chemistry major must complete the following courses.

In addition to completing the University's lower-division general education study at the master's and Ph.D. levels, entry into medical, dental, and pharmacy schools, as well as a career in the chemical industry. Students not only gain an excellent education, but also have many research opportunities available to enrich their understanding of real-world problems. Cooperative arrangements exist with the nearby Eastern Virginia Medical School, NASA Langley Research Center and the Thomas Jefferson National Accelerator Facility.

Bachelor of Science–Chemistry Major

Lower Division General Education

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMM 101R</td>
<td>Public Speaking</td>
<td>3</td>
</tr>
<tr>
<td>MATH 163</td>
<td>Precalculus II (required)</td>
<td>3</td>
</tr>
</tbody>
</table>

Mathematics

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 231N</td>
<td>University Physics I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; PHYS 232N</td>
<td>and University Physics</td>
<td>4</td>
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</table>

Impact of Technology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 110C</td>
<td>Writing Intensive Course (W)</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 211C</td>
<td>Academic Writing</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours for Lower Division General Education: 41-47

* Grade of C or better required in both courses

In addition to completing the University's lower-division general education requirements and upper-division general education requirements, a chemistry major must complete the following courses.

Required Chemistry Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 121N</td>
<td>Foundations of Chemistry I Lecture (cannot earn credit for both 121N and 105N)</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 122N</td>
<td>Foundations of Chemistry I Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 123N</td>
<td>Foundations of Chemistry II Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 124N</td>
<td>Foundations of Chemistry II Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 211</td>
<td>Organic Chemistry Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 212</td>
<td>Organic Chemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 213</td>
<td>Organic Chemistry Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 214</td>
<td>Organic Chemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>or CHEM 216</td>
<td>Advanced Organic Chemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 321</td>
<td>Analytical Chemistry Lecture</td>
<td>5</td>
</tr>
<tr>
<td>&amp; CHEM 322</td>
<td>and Analytical Chemistry Laboratory</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 351</td>
<td>Inorganic Chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

1 Chemistry and Biochemistry

CHEM 331 Physical Chemistry Lecture I 3
CHEM 332W Experimental Physical Chemistry I 2
CHEM 333 Physical Chemistry Lecture II 3
CHEM 334W Experimental Physical Chemistry II 2
CHEM 421 Instrumental Analysis Lecture 6
& CHEM 422 and Instrumental Analysis Laboratory
CHEM 441 Biochemistry Lecture 3
CHEM 485 Chemistry and Biochemistry Seminar 1

Select two CHEM Electives from the following: 6

CHEM 415 Intermediate Organic Chemistry
CHEM 439 Introduction to Pharmaceutical Chemistry
CHEM 443 Intermediate Biochemistry
CHEM 449 Environmental Chemistry
CHEM 451 Advanced Inorganic Chemistry
CHEM 453 Essentials of Toxicology

Select one CHEM Laboratory from the following: 1-4

CHEM 352 Inorganic Chemistry Laboratory
CHEM 411 Natural Products Chemistry in the Caribbean
CHEM 442W Biochemistry Laboratory
CHEM 452 Advanced Inorganic Chemistry Laboratory

Other required courses

MATH 211 Calculus I 4
MATH 212 Calculus II 4
MATH 312 Calculus III 4

Elective Credit 1-7

(as needed to meet 120-credit hour requirement)

Total Hours for Upper Division General Education: 66-75

Chemistry majors must have a C or better in all courses required for the major, including prerequisite courses, and must complete a minimum of 12 credits in upper-level (300/400) chemistry courses at Old Dominion University. Written permission by the chief departmental advisor or chair is required prior to taking upper-level chemistry courses at other institutions.

Upper Division General Education

- Option A. Approved Disciplinary Minor (a minimum of 12 hours determined by the department), or second degree or second major.
- Option B: Interdisciplinary Minor (specifically 12 hours, 3 of which may be in the major)
- Option C. International Business and Regional Courses or an approved Certification Program such as teaching licensure
- Option D. Two Upper-Division Courses from outside the College of Sciences and not required by the major (6 hours)

Requirements for Graduation

Requirements for graduation include a minimum cumulative grade point average of 2.00 overall and in the major, a grade of C or better in all courses required for the major, including prerequisite courses, 120 credit hours, which must include both a minimum of 30 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University, completion of ENGL 110C, ENGL 211C or ENGL 221C or ENGL 231C, and the writing intensive (W) course in the major with a grade of C or better, and completion of Senior Assessment. Additional hours may be required to meet the foreign language requirement.

Bachelor of Science–Biochemistry Major

Lower Division General Education

Written Communication * 6
Oral Communication 3
COMM 101R Public Speaking 3
Mathematics

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 163</td>
<td>Precalculus II (required)</td>
<td>3</td>
</tr>
</tbody>
</table>

1 Chemistry and Biochemistry
Biochemistry majors must have a C or better in all courses required for the major, including prerequisite courses, and must complete a minimum of 12 credits in upper-level (300/400) chemistry courses at Old Dominion University. Written permission by the chief departmental advisor or chair is required prior to taking upper-level chemistry courses at other institutions.

Biochemistry majors must have a C or better in all courses required for the major, including prerequisite courses, and must complete a minimum of 30 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University, completion of ENGL 110C, ENGL 211C or ENGL 221C or ENGL 231C, and the writing intensive (W) course in the major with a grade of C or better, and completion of Senior Assessment. Additional hours may be required to meet the foreign language requirement. Biochemistry majors may not use the chemistry minor to fulfill upper-division general education requirements.

### Bachelor of Science—Chemistry Major with Teaching Licensure

This program leads to eligibility for teacher licensure in Virginia and is available only to individuals holding a baccalaureate degree or completing requirements for a Bachelor of Science degree in chemistry. Due to changing University requirements, national accreditation standards, and the Virginia Board of Education education program must satisfy the Virginia Board of Education Required assessments and earn the minimum required grade point averages (GPA).

**Admission**

Students must first declare the chemistry teacher preparation track as their major with the chemistry departmental advisor. All students must apply for and be admitted into the approved chemistry teacher preparation program. Students must meet the required criteria for admission by passing the Virginia Board of Education prescribed assessments and earn the minimum required grade point averages (GPA).

**Virginia Board of Education prescribed assessments**

Old Dominion University students seeking admission to an approved teacher education program must satisfy the Virginia Board of Education Required Assessment for Admission to an Approved Teacher Education Program. This requirement can be satisfied by meeting a passing score in one of the selected criteria below:

1. Passing Praxis I composite score of 532 by December 31, 2013; or
2. Passing Praxis Core Academic Skills Tests beginning January 1, 2014: Reading Score of 156, Writing Score of 162, and Mathematics Score of 150; or

### Requirements for Graduation

Requirements for graduation include a minimum cumulative grade point average of 2.00 overall and in the major, a grade of C or better in all courses required for the major, including prerequisite courses, 120 credit hours, which must include both a minimum of 30 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University.

### Course Descriptions

#### Required Chemistry Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 121N</td>
<td>Foundations of Chemistry I Lecture</td>
<td>4</td>
</tr>
<tr>
<td>&amp; CHEM 122N</td>
<td>Foundations of Chemistry I Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 123N</td>
<td>Foundations of Chemistry II Lecture</td>
<td>3</td>
</tr>
<tr>
<td>&amp; CHEM 124N</td>
<td>Foundations of Chemistry II Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 321</td>
<td>Organic Chemistry Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 322</td>
<td>Organic Chemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 323</td>
<td>Analytical Chemistry Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 440</td>
<td>Biochemistry Lecture</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 441</td>
<td>Biochemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 442W</td>
<td>Intermediate Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 485</td>
<td>Chemistry and Biochemistry Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

**Other Required courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 211</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 212</td>
<td>Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 312</td>
<td>Calculus III</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 231N</td>
<td>University Physics I</td>
<td>8</td>
</tr>
<tr>
<td>&amp; PHYS 232N</td>
<td>University Physics</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 293</td>
<td>Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 303</td>
<td>Genetics</td>
<td>3</td>
</tr>
</tbody>
</table>

**Elective Credit**

(as needed to meet 120-credit hour requirement)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 332W</td>
<td>Experimental Physical Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 351</td>
<td>Inorganic Chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

Two of the following laboratory electives:

- CHEM 411 Natural Products Chemistry in the Caribbean

#### Required Chemistry Courses

**Upper Division General Education**

- **Option A.** Approved Disciplinary Minor (a minimum of 12 hours determined by the department), or second degree or second major.
- **Option B.** Interdisciplinary Minor (specifically 12 hours, 3 of which may be in the major)
- **Option C.** International Business and Regional Courses or an approved Certification Program such as teaching licensure
- **Option D.** Two Upper-Division Courses from outside the College of Sciences and not required by the major (6 hours)
3. Approved substitute test scores:
   a. SAT score of 1000 with at least 450 verbal and 510 mathematics taken prior to April 1, 1995; or
   b. SAT score of 1100 with at least 530 verbal and 530 mathematics taken after April 1, 1995 and before March 2016; or
   c. ACT composite score of 21 with ACT mathematics score of at least 21, and ACT English plus Reading score of at least 37, taken prior to April 1, 1995; or
   d. ACT composite score of 24 with ACT mathematics score of at least 22, and ACT English plus Reading score of at least 46, taken after April 1, 1995; or
   e. PRAXIS I Math test score of 178 by December 31, 2013 and a composite Virginia Communication and Literacy Assessment (hereafter referred to as the VCLA) score of 470; or
   f. Praxis Core Academic Skills Mathematics test score of 150 beginning January 1, 2014 and a VCLA score of 470; or
   g. SAT Mathematics test score of at least 510 taken prior to April 1, 1995 and a VCLA score of 470; or
   h. SAT Mathematics test score of at least 530 taken prior to April 1, 1995 and a composite VCLA score of 470; or
      i. ACT Mathematics test score of at least 21 taken prior to April 1, 1995 and a composite VCLA score of 470; or
      j. ACT Mathematics test score of at least 22 taken after April 1, 1995 and a composite VCLA score of 470.
   * A new SAT test was released in March 2016. Praxis Core substitute scores for the new SAT have not been determined.

For the most current information on the prescribed Virginia Board of Education admission assessment, visit the Teacher Education Services website, http://www.odu.edu/tes and review the Teacher Education Handbook.

**Required grade point averages (GPA)**

- A cumulative GPA of 2.75 is required.
- A major/content GPA of 2.75 is required - all chemistry courses must be passed with a grade of C (2.0) or above and all other science content courses must be passed with a grade of C- or higher.
- A professional education GPA of 2.75 is required – all professional education courses must be passed with a grade of C- or higher.

Although students may enroll in a limited number of education courses, students must be admitted into the approved chemistry teacher preparation program prior to enrolling in any instructional strategies practicum education course. Students must also meet with an education advisor in the Office of Teacher Education Services.

**Continuance**

Students must maintain a cumulative GPA of 2.75, a major/content GPA of 2.75 and a professional education GPA of 2.75. Chemistry courses must be passed with a grade of C (2.0) or higher. The remaining courses required for the major and in the professional education core must be completed with a grade of C- or higher for continuance. A professional education GPA of 2.75 is required for continuance. Students must take and pass the Virginia Communication and Literacy Assessment (VCLA) and the Praxis Subject Assessment, Chemistry content knowledge (formerly Praxis II) prior to or while enrolled in the instructional strategies course. All assessments must be passed prior to the start of the Teacher Candidate Internship Orientation session.

**Background Clearance Requirement**

Old Dominion University requires a background clearance check of candidates interested in many of the professional education programs. Professional education programs have several field experiences that are required for continuance and graduation from the program. The background clearance must be successfully completed prior to a field experience placement. Candidates will be provided a field experience placement when the background check process is completed with resolution of any issues. The process to complete the ODU clearance background check is located at: http://www.odu.edu/success/academic/teacher-education/placement/background-checks. The ODU clearance process includes: an FBI fingerprint, a child protective service/social service review, and a Virginia State Police sex offender registry review. Candidates interested in the professional education programs are advised to complete this clearance process immediately upon entry into the program since the clearance process takes a minimum of eight weeks to complete.

**Virginia Board of Education prescribed assessments**

Virginia Communication and Literacy Assessment (VCLA) – a passing composite score of 470 is required on this reading and writing assessment

Praxis Subject Assessment, Chemistry content knowledge (test code: 5245) – passing score of 153 is required

To review more information on the Virginia Board of Education prescribed assessments visit the Teacher Education Services website, www.odu.edu/tes.

**Graduation**

Requirements for graduation include completion of ENGL 110C, ENGL 211C or ENGL 221C or ENGL 231C, and the writing intensive (W) course in the major with a grade of C or better, completion of the Senior Assessment, a minimum cumulative 2.75 GPA, in the major area, and in the professional education core, with no grade less than a C in the major and C- in the professional education core; successful completion of the Teacher Candidate Internship and a minimum of 132 credit hours, which must include both a minimum of 33 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University. Note that a C (2.0) must be earned in all chemistry courses used to satisfy departmental requirements.

Additional hours may be required to meet the foreign language requirement. The professional education core satisfies the Upper Division General Education requirement.

The curriculum is as follows:

**Lower Division General Education**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 101R</td>
<td>Public Speaking</td>
<td>3</td>
</tr>
<tr>
<td>MATH 163</td>
<td>Precalculus II (required)</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 231N</td>
<td>University Physics I</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 232N</td>
<td>and University Physics</td>
<td>4</td>
</tr>
<tr>
<td>Impact of Technology</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Human Behavior</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

| Total Hours | 41-47 |

* Grade of C or better required in both courses

In addition to completing the University's lower-division general education requirements and upper-division general education requirements, a chemistry major seeking teacher licensure must complete the following courses.
The professional education core courses and requirements

**STEM 101**  
Step 1 – Inquiry Approaches to Teaching STEM  
1

**STEM 102**  
Step 2 - Inquiry Based STEM Lesson Design  
1

**STEM 201**  
Knowing and Learning in STEM Education  
3

**STEM 202**  
Classroom Interactions in STEM Education  
3

**STEM 401**  
Project Based Instruction in STEM Education  
3

**STEM 402**  
Perspectives on STEM  
3

**STEM 485**  
Apprentice Teaching  
9

**CHEM 468**  
Research Methods in Mathematics and Science  
3

Total Hours 26

The courses designated for the minor and taken by students must be completed with an overall cumulative grade point average of 2.00 or better. CHEM 121N/122N and CHEM 123N/124N must be completed as prerequisites for the minor in chemistry and are not included in the calculation of the grade point average for the minor. Additional prerequisite courses may also be required and are not included in the grade point average for the minor. Students electing the minor must complete a minimum of six credit hours in the minor requirement through courses offered by Old Dominion University. Any substitutions must be approved in writing by the chief departmental advisor.

**Prep-optometry Program**

Old Dominion University has an affiliation agreement with the Pennsylvania College of Optometry whereby students may transfer to the latter institution at the end of their third year and/or receive reduced tuition if they are Virginia residents. Students should contact the Office of the Dean, College of Sciences, 757 683-5201 for more information.

**Minor in Chemistry**

The chemistry minor consists of 13 credits of which nine credits must be selected from the following:

Select nine credits from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 213</td>
<td>Organic Chemistry Lecture</td>
</tr>
<tr>
<td>CHEM 321</td>
<td>Analytical Chemistry Lecture</td>
</tr>
<tr>
<td>CHEM 331</td>
<td>Inorganic Chemistry</td>
</tr>
<tr>
<td>CHEM 332W</td>
<td>Experimental Physical Chemistry I</td>
</tr>
<tr>
<td>CHEM 333</td>
<td>Physical Chemistry Lecture II</td>
</tr>
<tr>
<td>CHEM 421</td>
<td>Instrumental Analysis Lecture</td>
</tr>
<tr>
<td>CHEM 441</td>
<td>Biochemistry Lecture</td>
</tr>
<tr>
<td>CHEM 449</td>
<td>Environmental Chemistry</td>
</tr>
<tr>
<td>CHEM 485</td>
<td>Chemistry and Biochemistry Seminar</td>
</tr>
<tr>
<td>CHEM 452</td>
<td>Inorganic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 453</td>
<td>Essentials of Toxicology</td>
</tr>
<tr>
<td>CHEM 499</td>
<td>Senior Thesis I</td>
</tr>
</tbody>
</table>

Select four credits from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 214</td>
<td>Organic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 322</td>
<td>Analytical Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 332W</td>
<td>Experimental Physical Chemistry I</td>
</tr>
<tr>
<td>CHEM 334W</td>
<td>Experimental Physical Chemistry II</td>
</tr>
<tr>
<td>CHEM 335</td>
<td>Environmental Chemistry</td>
</tr>
<tr>
<td>CHEM 351</td>
<td>Environmental Chemistry</td>
</tr>
<tr>
<td>CHEM 442W</td>
<td>Advanced Inorganic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 495</td>
<td>Advanced Inorganic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 499</td>
<td>Advanced Inorganic Chemistry Laboratory</td>
</tr>
</tbody>
</table>

Total Hours 13

Chemistry and Biochemistry
designated by the department to be honors courses. These are termed "Contract Honors Courses." A description of the procedures for these contract courses is found in the Honors College section of this Catalog.

Advanced Placement
Students who receive a qualifying score on the Advanced Placement of the College Board exam in chemistry may receive credit for introductory chemistry courses. Students who score a 3 on the AP exam may receive 4 credits for either CHEM 105N/CHEM 106N or CHEM 121N/CHEM 122N. The appropriate credit will be determined after consultation with an advisor. Students who receive a score of 4 or 5 on the AP exam will receive 8 credits for CHEM 121N/CHEM 122N - CHEM 123N/CHEM 124N. Credit for CHEM 107N/CHEM 108N is not awarded by the AP exam. Students may also refer to the section of this Catalog on Prior Learning Assessment Credit Options at the Undergraduate Level.

CHEMISTRY AND BIOCHEMISTRY Courses

CHEM 103. Introductory Chemistry. 3 Credits.
An introductory course designed to acquaint the student with the basic principles of chemistry. Prerequisite: knowledge of basic algebra.

CHEM 105N. Introductory Chemistry. 3 Credits.
This course is the first part of a two-semester sequence of chemistry covering topics in general, organic, and biological chemistry. In this part, an introduction to the principles of inorganic (general) chemistry is provided. The topics to be covered include measurements, atoms and elements, compounds and their bonds, energy and matter, gases, solutions, acids and bases, chemical reactions and quantities, chemical equilibrium, and nuclear chemistry. This course does not meet the prerequisite for CHEM 123N, and cannot be used toward the CHEM major or minor. Students wishing to pursue advanced study in chemistry should take CHEM 121N, CHEM 122N, CHEM 123N, and CHEM 124N. Credit for CHEM 105N is not allowed if a student has prior credit for CHEM 121N. CHEM 105N + CHEM 106N satisfy four credits of the University's Nature of Science general education requirement. Corequisite: CHEM 106N. Prerequisite: knowledge of basic algebra.

CHEM 106N. Introductory Chemistry Laboratory. 1 Credit.
An introduction to common laboratory techniques and the process of science is provided. CHEM 105N + CHEM 106N satisfy four credits of the University's Nature of Science general education requirement. Pre- or corequisite: CHEM 105N.

CHEM 107N. Introductory Organic and Biochemistry. 3 Credits.
This course is the second part of a two-semester sequence of chemistry covering topics in general, organic, and biological chemistry. In this part, an introduction to organic compounds and their role in biological systems is provided. The topics to be covered include the structure, nomenclature, and reactivity of organic compounds, the structure and function of important biomolecules, and the chemistry of metabolic pathways. This course does not meet the prerequisite for CHEM 211, and cannot be used toward the CHEM major or minor. Students wishing to pursue advanced study in chemistry should take CHEM 121N, CHEM 122N, CHEM 123N, and CHEM 124N. CHEM 107N + CHEM 108N satisfy four credits of the University's Nature of Science general education requirement. Corequisite: CHEM 108N. Prerequisite: CHEM 105N with a grade of C or better.

CHEM 108N. Introductory Organic and Biochemistry Laboratory. 1 Credit.
Laboratory experiments involving organic compounds and biomolecules are performed. CHEM 107N + CHEM 108N satisfy four credits of the University's Nature of Science general education requirement. Prerequisite: CHEM 106N with a grade of C or better. Pre- or corequisite: CHEM 107N.

CHEM 121N. Foundations of Chemistry I Lecture. 3 Credits.
This is the first of a two-course series, designed for science and engineering majors, that prepares the student for subsequent studies in molecular science and constitutes the foundation for all upper-level chemistry courses. Topics include the descriptive chemistry of selected elements, modern atomic and molecular structure, stoichiometry, thermochemistry, and gas laws. A student receiving credit for CHEM 121N cannot receive additional credit for CHEM 103 or CHEM 105N or CHEM 137N. CHEM 121N + CHEM 122N satisfy 4 credits of the University's Nature of Science general education requirement. Prerequisites: MATH 102M or MATH 103M or higher with a grade of C or better and a qualifying score on the Chemistry Placement Exam or successful completion of the Chemistry Placement online modules or CHEM 103 or CHEM 105N with a grade of C or better. Pre- or corequisites: CHEM 122N.

CHEM 122N. Foundations of Chemistry I Laboratory. 1 Credit.
Laboratory experiments are designed to complement the topics presented in the companion lecture course, CHEM 121N. A student receiving credit for CHEM 122N cannot receive additional credit for CHEM 106N. CHEM 121N + CHEM 122N satisfy 4 credits of the University's Nature of Science general education requirement. Pre- or corequisite: CHEM 121N.

CHEM 123N. Foundations of Chemistry II Lecture. 3 Credits.
This is the second of a two-course series, designed for science majors, that prepares the student for subsequent studies in molecular science and constitutes the foundation for all upper-level chemistry courses. Topics include states of matter, solutions, electrochemistry, thermodynamics, equilibria, and kinetics. CHEM 123N + CHEM 124N satisfy 4 credits of the University's Nature of Science general education requirement. Prerequisite: CHEM 121N with a grade of C or better. Pre- or corequisite: CHEM 124N.

CHEM 124N. Foundations of Chemistry II Laboratory. 1 Credit.
Laboratory experiments are designed to complement the topics in the companion lecture course, CHEM 123N. CHEM 123N + CHEM 124N satisfy 4 credits of the University's Nature of Science general education requirement. Prerequisites: CHEM 121N and CHEM 122N with grades of C or better. Pre- or corequisite: CHEM 123N.

CHEM 137N. Advanced General Chemistry I and II Lecture. 4 Credits.
This lecture, along with CHEM 138N, will fulfill all requirements for a complete year of general chemistry. This combination will satisfy all general chemistry prerequisites for upper level chemistry courses. Prerequisite: Chemistry Placement Exam with a score of 4 or better. Pre- or corequisite: MATH 162M.

CHEM 138N. Advanced General Chemistry I and II Laboratory. 4 Credits.
This laboratory course is intended for students who have completed CHEM 137N. Experiments cover foundational topics and skills in chemistry and introduce students to chemical research. Prerequisite: CHEM 137N.

CHEM 171T. Influence of Polymers on Society. 3 Credits.
In this course, the history of synthetic and natural polymers will be studied from their initial development to modern day. Through these studies, students will learn how polymers are produced, the properties of polymers, and the many applications of polymers. Further, the impact these materials have on society will be examined in many different areas such as medicine, electronics, consumer goods and the environment.

CHEM 173T. Nutritional Biochemistry. 3 Credits.
Students will explore the role of biotechnology plays in understanding and advancing nutrition and the effects this has on human health, development and societies. The key biological molecules such as vitamins, amino acids, proteins, fats and carbohydrates and their nutritional functions will be discussed. Nutritional biochemistry as it relates to human development, medicine and the evolution of human species will be explored. Students will review present day nutritional issues such as popular diets, organic foods, farming practices and advances such as genetically modified foods.

CHEM 195. Selected Topics. 1-3 Credits.
Selected laboratory or lecture topics designed for students who need to supplement a transfer course to fulfill a course requirement. Prerequisite: permission of the chief departmental advisor or chair of the department.
CHEM 211. Organic Chemistry Lecture. 3 Credits.
Introduction to organic compounds, isomerism and nomenclature, stereochemistry and conformational analysis, in depth mechanistic understanding of proton transfer reactions, substitution and elimination reactions, and addition to C=C bonds. Prerequisites: CHEM 123N or CHEM 137N with a grade of C or better.

CHEM 212. Organic Chemistry Laboratory. 2 Credits.
Experience is offered in fundamental laboratory techniques applicable to the characterization, separation and purification of various organic compounds including stereoisomers and introduction to organic reactions. Prerequisites: CHEM 124N or CHEM 138N with a grade of C or better. Pre- or corequisite: CHEM 211 with a grade of C or better.

CHEM 213. Organic Chemistry Lecture. 3 Credits.
Chemistry of carbon compounds with in-depth treatments of reaction mechanisms, modern spectral techniques, and new synthetic methods to meet the needs of chemistry and biochemistry majors. Prerequisite: CHEM 211 with a grade of C or better.

CHEM 214. Organic Chemistry Laboratory. 2 Credits.
Experience is offered in synthetic, separation, and analytical methods of organic chemistry. Modern synthetic and spectroscopic techniques are introduced. Prerequisites: CHEM 212 with a grade of C or better. Pre- or corequisite: CHEM 213 with a grade of C or better.

CHEM 216. Advanced Organic Chemistry Laboratory. 2 Credits.
Experience is offered in advanced organic reactions and spectroscopic techniques. In addition, students will carry out a short, customized, research project in Organic Chemistry or Organic Materials. Prerequisites: CHEM 211 and CHEM 212 with a grade of C or better; approval by the course instructor or coordinator. Pre- or corequisite: CHEM 213.

CHEM 321. Analytical Chemistry Lecture. 3 Credits.
A study of the fundamental principles of quantitative chemical analysis including the application of principles of equilibria to analytical processes. Emphasis is given to gravimetric and titrimetric methods as well as consideration of electrical, optical, and other methods of chemical analysis. Prerequisites: CHEM 134N or CHEM 138N and MATH 163 with a grade of C or better.

CHEM 322. Analytical Chemistry Laboratory. 2 Credits.
Statistical principles or measurements and error analysis are integrated with experiments designed to evaluate and refine techniques of fundamental measurements to a level of analytical competency. These techniques are applied to the analysis of samples using gravimetric, titrimetric, electrical, and optical methods. Prerequisite: CHEM 124N or CHEM 138N with a grade of C or better. Pre- or corequisite: CHEM 321 or permission of the instructor.

CHEM 331. Physical Chemistry Lecture I. 3 Credits.
Quantum chemistry, molecular structure, and spectroscopy. Prerequisites: CHEM 321, CHEM 213 and PHYS 231N-PHYS 232N with a grade of C or better. Pre-or corequisite: MATH 312 with a grade of C or better.

CHEM 332W. Experimental Physical Chemistry I. 2 Credits.
Physical chemical techniques are applied to studies on thermodynamics, solution phenomena, gases, electrochemistry, chemical kinetics, and spectroscopy. Statistical analysis of data. (This is a writing intensive course.) Prerequisite: grade of C or better in ENGL 211C or ENGL 221C or ENGL 231C. Pre- or corequisite: CHEM 331 with a grade of C or better.

CHEM 333. Physical Chemistry Laboratory II. 3 Credits.
Chemical thermodynamics of pure substances and solutions, chemical equilibrium, electrochemistry, chemical kinetics, and statistical thermodynamics. Prerequisites: CHEM 331 with a grade of C or better.

CHEM 334W. Experimental Physical Chemistry II. 2 Credits.
Physical chemical techniques are applied to studies on thermodynamics, solution phenomena, gases, electrochemistry, chemical kinetics, and spectroscopy. Statistical analysis of data. (This is a writing intensive course.) Prerequisite: grade of C or better in ENGL 211C or ENGL 221C or ENGL 231C. Pre- or corequisite: CHEM 332W and CHEM 333 with a grade of C or better.

CHEM 339T. The Chemistry of the Environment. 3 Credits.
This class explores the impact of chemical technologies on current environmental topics using basic chemical principles and the scientific method as standards for evaluating and understanding pressing environmental issues. Topics include global and ocean warming, air pollution, atmospheric ozone depletion, effects of enhanced UV light, acid rain and ocean acidification, toxic heavy metals, radioactivity and nuclear power plant disasters, indoor air quality and radon, water pollution, sewage and water treatment, drinking water quality, waste disposal and plastics, pesticides, and the food chain. The course will use math to a modest degree including basic Algebra. It is highly recommended that students have passed a college level algebra math class (e.g., MATH 102M or MATH 103M or higher) and one year of high school chemistry. Prerequisites: Any General Education Nature of Science (N) course.

CHEM 343T. Science and Technology in Art. 3 Credits.
This combined lecture and lab course will explore the chemical and physical properties of artists’ materials from pigments and binders to ceramics. Topics will include the nature of light and color, historical origins and development of pigments and artistic methods, synthesis of dyes and pigments, and the application of technology to art historical analysis. The course will include hands-on experience with modern laboratory equipment and field trips to local museums and conservation labs. Prerequisites: Completion of one Nature of Science general education course or permission of the instructor.

CHEM 351. Inorganic Chemistry. 3 Credits.
This foundational course provides an introduction to inorganic chemistry. Topics include periodic law, bonding theory, oxidation/reduction, acid/base theory, descriptive chemistry of the main group, an introduction to transition metal coordination chemistry, and human applications of inorganic chemistry. Prerequisites: Grade of C or better in CHEM 137N or CHEM 123N.

CHEM 352. Inorganic Chemistry Laboratory. 2 Credits.
Synthesis of metal and nonmetal inorganic compounds and organometallic compounds, their characterization by physical methods, and a study of their properties. Pre- or corequisite: CHEM 351 with a grade of C or better.

CHEM 365. Undergraduate Teaching Experience. 1-3 Credits.
Teaching experience in a chemistry classroom or laboratory setting under the direct supervision of the course instructor. Prerequisite: junior standing and/or approval of the appropriate departmental coordinator. Available for Pass/Fail grading only.

CHEM 367. Cooperative Education. 1-3 Credits.
May be repeated for credit. Student participation for credit is based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and the Cooperative Education program prior to the semester in which the work experience is to take place. Available for pass/fail grading only. (qualifies as a CAP experience) Prerequisite: approval by the department and Cooperative Education/Career Development Services in accordance with the policy for granting credit for Cooperative Education programs.

CHEM 369. Chemistry Practicum. 1-3 Credits.
A student may choose a coop, internship, research, or student teaching experience to gain out-of-class experience related to the major. (qualifies as a CAP experience) Prerequisites: CHEM 331/CEM 332W (Chemistry major) or CHEM 441/CEM 442W (Biochemistry major) and the approval of the appropriate departmental coordinator.

CHEM 411/511. Natural Products Chemistry in the Carribbean. 4 Credits.
A bioinorganic and natural products course that entails the chemistry of the use of chromium, vanadium, and herbs in medicine and the use of tunicates as biomonitors of heavy metal pollution in Jamaica. This is a study abroad course intended for the Maymester term. Prerequisites: CHEM 211 and CHEM 212 with a C or better.

CHEM 415/515. Intermediate Organic Chemistry. 3 Credits.
An in-depth look at organic reaction mechanisms, including polar, pericyclic, radical and organometallic reactions. Prerequisites: CHEM 211-CHEM 213 with a grade of C or better.

CHEM 369. Chemistry Practicum. 1-3 Credits.
May be repeated for credit. Student participation for credit is based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and the Cooperative Education program prior to the semester in which the work experience is to take place. Available for pass/fail grading only. (qualifies as a CAP experience) Prerequisite: approval by the department and Cooperative Education/Career Development Services in accordance with the policy for granting credit for Cooperative Education programs.

CHEM 367. Cooperative Education. 1-3 Credits.
May be repeated for credit. Student participation for credit is based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and the Cooperative Education program prior to the semester in which the work experience is to take place. Available for pass/fail grading only. (qualifies as a CAP experience) Prerequisite: approval by the department and Cooperative Education/Career Development Services in accordance with the policy for granting credit for Cooperative Education programs.
CHEM 421/521. Instrumental Analysis Lecture. 3 Credits.
Designed to be taken concurrently with CHEM 422/CHEM 522. A study of the basic principles of spectroscopic, chromatographic, and electrochemical methods of quantitative chemical analysis. Methods of chemical instrumentation are also included. Prerequisite: CHEM 331 with a grade of C or better.

CHEM 422/522. Instrumental Analysis Laboratory. 3 Credits.
An intensive laboratory study of the principles of analytical chemistry. Experiments in spectroscopic, chromatographic, and electrochemical methods are conducted to illustrate fundamental principles and to provide the opportunity to develop skills in the use of instrumentation for chemical measurement. Prerequisite: CHEM 332W with a grade of C or better. Pre- or corequisite: CHEM 421/CHEM 521 with a grade of C or better.

CHEM 439/539. Introduction to Pharmaceutical Chemistry. 3 Credits.
An introduction to the fundamental concepts of drug action including pharmacodynamics (effect of drugs on the body) and pharmacokinetics (ADME: absorption, distribution, metabolism and elimination) of drugs; an introduction to the process of new drug discovery and synthesis will also be taught. Prerequisites: CHEM 213 and CHEM 214 (or CHEM 216) with a grade of "C" or higher; CHEM 321 and CHEM 441 recommended.

CHEM 441/541. Biochemistry Lecture. 3 Credits.
This course is a one-semester survey of the major molecular constituents, bioenergetics, enzymes, nucleic acid structure, and genetic information transfer pathways fundamental to biochemistry. Prerequisite: CHEM 213 with a grade of C or better.

CHEM 442W/542. Biochemistry Laboratory. 4 Credits.
Principles and techniques of biochemical and immunological procedures involving protein characterization and isolation, enzymology, bioinformatics, and common molecular biology techniques for nucleic acids will be presented. (This is a writing intensive course.) Prerequisite: CHEM 214 with a grade of C or better and ENGL 211C or ENGL 221C or ENGL 231C with a grade of C or better. Pre- or corequisite: CHEM 441/ CHEM 541 with a grade of C or better.

CHEM 443/543. Intermediate Biochemistry. 3 Credits.
This course presents and in-depth study of protein structure, folding, and synthesis. The major metabolic pathways will be studied in detail regarding thermodynamics and mechanism of regulation or control of individual enzymes and entire metabolic pathways. Concepts of metabolic disease will be introduced and effects on integrated metabolism will be presented. Prerequisite: CHEM 441/CHEM 541 with a grade of C or better or equivalent.

CHEM 449/549. Environmental Chemistry. 3 Credits.
An overview of the natural chemical systems operating in the atmosphere, in the terrestrial environment (both water and soils), and in the oceans, and the potential effects that human activities may have on them. Specific topics include the origin and evolution of the earth and life, the chemistry of the atmosphere (including the ozone layer and greenhouse effect), the organic and inorganic components of soil and water, chemical weathering of rocks, metal complexation, biological processes in soil and water, and global-scale chemical processes. Prerequisites: CHEM 123N or CHEM 137N, CHEM 213 and CHEM 321 with a grade of C or higher or permission of the instructor.

CHEM 451/551. Advanced Inorganic Chemistry. 3 Credits.
Theoretical aspects of modern inorganic chemistry: bonding theories, stereochemistry, acid-base theories, coordination compounds, organometallic and bioinorganic compounds. Prerequisites: CHEM 351 with a grade of C or better.

CHEM 452/552. Advanced Inorganic Chemistry Laboratory. 2 Credits.
Synthesis of metal and nonmetal inorganic compounds and organometallic compounds, their characterization by modern physical methods, and a study of their properties. Prerequisites: CHEM 351 and CHEM 352.

CHEM 453/553. Essentials of Toxicology. 3 Credits.
Fundamental principles of toxicology: dose-response relationship, toxicologic testing, chemical and biological factors influencing toxicity, organ toxicity, carcinogenesis, mutagenesis, teratogenesis. Prerequisite: CHEM 213 with a grade of C or higher.

CHEM 460/560. Frontiers in Nanoscience and Nanotechnology. 1 Credit.
Nanotechnology presents unparalleled opportunities for advances in technology and medicine. Simultaneously, nanotechnology presents new challenges to organisms and to our environment. These undefined risk factors threaten to slow the development of new technologies and novel medical therapies. This course will review: structure, synthesis and properties of key nanomaterials; key applications of nanomaterials in technology and medicine; and impacts of nanomaterials on plant and animal physiology and the environment more generally. This course will be team-taught by faculty members in Biological Sciences, Chemistry and Biochemistry, and Engineering. Prerequisite: junior standing.

CHEM 468. Research Methods in Mathematics and Science. 3 Credits.
Emphasizes the tools and techniques used to solve scientific problems. Topics include use and design of experiments, use of statistics to interpret experimental results, mathematical modeling of scientific phenomena, and oral and written presentation of scientific results. Students will perform four independent inquiries, combining skills from mathematics and science to solve research problems. Required for Chemistry teaching licensure track; not available as upper-division elective in content area. Prerequisites: CHEM 331 and admission to the MonarchTeach program.

CHEM 485. Chemistry and Biochemistry Seminar. 1 Credit.
The formal presentation of a chemical or biochemical topic before students and faculty. Students will also take Major Field Test during this course. Prerequisite: CHEM 331 and Senior standing.

CHEM 490. Senior Thesis I. 1 Credit.
Part one of a two-semester thesis project involving literature research, development of scientific writing skills, and obtaining lab experience using a variety of techniques and equipment. Each student will undertake a research experience under the supervision of a departmental faculty member. A preliminary report of research findings is required at the end of the semester. Prerequisite: Chemistry or Biochemistry major; Senior standing; Cumulative GPA of 3.20 or higher.

CHEM 495. Selected Topics. 1-3 Credits.
Study of selected topics. Prerequisite: permission of the instructor.

CHEM 497. Independent Study. 1 Credit.
An opportunity is afforded students to undertake independent study or an original investigation under the direction of a faculty member. Prerequisites: course background appropriate to the proposed study project and approval of the department chair and the faculty/research advisor.

CHEM 498. Independent Study. 2 Credits.
An opportunity is afforded students to undertake independent study or an original investigation under the direction of a faculty member. Prerequisites: course background appropriate to the proposed study project and approval of the department chair and the faculty/research advisor.

CHEM 499. Senior Thesis II. 2 Credits.
Continuation of CHEM 490. The research culminates in a thesis that includes a literature review, description of methods, results and conclusions, and an oral presentation. Prerequisite: CHEM 490 and a cumulative GPA of 3.20 or better.