup>5</sup> Offered fall semester only

<sup>6</sup> Offered spring semester only

## BS Degree in Biochemistry with Honors

A BS degree in Biochemistry with honors can be earned by meeting the following requirements:

1. Minimum GPA of 3.50 in chemistry courses
2. Overall GPA of 3.30
3. Completion of 15 credits of honors work by successfully completing honors contracts in the following courses:

<b>CHEM 4800 (CI)</b> Research Problems (F,Sp,Su).....	3-6
<b>CHEM 4890 (CI)</b> Undergraduate Biochemistry Seminar.....	2
3-6 credits selected from Honors courses numbered 3000 or higher in chemistry or related subjects, as appropriate. Three credits may be selected from chemistry courses numbered 6000 or higher.....	3-6

In addition, select two courses from the following:

<b>CHEM 2320</b> Organic Chemistry II (Sp).....	4
<b>CHEM 5070</b> Biophysical Chemistry (F).....	3
<b>CHEM 5700</b> General Biochemistry I (F).....	3
<b>CHEM 5710</b> General Biochemistry II (Sp).....	3

## Chemistry Minor

In addition to CHEM 1210, 1215, 1220, and 1225, 10 additional credits in Chemistry prefix courses at the 2000 level or higher, as approved by department, are required (either CHEM 2300 or 2310 may be included). (**Note:** Biochemistry Majors *cannot* declare a Chemistry Minor.)

## Chemistry Teaching Minor

In addition to CHEM 1210, 1215, 1220, 1225, CHEM 2300 or 2310, and CHEM 2315, 3-4 additional credits selected from the following are required:

<b>CHEM 2320</b> Organic Chemistry II (Sp) (if CHEM 2310 has been previously selected).....	4
<b>CHEM 3000 (QI)</b> Quantitative Analysis (F).....	3
<b>CHEM 3060 (QI)</b> Physical Chemistry (F).....	3
<b>CHEM 3510</b> Intermediate Inorganic Chemistry (Sp) (2 cr) <b>and</b>	
<b>CHEM 3520</b> Inorganic Chemistry Laboratory (Sp) (1 cr).....	3
<b>CHEM 3650 (DSC)</b> Environmental Chemistry (Sp) (3 cr) <b>or</b>	
<b>CHEM 3700</b> Introductory Biochemistry (Sp) (3 cr).....	3
Enrollment in the Secondary Teacher Education Program (STEP) (see details on page 199).....	35

## Undergraduate Research Opportunities

The Chemistry and Biochemistry Department encourages students in all departmental majors to engage in undergraduate research. For information about how they can become involved in undergraduate research, students should contact Joan Hevel, the departmental undergraduate research coordinator, (435) 797-1622, joanie.hevel@usu.edu.

## 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.

The major in Biochemistry is appropriate both for students who wish to terminate their studies at the bachelor's degree and for those planning to continue their education at the graduate or professional level. For those who terminate at the bachelor's degree, career opportunities are available in research and development, sales, quality control, and analysis within a range of biochemical, pharmaceutical, and biotechnological industries. For those planning to pursue a career in the health professions, the biochemistry major provides an excellent and well-rounded background for medical, dental, and veterinary school admission. The biochemistry major also provides excellent preparation for students planning to pursue graduate work in a range of biological, environmental, and chemical sciences, including biochemistry, molecular biology, genetics, genomics, oncology, and bioinformatics. For those students interested in pursuing a legal career in areas such as patent law, bioethics, and environmental protection and regulation, the major is also excellent preparation for law school.

For further information about career opportunities for chemistry majors and biochemistry majors, students should contact their advisor.

## Departmental Honors

Students who would like to experience greater academic depth within their major are encouraged to enroll in departmental honors. Through original, independent work, Honors students enjoy the benefits of close supervision and mentoring, as they work one-on-one with faculty

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in select upper-division departmental courses. Honors students also complete a senior project, which provides another opportunity to collaborate with faculty on a problem that is significant, both personally and in the student's discipline. Participating in departmental honors enhances students' chances for obtaining fellowships and admission to graduate school. Minimum GPA requirements for participation in departmental honors vary by department, but usually fall within the range of 3.30-3.50. Students may enter the Honors Program at almost any stage in their academic career, including at the junior (and sometimes senior) level. The campus-wide Honors Program, which is open to all qualified students regardless of major, offers a rich array of cultural and social activities, special classes, and the benefit of Honors early registration. Interested students should contact the Honors Program, Main 15, (435) 797-2715, [honors@usu.edu](mailto:honors@usu.edu). Additional information can be found online at: <http://www.usu.edu/honors/>

## Additional Information

For more information about requirements for the majors and minors within the Chemistry and Biochemistry Department, see the major requirement sheets, available from the department, or online at: <http://www.usu.edu/majorsheets/>

## Graduate Programs

### Admissions Requirements

See the general admission requirements for the School of Graduate Studies (pages 36-37). 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 116-119), 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 chairperson of the Graduate Recruiting and Admissions Committee to be certain of their eligibility for this program. The chairperson will then submit an application to the department head and to the School of Graduate Studies for approval. Students must earn a satisfactory score 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 at least four of the graduate biochemistry core courses (CHEM 6730, 6740, 6750, and 6760). 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.

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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 \$22,000 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

### Professors

*Stephen E. Bialkowski*, analytical chemistry  
*Alexander I. Boldyrev*, physical chemistry  
*Scott A. Ensign*, biochemistry  
*David Farrelly*, physical chemistry  
*Alvan C. Hengge*, organic chemistry  
*Vernon D. Parker*, physical organic chemistry  
*Steve Scheiner*, computational chemistry  
*Lance C. Seefeldt*, biochemistry

### Trustee Professor Emeritus

*Ann E. Aust*, biochemistry

### Professors Emeritus

*Steven D. Aust*, biochemistry  
*William M. Moore*, physical chemistry  
*Richard K. Olsen*, organic chemistry  
*Grant G. Smith*, organic chemistry  
*Jack T. Spence*, inorganic chemistry

### Associate Professors

*Lisa M. Berreau*, inorganic chemistry  
*Robert S. Brown*, analytical chemistry  
*Cheng-Wei Tom Chang*, organic chemistry  
*Bradley S. Davidson*, organic chemistry  
*John L. Hubbard*, inorganic chemistry

### Assistant Professors

*Joan M. Hevel*, biochemistry  
*Sean J. Johnson*, biochemistry

### Research Assistant Professor

*Tapas Kar*, physical chemistry

### Lecturer

*Douglas G. Harris*

## Course Descriptions

Chemistry and Biochemistry (CHEM), [click here](#)