The Department of Chemistry and Biochemistry offers the following undergraduate and graduate programs. Specific requirements for these programs are listed within this Department of Chemistry and Biochemistry section in the following order:

**Undergraduate Majors (B.S.)**
- Biochemistry (p. 1)
- Chemistry (p. 2)

**Undergraduate Majors (B.A.)**
- Biochemistry (p. 3)
- Chemistry (p. 3)
- Chemistry-Teaching (p. 4)

**Minors**
- Chemistry (p. 4)
- Materials Science and Technology (p. 5) (also listed in Department of Physics and Department of Technology)

Major programs are offered by the Department of Chemistry and Biochemistry in two baccalaureate degree areas:
- the Bachelor of Science and
- the Bachelor of Arts

1. Students considering a baccalaureate chemistry major should complete two semesters of general chemistry, CHEM 1110 (860:044) and CHEM 1120 (860:048), in the freshman year. Well-prepared students may be permitted to take CHEM 1130 (860:070), an accelerated course in general chemistry, during their first semester. It is strongly recommended that chemistry majors complete requirements in mathematics and physics within the first two years.

2. Prior to enrollment in a chemistry course, all pre-requisite courses must be completed with a grade of C- or higher.

3. A student enrolled in a chemistry course during fall or spring semester and who wishes to enroll in the same course in the subsequent spring or fall semester should contact the department. The student will be allowed to register only if space remains after all advance registrations are completed.

4. A student cannot declare a Chemistry minor if they are pursuing any B.A. or B.S. major in the Department of Chemistry and Biochemistry. Two majors cannot be earned within the department except for the combination of the B.A. Chemistry Teaching major and either the B.S. Chemistry or the B.S. Biochemistry major.

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### Bachelor of Science Degree Programs

#### Biochemistry Major

The B.S. Biochemistry major requires a minimum of 126 total hours to graduate. This total includes Liberal Arts Core requirements and the following specified major requirements, plus electives to complete the minimum of 126 hours.

The Bachelor of Science Biochemistry major is accredited by the American Chemical Society. This major prepares students for careers and/or advanced study in biochemistry. It also provides partial preparation appropriate for medical school and other health-related programs.

**Required**

<table>
<thead>
<tr>
<th>Mathematics:</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420 (800:060)</td>
<td>Calculus I *</td>
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<tr>
<td>MATH 1421 (800:061)</td>
<td>Calculus II</td>
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<thead>
<tr>
<th>Biology:</th>
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<tbody>
<tr>
<td>BIOL 2052 (840:052)</td>
<td>General Biology: Cell Structure and Function</td>
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<tr>
<td>BIOL 3140 (840:140)</td>
<td>Genetics ***</td>
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<table>
<thead>
<tr>
<th>Chemistry and Biochemistry:</th>
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</thead>
<tbody>
<tr>
<td>CHEM 1110 (860:044) &amp; CHEM 1120 (860:048)</td>
<td>General Chemistry I and General Chemistry II (*)</td>
<td>5-8</td>
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<tr>
<td>or CHEM 1130 (860:070)</td>
<td>General Chemistry I-II</td>
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<tr>
<td>CHEM 2110 (860:110)</td>
<td>Descriptive Inorganic Chemistry</td>
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</tr>
<tr>
<td>CHEM 2210 (860:120)</td>
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<td>3</td>
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<tr>
<td>CHEM 2220 (860:123)</td>
<td>Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 2230 (860:121)</td>
<td>Organic Chemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 2310 (860:132)</td>
<td>Chromatography and Quantitative Analysis</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 3600 (860:180)</td>
<td>Undergraduate Research in Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 4220/5220 (860:161g) or CHEM 4310/5310 Instrumental Analysis (860:137g)</td>
<td>Organic Structure Analysis</td>
<td>3-4</td>
</tr>
<tr>
<td>CHEM 4420/5420 (860:140g)</td>
<td>Physical Chemistry I</td>
<td>3</td>
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<tr>
<td>CHEM 4430/5430 (860:141g)</td>
<td>Physical Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 4440/5440 (860:143g)</td>
<td>Physical Chemistry Laboratory</td>
<td>2</td>
</tr>
</tbody>
</table>
CHEM 4510/5510  (860:154g)
Biochemistry I  3
CHEM 4520/5520  (860:155g)
Biochemistry II  3
CHEM 4530/5530  (860:156g)
Biochemistry Laboratory  2

Physics:
Select one of the following:  8

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 1511 (880:054) &amp; PHYSICS 1512 (880:056)</td>
<td>General Physics I and General Physics II</td>
</tr>
<tr>
<td>PHYSICS 1701 (880:130) &amp; PHYSICS 1702 (880:131)</td>
<td>Physics I for Science and Engineering and Physics II for Science and Engineering</td>
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OR

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>PHYSICS 1701 (880:130) &amp; PHYSICS 1702 (880:131)</td>
<td>Physics I for Science and Engineering and Physics II for Science and Engineering</td>
</tr>
</tbody>
</table>

Electives  3-4

One 3000-level or higher content course in biology, biochemistry, or chemistry (with the exception of CHEM 4630/5630 which will not count as an elective option)

Total hours  71-74

* Has prerequisite of satisfactory score on ALEKS exam or subsequent remediation.

** Students taking the 3 hour course CHEM 4220/5220 (860:161g) Organic Structure Analysis as an alternative to the 4 hour course CHEM 4310/5310 (860:137g) Instrumental Analysis are required to take a 4 hour elective that includes a lab component.

*** BIOL 3140 (840:140) has a prerequisite of BIOL 2051 (840:051). BIOL 2051 (840:051) is waived as a prerequisite for Biochemistry majors.

Notes:

1. The elective course should be chosen with the help of the major advisor. This is particularly important for students wishing to earn a certified degree, to assure consistency with the certification guidelines of the American Chemical Society. An appropriate advanced course in another science may be substituted with department head approval.

2. To satisfy American Chemical Society guidelines for certification of the Biochemistry major, the two hours of CHEM 3600 (860:180) Undergraduate Research required for this program must include completion of a final written report.

Chemistry Major

The B.S. Chemistry major requires a minimum of 126 total hours to graduate. This total includes Liberal Arts Core requirements and the following specified major requirements, plus electives to complete the minimum of 126 hours.

The Bachelor of Science Chemistry major is accredited by the American Chemical Society. This program is recommended for students who wish to prepare for careers as professional chemists. It also provides the most complete preparation for post-graduate study in the field of chemistry.

Required

Mathematics:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
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<tbody>
<tr>
<td>MATH 1420 (800:060)</td>
<td>Calculus I *</td>
</tr>
<tr>
<td>MATH 1421 (800:061)</td>
<td>Calculus II</td>
</tr>
</tbody>
</table>

Chemistry and Biochemistry:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1110 (860:044) &amp; CHEM 1120 (860:048)</td>
<td>General Chemistry I and General Chemistry II (*)</td>
</tr>
<tr>
<td>CHEM 1130 (860:070)</td>
<td>General Chemistry I-II</td>
</tr>
<tr>
<td>CHEM 2010</td>
<td>Chemical Safety Seminar</td>
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<tr>
<td>CHEM 2110 (860:110)</td>
<td>Descriptive Inorganic Chemistry</td>
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<tr>
<td>CHEM 2210 (860:120)</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>CHEM 2220 (860:123)</td>
<td>Organic Chemistry II</td>
</tr>
<tr>
<td>CHEM 2230 (860:121)</td>
<td>Organic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 2310 (860:132)</td>
<td>Chromatography and Quantitative Analysis</td>
</tr>
<tr>
<td>CHEM 3600 (860:180)</td>
<td>Undergraduate Research in Chemistry</td>
</tr>
<tr>
<td>CHEM 4110/5110 (860:145g)</td>
<td>Inorganic Chemistry</td>
</tr>
<tr>
<td>CHEM 4310/5310 (860:137g)</td>
<td>Instrumental Analysis</td>
</tr>
<tr>
<td>CHEM 4420/5420 (860:140g)</td>
<td>Physical Chemistry I</td>
</tr>
<tr>
<td>CHEM 4430/5430 (860:141g)</td>
<td>Physical Chemistry II</td>
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<tr>
<td>CHEM 4440/5440 (860:143g)</td>
<td>Physical Chemistry Laboratory</td>
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<tr>
<td>CHEM 4510/5510 (860:154g)</td>
<td>Biochemistry I</td>
</tr>
<tr>
<td>CHEM 4610/5610 (860:149g)</td>
<td>Advanced Synthesis Laboratory</td>
</tr>
</tbody>
</table>

Elective  3

A 4000-level chemistry content course.

Total Hours  63-66

* Has prerequisite of satisfactory score on ALEKS exam or subsequent remediation.

Notes:

1. To satisfy American Chemical Society guidelines for certification of the Chemistry major, the two hours of CHEM 3600 (860:180) Undergraduate Research required for this program must include completion of a final written report.
2. The elective course should be chosen with the help of the major advisor. This is particularly important for students wishing to earn a certified degree, to assure consistency with the certification guidelines of the American Chemical Society. An appropriate advanced course in another science may be substituted with department head approval.

3. Students wishing to earn a non-certified Bachelor of Science degree may omit CHEM 4110/5110 (860:145g), CHEM 4610/5610 (860:149g), and CHEM 4510/5510 (860:154g), but must include six additional elective hours in chemistry at the 4000-level or higher.

Emphasis-Honors Research
This emphasis is available to qualified students pursuing the Bachelor of Science program by invitation at the beginning of their junior year. Completion of Honors Research requires 5 credit hours in CHEM 3600 (860:180) Undergraduate Research and the writing of a senior research thesis. The research credit may be applied to the elective hours of the B.S. degree.

Bachelor of Arts Degree Programs

Biochemistry Major
The B.A. Biochemistry major requires a minimum of 120 total hours to graduate. This total includes Liberal Arts Core requirements and the following specified major requirements, plus electives to complete the minimum of 120 hours.

This program provides experience in most basic areas of chemistry, with a focus on biochemistry. With appropriate choice of university electives, the B.A. Biochemistry major meets the needs of pre-medical students and students preparing for additional study in related areas such as pharmacology, medicinal chemistry, clinical chemistry, and toxicology. It is also suitable for students who wish to combine a chemistry major with a major in another discipline.

Required
Mathematics:
MATH 1420 (800:060) Calculus I * 4

Biology:
BIOL 2052 (840:052) General Biology: Cell Structure and Function 4

BIOL 3140 (840:140) Genetics ** 4

Chemistry and Biochemistry:
CHEM 1110 (860:044) General Chemistry I 5-8
& CHEM 1120 (860:048) and General Chemistry II (*)
or CHEM 1130 (860:070) General Chemistry I-II

CHEM 2110 (860:110) Descriptive Inorganic Chemistry 4
or CHEM 2310 (860:132) Chromatography and Quantitative Analysis

CHEM 2210 (860:120) Organic Chemistry I 3
CHEM 2220 (860:123) Organic Chemistry II 3
CHEM 2230 (860:121) Organic Chemistry Laboratory 2

CHEM 4420/5420 (860:140g) Physical Chemistry I 3

CHEM 4510/5510 (860:154g) Biochemistry I 3
CHEM 4520/5520 (860:155g) Biochemistry II 3
CHEM 4530/5530 (860:156g) Biochemistry Laboratory 2

Electives
One 3000-level or higher content course in biology, biochemistry, or chemistry

Total Hours 52-56

* Has prerequisite of satisfactory score on ALEKS exam or subsequent remediation.
** BIOL 3140 (840:140) has a prerequisite of BIOL 2051 (840:051). BIOL 2051 (840:051) is waived as a prerequisite for Biochemistry majors.

Chemistry Major
The B.A. Chemistry major requires a minimum of 120 total hours to graduate. This total includes Liberal Arts Core requirements and the following specified major requirements, plus electives to complete the minimum of 120 hours.

This program provides experience in all basic areas of chemistry. With appropriate choice of university electives, the B.A. Chemistry major meets the needs of pre-medical students and students preparing for additional study in related areas such as biochemistry, industrial hygiene, pharmacology and medicinal chemistry, clinical chemistry, and toxicology. It is also suitable for students who wish to combine a chemistry major with a major in another discipline.

Required
Mathematics:
MATH 1420 (800:060) Calculus I * 4

MATH 1421 (800:061) Calculus II 4

Chemistry and Biochemistry:
CHEM 1110 (860:044) General Chemistry I 5-8
& CHEM 1120 (860:048) and General Chemistry II (*)
or CHEM 1130 (860:070) General Chemistry I-II

CHEM 2110 (860:110) Descriptive Inorganic Chemistry 1
or CHEM 2310 (860:132) Chromatography and Quantitative Analysis

CHEM 2210 (860:120) Organic Chemistry I 3
CHEM 2220 (860:123) Organic Chemistry II 3
CHEM 2230 (860:121) Organic Chemistry Laboratory 2

CHEM 2310 (860:132) Chromatography and Quantitative Analysis 4

Department of Chemistry and Biochemistry
## Chemistry Major-Teaching

The B.A. Chemistry-Teaching major requires a minimum of 120 total hours to graduate. This total includes Liberal Arts Core requirements, the Professional Education Requirements, and the following specified major requirements, plus electives to complete the minimum of 120 hours.

This program provides preparation for chemistry teachers with successful completion leading to recommendation for State of Iowa licensure in 5-12 Chemistry. Coursework that leads to additional endorsements is recommended and should be selected in consultation with your advisor.

### Required

<table>
<thead>
<tr>
<th>Mathematics:</th>
<th>Chemistry and Biochemistry:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420 (800:060) Calculus I *</td>
<td>CHEM 1110 (860:044) General Chemistry I</td>
</tr>
<tr>
<td>CHEM 2110 (860:110) Descriptive Inorganic Chemistry</td>
<td>&amp; CHEM 1120 (860:048) General Chemistry II (*)</td>
</tr>
<tr>
<td>CHEM 2310 (860:132) Chromatography and Quantitative Analysis</td>
<td>CHEM 2010 Chemical Safety Seminar</td>
</tr>
<tr>
<td>CHEM 4420/5420 (860:140g) Physical Chemistry I</td>
<td>CHEM 2010 Physical Chemistry I</td>
</tr>
<tr>
<td>PHYSICS 1511 (880:054) &amp; PHYSICS 1512 (880:056) General Physics I and General Physics II</td>
<td>CHEM 2040 Applied Organic and Biochemistry</td>
</tr>
<tr>
<td>PHYSICS 1701 (880:130) &amp; PHYSICS 1702 (880:131) Physics I for Science and Engineering and Physics II for Science and Engineering</td>
<td></td>
</tr>
</tbody>
</table>

### Science and Science Education:

| SCI ED 3300/5300 Orientation to Science Teaching | SCI ED 4800/5800 Methods for Teaching Secondary Science or MTSS |
| SCI ED 3300/5300 Orientation to Science Teaching | SCI ED 4800/5800 Methods for Teaching Secondary Science or MTSS |

### Total Hours

**44**

* Has prerequisite of satisfactory score on ALEKS exam or subsequent remediation.

## Notes:

1. Well-prepared students may substitute CHEM 1130 (860:070) for CHEM 1110 (860:044) and CHEM 1120 (860:048); these students must also substitute CHEM 2210 (860:120) and CHEM 2230 (860:121) and CHEM 2220 (860:123) for CHEM 2040.

## Minors

### Chemistry Minor

A student cannot declare a Chemistry minor if they are pursuing any B.A. or B.S. major in the Department of Chemistry and Biochemistry.

### Required

<table>
<thead>
<tr>
<th>Chemistry and Biochemistry:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1110 (860:044) General Chemistry I</td>
</tr>
<tr>
<td>&amp; CHEM 1120 (860:048) General Chemistry II (*)</td>
</tr>
<tr>
<td>or CHEM 1130 (860:070) General Chemistry I-II</td>
</tr>
<tr>
<td>Electives</td>
</tr>
</tbody>
</table>

### Total Hours

**19-22**

* Has prerequisite of satisfactory score on ALEKS exam or subsequent remediation.

### Note:

Courses numbered 2000 and above may be used as electives for the Chemistry Minor, with the following exceptions: CHEM 2010, CHEM 4630/5630, and any Cooperative Education, Independent Study, Readings, Research, and Seminar courses.

### Following are some suggested elective courses to complete the Chemistry Minor:

| CHEM 2040 | Applied Organic and Biochemistry |
|-----------------------------|
| CHEM 2110 (860:110) Descriptive Inorganic Chemistry |
| CHEM 2210 (860:120) Organic Chemistry I |
| CHEM 2220 (860:123) Organic Chemistry II |
# Materials Science and Technology Minor

This is an interdisciplinary minor that is jointly offered by the Departments of Chemistry and Biochemistry, Physics, and Technology.

Materials science and the use of materials in technology requires the use of concepts from multiple disciplines. This interdisciplinary minor gives students the broad foundation they need to learn about the science of materials and an introduction to how these scientific principles are used in the development and application of materials in new technology. This minor is complementary preparation to a major in Chemistry and Biochemistry, Physics or Manufacturing Engineering Technology for students who are interested in working in industry or going on to advanced study in materials science.

## Required:

### Choose one of the following three options: *  
<table>
<thead>
<tr>
<th>Option 1 Chemistry (8 hours)</th>
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</thead>
<tbody>
<tr>
<td>CHEM 1110 (860:044)</td>
<td>General Chemistry I</td>
<td>CHEM 1120 (860:048)</td>
<td>General Chemistry II</td>
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</tbody>
</table>

OR

### Option 2 Chemistry (5 hours)  
| CHEM 1130 (860:070) | General Chemistry I-II |  |  |

OR

### Option 3 Chemistry/Technology (7 hours)  
| CHEM 1020 (860:020) | Chemical Technology &  | TECH 3127 (330:127) | Transport Phenomena for Technologists &  |

<table>
<thead>
<tr>
<th>Additional requirements (all three options)</th>
<th>Choose one of the following sets of Physics courses: 8</th>
</tr>
</thead>
</table>

| PHYSICS 1511 (880:054) | General Physics I & General Physics II (880:056) |

OR

| PHYSICS 1701 (880:130) | Physics I for Science and Engineering & PHYSICS 1702 (880:131) Engineering |

## Additional required (all three options)

<table>
<thead>
<tr>
<th>CHEM 4200/5200 (860:144g)</th>
<th>Nanoscience *</th>
<th></th>
</tr>
</thead>
</table>

## Electives (all three options) - choose one of the following: 3-4

Note: in order to earn the Materials Science and Technology minor, the elective course students take for the minor cannot be a required course for their primary major.

<table>
<thead>
<tr>
<th>CHEM 2110 (860:110)</th>
<th>Descriptive Inorganic Chemistry *</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 2310 (860:132)</td>
<td>Chromatography and Quantitative Analysis *</td>
</tr>
<tr>
<td>CHEM 4210/5210 (860:148g)</td>
<td>Nanotechnology *</td>
</tr>
<tr>
<td>PHYSICS 4750/5750 (880:174g)</td>
<td>Physics of Modern Materials #</td>
</tr>
<tr>
<td>TECH 3132/5132 (330:132)</td>
<td>Metallurgy and Phase Transformation</td>
</tr>
</tbody>
</table>

## Total Hours 22-26

+ There are additional prerequisite courses that must be taken along with the required courses in some options – choose the option that aligns with the courses for your major.

- Students who have declared a Materials Science and Technology Minor may take these courses after completing CHEM 1020 (860:020) Chemical Technology and TECH 3127 (330:127) Transport Phenomena for Technologists in place of the usual CHEM 1120 (860:048) General Chemistry II prerequisite.

* These courses are taken by students in the Manufacturing Engineering Technology major.

# Prerequisite for CHEM 2310 (860:132); CHEM 1120 (860:048) or CHEM 1130 (860:070).

- Prerequisite for PHYSICS 4750/5750 (880:174g): PHYSICS 4100/5100 (880:137g) and PHYSICS 4110/5110 (880:138g).
Courses

Basic concepts of chemistry, the periodic table and its relation to atomic structure and chemical properties. How the understanding of changes in matter and energy is important in both living and non-living systems. Work of the chemist and the interactions of chemistry with other activities of humankind. Discussion, 3 periods; lab, 2 periods. No credit for student with credit in any college chemistry course. Prerequisite(s): student must have satisfied university entrance requirements in English and Mathematics. (Fall and Spring)

Basic concepts of chemistry, with an emphasis on the structure and function of molecules in living systems. Discussion, 3 periods. No credit for student with credit in any college chemistry course. Prerequisite(s): student must have satisfied university entrance requirements in English and Mathematics. (Fall and Spring)

Basic concepts of inorganic and organic chemistry and their applications to industrial processes. Emphasis on application of chemical principles in materials, energy production and use, and environmental problems. Discussion, 3 periods; lab, 3 periods. No credit for student with credit in any college chemistry course. (Fall and Spring)

CHEM 1110 (860:044). General Chemistry I — 4 hrs.
Structure of matter, its physical properties and laws describing them, the periodic table and its relation to atomic structure and chemical properties, and non-metallic elements and their compounds. Students with extensive background in high school chemistry and mathematics may enter CHEM 1130 (860:070) following departmental advisement. Discussion, 3 periods; lab, 3 periods. Prerequisite(s): student must have satisfied university entrance requirements in English and Mathematics; MATH 1120 (800:056) or MATH 1130 (800:044) or MATH 1140 (800:046) or MATH 1150 (800:048) or MATH 1420 (800:060) or equivalent, or a satisfactory ALEKS score. (Fall, Spring, Summer)

CHEM 1120 (860:048). General Chemistry II — 4 hrs.
Continuation of CHEM 1110 (860:044) with emphasis on intermolecular forces, solutions, kinetics, chemical and ionic equilibrium, and thermodynamics. Discussion, 3 periods; lab, 3 periods. For pre-professional students and science majors with a special interest in chemistry. Prerequisite(s): CHEM 1110 (860:044) or equivalent. (Fall, Spring, Summer)

CHEM 1130 (860:070). General Chemistry I-II — 5 hrs.
Accelerated course for well-prepared students. Content similar to CHEM 1110 (860:044) and CHEM 1120 (860:048) but covered in one semester. Completion satisfies General Chemistry requirement of any chemistry major. Discussion, 4 periods; lab, 3 periods. Prerequisite(s): consent of department head. (Fall)

CHEM 1610 (860:030). Careers in Chemistry — 1 hr.
Presentations describing career opportunities and current areas of research in chemistry. Offered on credit/no credit basis only. No credit toward any major. Discussion, 1 period. (Spring)

CHEM 2010. Chemical Safety Seminar — 1 hr.
Overview of laboratory and chemical safety principles, including regulatory considerations. May not be used for credit toward a chemistry minor. Prerequisite(s): CHEM 2040 or CHEM 2210 (860:120) or equivalent. (Spring)

Basic concepts in organic chemistry and biochemistry, including nomenclature, functional groups, reactivity, and macromolecules. No credit for students with credit in CHEM 2220 (860:123). Discussion, 3 periods; lab, 3 periods. Prerequisite(s): CHEM 1010 (860:010) or CHEM 1120 (860:048) or CHEM 1130 (860:070). (Fall and Spring)

Properties, structures, reactions, and applications of elements and their most important compounds. Discussion, 3 periods; lab, 3 periods. Prerequisite(s): CHEM 1120 (860:048) or CHEM 1130 (860:070). (Fall and Spring)

Fundamentals of organic chemistry. For majors in the sciences and those preparing for medically-related careers. Discussion, 3 periods. Prerequisite(s): CHEM 1120 (860:048) or CHEM 1130 (860:070). (Fall, Spring, Summer)

Continuation of CHEM 2210 (860:120). Discussion, 3 periods. Prerequisite(s): CHEM 2210 (860:120). (Fall, Spring, Summer)

Purification and identification techniques and some representative organic reactions. Lab, 6 periods. Prerequisite(s) or corequisite(s): CHEM 2210 (860:120). (Fall and Spring)

Theory, technique, and calculations of volumetric and gravimetric analysis. Statistical treatment of data. Classical analytical procedures supplemented by chromatographic and instrumental techniques. Discussion, 2 periods; lab, 6 periods. Prerequisite(s): CHEM 1120 (860:048) or CHEM 1130 (860:070). (Fall and Spring)

CHEM 3600 (860:180). Undergraduate Research in Chemistry — 1-3 hrs.
May be repeated. Prerequisite(s): Credit applied to the B.S. Biochemistry or B.S. Chemistry major requires the following prerequisites: CHEM 1110 (860:110) or CHEM 2210 (860:121) or CHEM 2310 (860:132) or consent of department head. (Fall, Spring, Summer)

CHEM 4110/5110 (860:145g). Inorganic Chemistry — 3 hrs.
Applications of principles of physical chemistry to inorganic systems, with emphasis on chemistry of transition elements. Discussion, 3 periods. Prerequisite(s): CHEM 2110 (860:110); CHEM 2210 (860:120); CHEM 4420/5420 (860:140g); junior standing. (Odd Springs)

CHEM 4150/5150. Advanced Inorganic Chemistry — 3 hrs.
Coordination chemistry, organometallics, materials chemistry, or other advanced topics in inorganic chemistry. May be repeated on different topics with consent of instructor. Discussion, 3 periods. Prerequisite(s): CHEM 4110/5110 (860:145g) or consent of instructor; junior standing. (Variable)

CHEM 4200/5200 (860:144g). Nanoscience — 3 hrs.
Study of nanoscale materials and processes, with emphasis on the preparation and characterization of materials with nanometer scale dimensions; investigation of how nanoscale dimensions produce unique chemical and physical properties; nanoscale microscopy and spectroscopic methods of investigation. Prerequisite(s): CHEM 1110 (860:044) and CHEM 1120 (860:048) or CHEM 1130 (860:070); PHYSICS 1511 (880:130);
PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131); junior standing. [Same as PHYSICS 4200/5200 (880:144g)] (Odd Falls)

CHEM 4210/5210 (860:148g). Nanotechnology — 3 hrs.
Study of nanoscale materials and processes, with emphasis on the current and potential future applications of materials with distinctive properties due to their nanometer scale dimensions; nanoporous materials; discussion of the broader implications of nanotechnology in areas such as government policy, occupational safety and medical technology. Prerequisite(s): CHEM 1110 (860:044) and CHEM 1120 (860:048) (or CHEM 1130 (860:070)), PHYSICS 1511 (880:054) or PHYSICS 1701 (880:130), PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131); junior standing. [Same as PHYSICS 4210/5210 (880:148g)] (Even Falls)

CHEM 4220/5220 (860:161g). Organic Structure Analysis — 3 hrs.
Use of infrared and ultraviolet-visible spectroscopy, proton and carbon magnetic resonance, mass spectrometry, and other physical and chemical methods for assignment of structure to organic compounds. Discussion, 3 periods. Prerequisite(s): CHEM 2230 (860:121); CHEM 2310 (860:132); junior standing. (Even Springs)

Product analysis, kinetics, and mechanism of organic reactions. May be repeated on different topics with consent of instructor. Discussion, 3 periods. Prerequisite(s): CHEM 2230 (860:121); CHEM 2310 (860:132); junior standing. (Variable)

CHEM 4310/5310 (860:137g). Instrumental Analysis — 4 hrs.
Application of physical chemical principles to theory and practice of instrumental methods of analysis such as spectrophotometric, electroanalytical, chromatographic, and computerized techniques. Discussion, 3 periods; lab, 3 periods. Prerequisite(s): CHEM 2210 (860:120); CHEM 2310 (860:132); junior standing. Prerequisite(s) or corequisite(s): CHEM 4420/5420 (860:140g); or consent of instructor; junior standing. (Variable)

CHEM 4350/5350. Advanced Analytical Chemistry — 3-4 hrs.
Chromatography, spectroscopy, electrochemistry, or other advanced topics in analytical chemistry. May be repeated on different topics with consent of instructor. Discussion, 3 periods; if offered for 4 hours, lab 3 additional periods. Prerequisite(s): CHEM 4310/5310 (860:137g); CHEM 4420/5420 (860:140g); or CHEM 4430/5430 (860:141g); or consent of instructor; junior standing. (Variable)

CHEM 4420/5420 (860:140g). Physical Chemistry I — 3 hrs.
Application of quantum mechanics, thermodynamics, and kinetics to chemical behavior on the microscopic and macroscopic scales. Discussion of the harmonic oscillator, atoms and molecules, spectroscopy, energy changes during reactions, chemical equilibrium and reaction mechanisms. Discussion, 3 periods. Prerequisite(s): CHEM 1120 (860:048) or CHEM 1130 (860:070); MATH 1420 (800:060); PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131); junior standing. (Fall)

CHEM 4430/5430 (860:141g). Physical Chemistry II — 3 hrs.
Continued applications of quantum mechanics, thermodynamics, and kinetics to chemical behavior. Relationships between thermodynamic energies, properties of mixtures, angular momentum, multielectron systems, the Boltzmann distribution, and the kinetic theory of gases. Discussion, 3 periods. Prerequisite(s): CHEM 4420/5420 (860:140g), MATH 1421 (800:061); junior standing. (Spring)

CHEM 4440/5440 (860:143g). Physical Chemistry Laboratory — 2 hrs.
Physical measurement techniques in chemistry. Lab, 6 periods. Prerequisite(s): CHEM 2310 (860:132); CHEM 4420/5420 (860:140g); junior standing. Prerequisite(s) or corequisite(s): CHEM 4430/5430 (860:141g). (Spring)

CHEM 4450/5450. Advanced Physical Chemistry — 3 hrs.
Molecular structure, chemical kinetics, quantum mechanics, or other advanced topics in physical chemistry. May be repeated on different topics with consent of instructor. Discussion, 3 periods. Prerequisite(s): CHEM 4420/5420 (860:140g); CHEM 4430/5430 (860:141g); or consent of instructor; junior standing. (Variable)

CHEM 4505/5505. Drugs, Poisons, and Venoms — 3 hrs.
Biology, chemistry, and biochemistry of drugs, poisons, and venoms, with consideration of associated criminal and societal issues. Discussion, 3 periods. Prerequisite(s): CHEM 2040 or CHEM 2220 (860:123); junior standing. (Fall and Spring)

CHEM 4510/5510 (860:154g). Biochemistry I — 3 hrs.
Structure and function of biologically important molecules including amino acids, proteins, carbohydrates, lipids, and nucleic acids, and enzyme kinetics. Lecture, 3 periods. Prerequisite(s): CHEM 2220 (860:123); junior standing. (Fall and Spring)

CHEM 4520/5520 (860:155g). Biochemistry II — 3 hrs.
Continuation of CHEM 4510/5510 (860:154g)/5510. Bioenergetics; intermediary metabolism of carbohydrates, lipids, and amino acids; macromolecular biosynthesis; and current topics in biochemistry. Lecture, 3 periods. Prerequisite(s): CHEM 4510/5510 (860:154g); junior standing. (Spring)

CHEM 4530/5530 (860:156g). Biochemistry Laboratory — 2 hrs.
Introduction to biochemical methodology. Chromatographic and electrophoretic purifications of proteins, lipids, and nucleic acids; chemical characterizations of amino acids, peptides, carbohydrates, and fatty acids; study of enzyme kinetics. Lab, 6 periods. Prerequisite(s): CHEM 4510/5510 (860:154g); junior standing. Prerequisite(s) or corequisite(s): CHEM 4520/5520 (860:155g). (Fall and Spring)

CHEM 4550/5550. Advanced Biochemistry — 3 hrs.
Amino acid and nucleotide biosynthesis and degradation, signal transduction, or other advanced topics in biochemistry. May be repeated on different topics with consent of instructor. Discussion, 3 periods. Prerequisite(s): CHEM 4510/5510 (860:154g); CHEM 4520/5520 (860:155g); junior standing. (Variable)

CHEM 4605/5605. Introduction to Polymer Science — 3 hrs.
This course is designed as an upper-level undergraduate and introductory graduate-level elective to teach the fundamentals of polymer science. The course is intended to introduce students to some of the major concepts of polymer science: a history of macromolecules; structure and bonding in polymers; types of polymerizations; natural and biological polymers; and sustainability and recycling. Prerequisite(s): CHEM 1120 (860:048) or CHEM 1130 (860:070); junior standing. (Odd Summers)

CHEM 4610/5610 (860:149g). Advanced Synthesis Laboratory — 2 hrs.
Advanced techniques in synthesis, purification, and characterization of organic and inorganic compounds. Lab, 6 periods. Prerequisite(s): CHEM 2110 (860:110); CHEM 2230 (860:121); junior standing. Prerequisite(s) or corequisite(s): CHEM 2220 (860:123). (Fall)

CHEM 4620/5620. Special Problems in Chemistry — 1-6 hrs.
Credit determined at registration. Problems selected according to needs of students. May be repeated for credit. Prerequisite(s): consent of department head; junior standing. (Variable)
CHEM 4630/5630. Research Methods and Chemical Literature — 1-3 hrs.
Concepts and procedures for developing a chemical research problem; use and importance of chemical literature. Prerequisite(s): junior standing. (Fall and Spring)

CHEM 4650/5650. Corporate Chemistry — 3 hrs.
Survey of the major fields of industrial chemistry, with an introduction to the most important chemicals from a corporate perspective and their production and uses. Includes study and discussion of corporate economics, regulatory environment, and environmental issues. Prerequisite(s): junior standing. (Variable)

CHEM 6289 (860:289). Seminar — 1 hr.
Current topics in chemistry. May be repeated.

CHEM 6299 (860:299). Research.
Prerequisite(s): consent of department head. (Fall, Spring, Summer)

(Fall and Spring)