Bachelor of Science (BS) Degree with a Major in Chemistry

Program Learning Outcomes for the BS Degree with a Major in Chemistry

Upon completing the BS degree with a major in Chemistry, students will be able to:

1. Demonstrate understanding of and proficiency with:
   a. the structure, bonding, spectroscopy, and reactivity of organic compounds and functional groups;
   b. curved-arrow formalism to describe reaction mechanisms, and
   c. the synthesis of organic compounds.
2. Demonstrate understanding of and proficiency with:
   a. thermochemical principles, acid-base and redox reactions,
   b. structure of simple solids and construction of molecular orbital diagrams (group theory), and
   c. survey of main group chemistry.
3. Demonstrate understanding of:
   a. the principles of quantum mechanics and applications to atomic and molecular structure and spectroscopy,
   b. classical and basic statistical thermodynamics and applications to equilibrium physico-chemical systems, and
   c. kinetics of gas phase processes and chemical reactions.
4. Design, conduct, record, and analyze chemical experiments, while practicing responsible and ethical scientific conduct.

Requirements for the BS Degree with a Major in Chemistry

For general university requirements, see Graduation Requirements (https://ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements/). Students pursuing the BS degree with a major in Chemistry must complete:

- A minimum of 24-28 courses, depending on course selection, (69 credit hours) to satisfy major requirements.
- A minimum of 120 credit hours to satisfy degree requirements.
- A minimum of 14-16 courses, depending on course selection, (39 credit hours) at the 300-level or above.
- The requirements for one area of specialization (see below for areas of specialization). The BS degree with a major in Chemistry offers four areas of specialization:
  - Biological and Medicinal Chemistry (p. 2), or
  - Inorganic Chemistry and Inorganic Materials (p. 2), or
  - Organic Chemistry (p. 3), or
  - Physical and Theoretical Chemistry (p. 3).

The courses listed below satisfy the requirements for this major. In certain instances, courses not on this official list may be substituted upon approval of the major's academic advisor, or where applicable, the department's Director of Undergraduate Studies. (Course substitutions must be formally applied and entered into Degree Works by the major's Official Certifier (https://registrar.rice.edu/facstaff/degreeworks/).) Students and their academic advisors should identify and clearly document the courses to be taken.

Summary

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Credit Hours Required for the Major in Chemistry</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Total Credit Hours Required for the BS Degree with a Major in Chemistry</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

Degree Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
</table>
| Core Requirements
  General Chemistry 1
  CHEM 121 & CHEM 123 | GENERAL CHEMISTRY I and GENERAL CHEMISTRY LABORATORY I | 4            |
  Select 1 from the following:
  CHEM 122 & CHEM 124 | GENERAL CHEMISTRY II and GENERAL CHEMISTRY LABORATORY II | 4            |
  CHEM 201 & CHEM 205 | ADVANCED TOPICS IN GENERAL CHEMISTRY and ADVANCED TOPICS IN GENERAL CHEMISTRY LABORATORY | |
  Chemistry Foundation Courses
  BIOS 301 | BIOCHEMISTRY I 2 | 3            |
  Select 1 from the following:
  CHEM 211 & CHEM 213 | ORGANIC CHEMISTRY I and ORGANIC CHEMISTRY DISCUSSION | 3            |
  CHEM 319 | ORGANIC CHEMISTRY I | 3            |
  CHEM 301 | PHYSICAL CHEMISTRY I | 3            |
  CHEM 302 | PHYSICAL CHEMISTRY II | 3            |
  CHEM 330 | ANALYTICAL CHEMISTRY | 3            |
  CHEM 360 | INORGANIC CHEMISTRY | 3            |
  Mathematics 3
  MATH 101 or MATH 105 | SINGLE VARIABLE CALCULUS I or AP/OTH CREDIT IN CALCULUS I | 3            |
  MATH 102 or MATH 106 | SINGLE VARIABLE CALCULUS II or AP/OTH CREDIT IN CALCULUS II | 3            |
  MATH 212 | MULTIVARIABLE CALCULUS 4 | 3            |
  Physics
  Select 1 from the following:
  PHYS 101 & PHYS 103 | MECHANICS (WITH LAB) and MECHANICS DISCUSSION | 4            |
  PHYS 111 | HONORS MECHANICS (WITH LAB) | |
  PHYS 125 | GENERAL PHYSICS (WITH LAB) | |
  Select 1 from the following:
  PHYS 102 & PHYS 104 | ELECTRICITY & MAGNETISM (WITH LAB) and ELECTRICITY AND MAGNETISM DISCUSSION | |
  PHYS 112 | HONORS ELECTRICITY & MAGNETISM (WITH LAB) | |
  PHYS 126 | GENERAL PHYSICS II (WITH LAB) | |
  Advanced Laboratories
  Select 3 courses from the following: | 6            |
BIOS 311  ADVANCED EXPERIMENTAL BIO SCIENCES
CHEM 365  ORGANIC CHEMISTRY LAB
CHEM 366  INORGANIC CHEMISTRY LAB
CHEM 367  MATERIALS CHEMISTRY LAB
CHEM 368  CHEMICAL MEASUREMENT LAB

Research
Select 8 credit hours from the following: 8
CHEM 391  RESEARCH FOR UNDERGRADUATES 5
CHEM 491  UNDERGRADUATE HONORS RESEARCH
CHEM 492  UNDERGRADUATE HONORS RESEARCH
CHEM 493  TEACHING PRACTICUM 6

Area of Specialization
Select 1 from the following Areas of Specialization (see Areas of Specialization below): 12
Biological and Medicinal Chemistry
Inorganic Chemistry and Inorganic Materials
Organic Chemistry
Physical and Theoretical Chemistry

Total Credit Hours Required for the Major in Chemistry 69
Additional Credit Hours to Complete Degree Requirements * 20
University Graduation Requirements (https://ga.rice.edu/undergraduate-students/academic-policies-procedures/graduation-requirements/) * 31
Total Credit Hours 120

Footnotes and Additional Information
* Note: University Graduation Requirements include 31 credit hours, comprised of Distribution Requirements (Groups I, II, and III), FWIS, and LPAP coursework. In some instances, courses satisfying major requirements may additionally meet distribution requirements.

Additional Credit Hours to Complete Degree Requirements include general electives, coursework completed as upper-level, residency (hours taken at Rice), and/or any other additional academic program requirements.

1 CHEM 111 may be substituted for CHEM 121;
CHEM 113 may be substituted for CHEM 123;
CHEM 112 may be substituted for CHEM 122;
CHEM 114 may be substituted for CHEM 124.

2 Chemistry students may enroll in BIOS 301 without the prerequisite BIOS 201 (previously BIOS 201). Requests to waive the prerequisite course are approved by the course instructor. Students should contact the course instructor for more information.

3 Though not required, MATH 211 is strongly recommended for students planning to specialize in Physical and Theoretical chemistry or planning to pursue graduate studies. Additionally, the Department of Mathematics may, after consultation with a student concerning his/her previous math preparation, recommend that a student be placed into a higher level math course than that for which the student has received official credit. The Department of Chemistry will accept this waiver of the math classes upon a written confirmation of the waiver from the Department of Mathematics and upon the student’s successful completion of the higher level math course.

4 MATH 221 and MATH 222 may substitute for MATH 212.

5 CHEM 391 must be taken as part of the Research requirement and for at least 3 credit hours. Enrollment in CHEM 391 requires permission of the course instructor. Students are expected to complete CHEM 391 before the end of their junior year; permission will not normally be granted for students in their final year of undergraduate study.

6 If CHEM 700 is selected as a Research course, it may only be taken for up to 2 credit hours.

Areas of Specialization
To fulfill the remaining Chemistry major requirements, students must complete advanced work that satisfies the requirements of one area of specialization as listed below. A student may, working with his or her chemistry major advisor and with the approval of the Director of the Undergraduate Program, propose a course of study in another specialization. Such proposed areas of specialization must have course and laboratory experiences comparable to those of the areas of specialization listed below.

Additionally, a double specialization can be earned by completing the requirements for two specialties. For double specialization, only two advanced lecture courses may count towards both specializations. The remaining two advanced courses in each specialization must be unique (i.e., double specialization requires six advanced lecture courses, and triple specialization requires eight). A NanoChemistry specialization can be added to any of the standard areas of specialization by adding two nanoscience courses.

Area of Specialization: Biological and Medicinal Chemistry
Students must complete a minimum of 4 courses (12 credit hours) as listed below to satisfy the requirements for the area of specialization in Biological and Medicinal Chemistry.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 212</td>
<td>ORGANIC CHEMISTRY II &amp; CHEM 214 and ORGANIC CHEM DISCUSSION II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 320</td>
<td>ORGANIC CHEMISTRY II</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 302</td>
<td>BIOCHEMISTRY II</td>
<td>3</td>
</tr>
</tbody>
</table>

Advanced Coursework in Chemistry
Select 2 courses from the following: 6
Any lecture course between CHEM 400 and CHEM 489
Any lecture course between CHEM 495 and CHEM 699

Total Credit Hours 12

Area of Specialization: Inorganic Chemistry and Inorganic Materials
Students must complete a minimum of 4 courses (12 credit hours) as listed below to satisfy the requirements for the area of specialization in Inorganic Chemistry and Inorganic Materials.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 475</td>
<td>PHYSICAL METHODS IN INORGANIC CHEMISTRY</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 495</td>
<td>TRANSITION METAL CHEMISTRY</td>
<td>3</td>
</tr>
</tbody>
</table>

Advanced Coursework in Chemistry
Select 2 courses from the following: 6
Any lecture course between CHEM 400 and CHEM 489
Any lecture course between CHEM 495 and CHEM 699

Total Credit Hours 12

Area of Specialization: Organic Chemistry
Students must complete a minimum of 4 courses (12 credit hours) as listed below to satisfy the requirements for the area of specialization in Organic Chemistry.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 212</td>
<td>ORGANIC CHEMISTRY II &amp; CHEM 214 and ORGANIC CHEM DISCUSSION II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 320</td>
<td>ORGANIC CHEMISTRY II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 401</td>
<td>ADVANCED ORGANIC CHEMISTRY</td>
<td>3</td>
</tr>
</tbody>
</table>

Advanced Coursework in Chemistry
Select 2 courses from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 302</td>
<td>BIOCHEMISTRY II</td>
<td>3</td>
</tr>
<tr>
<td>Any lecture course between CHEM 400 and CHEM 489</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Any lecture course between CHEM 495 and CHEM 699</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours 12

Area of Specialization: Physical and Theoretical Chemistry
Students must complete a minimum of 4 courses (12 credit hours) as listed below to satisfy the requirements for the area of specialization in Physical and Theoretical Chemistry.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 420</td>
<td>CLASSICAL AND STATISTICAL THERMODYNAMICS</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 430</td>
<td>QUANTUM CHEMISTRY</td>
<td>3</td>
</tr>
</tbody>
</table>

Select 1 course from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 415</td>
<td>CHEMICAL KINETICS AND DYNAMICS</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 531</td>
<td>ADVANCED QUANTUM CHEMISTRY</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 559</td>
<td>SPECTROSCOPY AT THE SINGLE MOLECULE/PARTICLE LIMIT</td>
<td>3</td>
</tr>
</tbody>
</table>

Select 1 course (for at least 3 credit hours) from MATH or PHYS course offerings at the 400-level or above

Total Credit Hours 12

Footnotes and Additional Information
1 For purposes of this requirement, “advanced coursework” includes chemistry lecture courses at the 400-level or higher (courses in Rice’s course catalog that have a course type listed as “lecture”). CHEM 212 or CHEM 320 or BIOS 302 (previously BIOC 302) count as “advanced coursework” for purposes of this requirement. Courses in other departments at the 400-level or higher with substantial chemistry content may count toward this requirement with approval of the Director of the Undergraduate Program.

Policies for the BS Degree with a Major in Chemistry

Transfer Credit
For Rice University’s policy regarding transfer credit, see Transfer Credit (https://ga.rice.edu/undergraduate-students/academic-policies-procedures/transfer-credit/). Some departments and programs have additional restrictions on transfer credit. The Office of Academic Advising maintains the university’s official list of transfer credit advisors on their website: https://oaa.rice.edu. Students are encouraged to meet with their academic program’s transfer credit advisor when considering transfer credit possibilities.

Departmental Transfer Credit Guidelines
Students pursuing the major in Chemistry should be aware of the following departmental transfer credit guidelines:

- Requests for transfer credit will be considered by the program director (and/or the program’s official transfer credit advisor) on an individual case-by-case basis. Please see https://chemistry.rice.edu/UG-transfer-credit (https://chemistry.rice.edu/UG-transfer-credit/) for more information.

Additional Information
For additional information, please see the Chemistry website: https://chemistry.rice.edu

Opportunities for the BS Degree with a Major in Chemistry

Academic Honors
The university recognizes academic excellence achieved over an undergraduate’s academic history at Rice. For information on university honors, please see Latin Honors (https://ga.rice.edu/undergraduate-students/honors-distinctions/university/) (summa cum laude, magna cum laude, and cum laude) and Distinction in Research and Creative Work (https://ga.rice.edu/undergraduate-students/honors-distinctions/university/). Some departments have department-specific Honors awards or designations.

Honors Research Program in Chemistry
The Chemistry Honors Research Program is a suite of courses (CHEM 492/CHEM 493) offering the opportunity for a rigorous two-semester “capstone” individual research project in Chemistry. This immersive program is intended to give students a first-hand experience of a career in research. Students interested in graduate school are strongly encouraged to apply. Students having completed previous independent research (as CHEM 391 and/or CHEM 491) in an off-campus laboratory in the Texas Medical Center are eligible to apply to perform honors research in that laboratory. The honors research courses (CHEM 492 and CHEM 493) function as a pair and must all be taken in the same academic year. Registration for CHEM 492 requires a commitment to register for CHEM 493.

Students who complete the Chemistry Honors Research Program are given primary consideration for the Distinction in Research and Creative Work, a university honor for select undergraduates, carefully selected by the department and granted at commencement, which appears on the transcript and diploma.

Chemistry Honors Research Program Components
- CHEM 492: Fall semester, 5 credit hours. For approved students only, requires a formal application and recommendation of a faculty research advisor. Requirements include at least 15 hours of laboratory research per week and regular written and/or oral progress reports.
- CHEM 493: Spring semester, 5 credit hours. Requirements include at least 15 hours of laboratory research per week and a formal thesis.
Applications may be submitted to the course instructor, February 1–August 1. Students are encouraged to apply early.

Additional Information
For additional information, please see the Chemistry website: https://chemistry.rice.edu