

# CHEMISTRY, BS

Banner Code: SC-BS-CHEM

## Academic Advising

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This program is approved by the American Chemical Society (<https://www.acs.org/content/acs/en.html>). Upon completion, students who choose either the B.S. in Chemistry with no concentration or the Analytical and Environmental Chemistry concentration are certified to the society. Students planning professional careers in chemistry should choose this degree.

## Teacher Licensure

Students who wish to become teachers and plan to seek teacher licensure should consider the following options:

- Secondary Education – Chemistry (6-12) Undergraduate Certificate
- Chemistry, BA or BS/Curriculum and Instruction, Accelerated MED (Secondary Education Chemistry concentration)

Interested students should attend an information session early in their undergraduate career. For more information, visit the Graduate School of Education's website (<http://gse.gmu.edu>).

## Admissions & Policies

### Admissions

University-wide admissions policies can be found in the Undergraduate Admissions Policies section of this catalog.

To apply for this program, please complete the George Mason University Admissions Application (<https://www2.gmu.edu/admissions-aid/apply-now>).

### Policies

Students must fulfill all Requirements for Bachelor's Degrees, including the Mason Core.

CHEM 336 Physical Chemistry Lab I or CHEM 465 Biochemistry Lab will fulfill the writing intensive requirement for students majoring in chemistry.

## Requirements

### Degree Requirements

Total credits: minimum 120

Students should refer to the Admissions & Policies tab for specific policies related to this program.

Students majoring in chemistry must complete the chemistry program requirements with a minimum GPA of 2.30 and present no more than two courses with a grade of 'D' (1.00) in CHEM coursework at graduation.

### BS without Concentration

Students who do not select an optional concentration complete the curriculum requirements listed below.

#### Mathematics Courses

|               |   |    |
|---------------|---|----|
| MATH 113      | Analytic Geometry and Calculus I (Mason Core) | 4  |
| MATH 114      | Analytic Geometry and Calculus II             | 4  |
| MATH 213      | Analytic Geometry and Calculus III            | 3  |
| Total Credits |   | 11 |

#### In-Depth Electives

|                                |   |   |
|--------------------------------|---|---|
| Select one from the following: |   | 3 |
| CHEM 413                       | Synthetic and Mechanistic Organic Chemistry |   |
| CHEM 427                       | Aquatic Environmental Chemistry             |   |
| CHEM 438                       | Atmospheric Chemistry                       |   |
| CHEM 458                       | Chemical Oceanography                       |   |
| CHEM 464                       | General Biochemistry II                     |   |
| CHEM 467                       | The Chemistry of Enzyme-Catalyzed Reactions |   |
| CHEM 468                       | Bioorganic Chemistry                        |   |
| Total Credits                  |   | 3 |

#### Additional Chemistry Courses

|   |  |    |
|---|--|----|
| CHEM 211  | General Chemistry I (Mason Core)                     | 3  |
| CHEM 213  | General Chemistry Laboratory I (Mason Core)          | 1  |
| CHEM 212  | General Chemistry II (Mason Core)                    | 3  |
| CHEM 214  | General Chemistry Laboratory II (Mason Core)         | 1  |
| CHEM 313  | Organic Chemistry I                                  | 3  |
| CHEM 314  | Organic Chemistry II                                 | 3  |
| CHEM 315  | Organic Chemistry Lab I                              | 2  |
| CHEM 318  | Organic Chemistry Lab II                             | 2  |
| CHEM 321  | Quantitative Chemical Analysis                       | 4  |
| CHEM 331  | Physical Chemistry I                                 | 3  |
| CHEM 332  | Physical Chemistry II                                | 3  |
| CHEM 336  | Physical Chemistry Lab I <sup>1</sup>                | 2  |
| CHEM 337  | Physical Chemistry Lab II                            | 2  |
| CHEM 422  | Instrumental Methods of Chemical Analysis            | 3  |
| CHEM 423  | Instrumental Methods of Chemical Analysis Laboratory | 2  |
| CHEM 441  | Properties and Bonding of Inorganic Compounds        | 3  |
| CHEM 445  | Inorganic Preparations and Techniques                | 2  |
| CHEM 463  | General Biochemistry I                               | 4  |
| Select 3 credits of chemistry electives (any lecture, lab, or research course(s)) |  | 3  |
| Total Credits   |  | 49 |

<sup>1</sup> Fulfills the writing intensive requirement.

### Physics Courses

Mason Core: Natural Science courses:

|               |   |   |
|---------------|---|---|
| PHYS 160      | University Physics I (Mason Core)             | 3 |
| PHYS 161      | University Physics I Laboratory (Mason Core)  | 1 |
| PHYS 260      | University Physics II (Mason Core)            | 3 |
| PHYS 261      | University Physics II Laboratory (Mason Core) | 1 |
| Total Credits |   | 8 |

### Concentration in Analytical and Environmental Chemistry (AEC)

Students planning professional careers in an industry involving chemical measurements, careers with a chemistry emphasis in the environmental science, or those seeking graduate study in analytical or environmental chemistry should choose this program.

#### Chemistry Courses

|                         |   |    |
|-------------------------|---|----|
| CHEM 211                | General Chemistry I (Mason Core)  | 3  |
| CHEM 213                | General Chemistry Laboratory I (Mason Core)                             | 1  |
| CHEM 212                | General Chemistry II (Mason Core)                                       | 3  |
| CHEM 214                | General Chemistry Laboratory II (Mason Core)                            | 1  |
| CHEM 313                | Organic Chemistry I   | 3  |
| CHEM 314                | Organic Chemistry II  | 3  |
| CHEM 315                | Organic Chemistry Lab I   | 2  |
| CHEM 318                | Organic Chemistry Lab II  | 2  |
| CHEM 321                | Quantitative Chemical Analysis  | 4  |
| CHEM 331                | Physical Chemistry I  | 3  |
| CHEM 332                | Physical Chemistry II   | 3  |
| CHEM 336                | Physical Chemistry Lab I <sup>1</sup>                                   | 2  |
| CHEM 337                | Physical Chemistry Lab II   | 2  |
| CHEM 422                | Instrumental Methods of Chemical Analysis                               | 3  |
| CHEM 423                | Instrumental Methods of Chemical Analysis Laboratory                    | 2  |
| CHEM 427<br>or CHEM 458 | Aquatic Environmental Chemistry<br>Chemical Oceanography                | 3  |
| CHEM 438                | Atmospheric Chemistry   | 3  |
| CHEM 463                | General Biochemistry I  | 4  |
| CHEM 441<br>or CHEM 446 | Properties and Bonding of Inorganic Compounds<br>Bioinorganic Chemistry | 3  |
| CHEM 465<br>or CHEM 445 | Biochemistry Lab <sup>1</sup><br>Inorganic Preparations and Techniques  | 2  |
| Total Credits           |   | 52 |

<sup>1</sup> Fulfills the writing intensive requirement.

### Physics Courses

Mason Core: Natural Science courses:

|          |                                   |   |
|----------|-----------------------------------|---|
| PHYS 160 | University Physics I (Mason Core) | 3 |
|----------|-----------------------------------|---|

|               |   |   |
|---------------|---|---|
| PHYS 161      | University Physics I Laboratory (Mason Core)  | 1 |
| PHYS 260      | University Physics II (Mason Core)            | 3 |
| PHYS 261      | University Physics II Laboratory (Mason Core) | 1 |
| Total Credits |   | 8 |

### Mathematics Courses

|               |   |    |
|---------------|---|----|
| MATH 113      | Analytic Geometry and Calculus I (Mason Core) | 4  |
| MATH 114      | Analytic Geometry and Calculus II             | 4  |
| MATH 213      | Analytic Geometry and Calculus III            | 3  |
| Total Credits |   | 11 |

### Supporting Science Electives

Select one of the following options: 7-8

#### Option One:

|          |                                     |
|----------|-------------------------------------|
| GEOL 101 | Introductory Geology I (Mason Core) |
| GEOL 309 | Introduction to Oceanography        |

#### Option Two: (Mason Core: Natural Science courses)

|          |   |
|----------|---|
| EVPP 110 | The Ecosphere: An Introduction to Environmental Science I (Mason Core)  |
| EVPP 111 | The Ecosphere: An Introduction to Environmental Science II (Mason Core) |

#### Option Three:

|  |                                 |
|--|---------------------------------|
| CHEM 341   | Fundamental Inorganic Chemistry |
| Select at least 4 additional credits of the following: |                                 |
| CHEM 355   | Undergraduate Research          |
| CHEM 451   | Special Projects in Chemistry   |
| CHEM 452   | Special Projects in Chemistry   |

Total Credits 7-8

The discipline sequences may be interchanged only with approval by the program coordinator.

### Concentration in Biochemistry (BC)

Students planning professional careers in biochemistry, the pharmaceutical industry, medicine, biotechnology, or related fields with a chemistry emphasis should choose this program instead of the Chemistry, BS without a concentration. This concentration provides students with a focus on biochemistry while retaining a strong chemistry foundation. Students are allowed to tailor the concentration to their interests with 9 credits of science electives.

#### Chemistry Courses

|          |  |   |
|----------|--|---|
| CHEM 211 | General Chemistry I (Mason Core)             | 3 |
| CHEM 213 | General Chemistry Laboratory I (Mason Core)  | 1 |
| CHEM 212 | General Chemistry II (Mason Core)            | 3 |
| CHEM 214 | General Chemistry Laboratory II (Mason Core) | 1 |
| CHEM 313 | Organic Chemistry I                          | 3 |
| CHEM 314 | Organic Chemistry II                         | 3 |
| CHEM 315 | Organic Chemistry Lab I                      | 2 |
| CHEM 318 | Organic Chemistry Lab II                     | 2 |
| CHEM 321 | Quantitative Chemical Analysis               | 4 |

|               |                                       |    |
|---------------|---------------------------------------|----|
| CHEM 331      | Physical Chemistry I                  | 3  |
| CHEM 336      | Physical Chemistry Lab I <sup>1</sup> | 2  |
| CHEM 446      | Bioinorganic Chemistry                | 3  |
| CHEM 463      | General Biochemistry I                | 4  |
| CHEM 464      | General Biochemistry II               | 3  |
| CHEM 465      | Biochemistry Lab <sup>1</sup>         | 2  |
| Total Credits |                                       | 39 |

<sup>1</sup> Fulfills the writing intensive requirement.

### Mathematics Courses

|               |   |   |
|---------------|---|---|
| MATH 113      | Analytic Geometry and Calculus I (Mason Core) | 4 |
| MATH 114      | Analytic Geometry and Calculus II             | 4 |
| Total Credits |   | 8 |

### Physics Courses

Select one Mason Core: Natural Science option: 8

#### Option One:

|          |                                  |  |
|----------|----------------------------------|--|
| PHYS 243 | College Physics (Mason Core)     |  |
| PHYS 244 | College Physics Lab (Mason Core) |  |
| PHYS 245 | College Physics (Mason Core)     |  |
| PHYS 246 | College Physics Lab (Mason Core) |  |

#### Option Two:

|          |   |  |
|----------|---|--|
| PHYS 160 | University Physics I (Mason Core)             |  |
| PHYS 161 | University Physics I Laboratory (Mason Core)  |  |
| PHYS 260 | University Physics II (Mason Core)            |  |
| PHYS 261 | University Physics II Laboratory (Mason Core) |  |

Total Credits 8

### Biology Courses

|               |  |   |
|---------------|--|---|
| BIOL 213      | Cell Structure and Function (Mason Core) | 4 |
| BIOL 305      | Biology of Microorganisms                | 3 |
| BIOL 306      | Biology of Microorganisms Laboratory     | 1 |
| Total Credits |  | 8 |

### Approved Science Electives

Select 9 credits of approved science electives chosen from CHEM or BIOL courses numbered 302-499 <sup>1</sup> 9

Total Credits 9

<sup>1</sup> Other science or math courses may be approved as electives, subject to prior approval of the coordinator.

## Concentration in Chemistry Education (CHME)

Those interested in teaching high school chemistry should choose this concentration. Degree completion with this concentration will lead to state licensure to teach in Virginia.

### Chemistry Courses

|          |   |   |
|----------|---|---|
| CHEM 211 | General Chemistry I (Mason Core)            | 3 |
| CHEM 213 | General Chemistry Laboratory I (Mason Core) | 1 |
| CHEM 212 | General Chemistry II (Mason Core)           | 3 |

|  |  |    |
|--|--|----|
| CHEM 214   | General Chemistry Laboratory II (Mason Core)   | 1  |
| CHEM 313   | Organic Chemistry I                            | 3  |
| CHEM 314   | Organic Chemistry II                           | 3  |
| CHEM 315   | Organic Chemistry Lab I                        | 2  |
| CHEM 321   | Quantitative Chemical Analysis                 | 4  |
| CHEM 331   | Physical Chemistry I                           | 3  |
| CHEM 446   | Bioinorganic Chemistry                         | 3  |
| CHEM 463   | General Biochemistry I                         | 4  |
| CHEM 336   | Physical Chemistry Lab I <sup>1</sup>          | 2  |
| or CHEM 465  | Biochemistry Lab                               |    |
| CHEM 470   | Laboratory Instructional Methods for Chemistry | 3  |
| Select one 3 credit upper-level chemistry elective |  | 3  |
| Total Credits                                      |  | 38 |

<sup>1</sup> CHEM 336 and CHEM 465 both fulfill the writing intensive requirement.

### Mathematics Courses

|               |   |    |
|---------------|---|----|
| MATH 113      | Analytic Geometry and Calculus I (Mason Core) | 4  |
| MATH 114      | Analytic Geometry and Calculus II             | 4  |
| STAT 250      | Introductory Statistics I (Mason Core)        | 3  |
| Total Credits |   | 11 |

### Physics Courses

Select one Mason Core: Natural Science option: 8

#### Option One:

|          |                                  |  |
|----------|----------------------------------|--|
| PHYS 243 | College Physics (Mason Core)     |  |
| PHYS 244 | College Physics Lab (Mason Core) |  |
| PHYS 245 | College Physics (Mason Core)     |  |
| PHYS 246 | College Physics Lab (Mason Core) |  |

#### Option Two:

|          |   |  |
|----------|---|--|
| PHYS 160 | University Physics I (Mason Core)             |  |
| PHYS 161 | University Physics I Laboratory (Mason Core)  |  |
| PHYS 260 | University Physics II (Mason Core)            |  |
| PHYS 261 | University Physics II Laboratory (Mason Core) |  |

Total Credits 8

### General Science Courses

Mason Core: Natural Science courses:

|               |  |   |
|---------------|--|---|
| GEOL 101      | Introductory Geology I (Mason Core)      | 4 |
| BIOL 103      | Introductory Biology I (Mason Core)      | 4 |
| or BIOL 213   | Cell Structure and Function (Mason Core) |   |
| Total Credits |  | 8 |

### Teacher Licensure Requirement

A grade of 'C' or better is required for all licensure coursework.

|          |  |   |
|----------|--|---|
| EDCI 473 | Teaching Science in the Secondary School                 | 3 |
| EDCI 483 | Advanced Methods of Teaching Science in Secondary School | 3 |

|               |  |    |
|---------------|--|----|
| EDCI 490      | Student Teaching in Education (Mason Core)             | 6  |
| EDRD 419      | Literacy in the Content Areas                          | 3  |
| EDUC 372      | Human Development, Learning, and Teaching (Mason Core) | 3  |
| EDUC 422      | Foundations of Secondary Education                     | 3  |
| Total Credits |  | 21 |

**Note:**

During their second year, students should contact the Graduate School of Education in order to attend an information session and to prepare for taking the Praxis Core Academic Skills for Educators Test (<https://www.ets.org/praxis/about/core>).

**Mason Core and Elective Credits**

In order to meet a minimum of 120 credits, this degree requires additional credits (specific credit counts by concentration are shown below), which may be applied toward any remaining Mason Core requirements (outlined below), Requirements for Bachelor's Degrees, and electives. Students are strongly encouraged to consult with their advisors to ensure that they fulfill all requirements.

- Without concentration: 49 credits
- AEC concentration: 41-42 credits
- BC concentration: 48 credits
- CHME concentration: 34 credits

**Mason Core**

Note: Some Mason Core requirements may already be fulfilled by the major requirements listed above. Students are strongly encouraged to consult their advisors to ensure they fulfill all remaining Mason Core requirements.

| Code                           | Title  | Credits |
|--------------------------------|--|---------|
| <b>Foundation Requirements</b> |  |         |
|                                | Written Communication                              | 6       |
|                                | Oral Communication                                 | 3       |
|                                | Quantitative Reasoning                             | 3       |
|                                | Information Technology                             | 3-7     |
| <b>Core Requirements</b>       |  |         |
|                                | Arts   | 3       |
|                                | Global Understanding                               | 3       |
|                                | Literature   | 3       |
|                                | Natural Science                                    | 7       |
|                                | Social and Behavioral Sciences                     | 3       |
|                                | Western Civilization/World History                 | 3       |
|                                | <b>Synthesis/Capstone Requirement</b> <sup>1</sup> |         |
|                                | Synthesis/Capstone                                 | 3       |
| Total Credits                  |  | 40      |

<sup>1</sup> minimum 3 credits

**Honors****Honors in the Major**

Chemistry majors who have completed prerequisites for CHEM 455 Honors Research in Chemistry and CHEM 456 Honors Research in

Chemistry and have maintained an overall GPA of at least 3.00 in mathematics and science courses are eligible to enter the departmental honors program. To graduate with honors in chemistry, a student is required to maintain a minimum GPA of 3.00 in mathematics and science courses and successfully complete the two semesters of CHEM 455 Honors Research in Chemistry and CHEM 456 Honors Research in Chemistry with a minimum GPA of 3.50.

In order to apply for Chemistry Honors, please complete the application (<https://cos.gmu.edu/chemistry/wp-content/uploads/sites/7/2015/08/form-honors-program-application-2016.pdf>) and submit it to the undergraduate coordinator.

**Accelerated Master's****Chemistry, BA or BS/Curriculum and Instruction, Accelerated MEd (Secondary Education Chemistry concentration)****Overview**

Highly-qualified undergraduates may be admitted to the bachelor's/accelerated master's option and obtain a BA or BS in Chemistry (degree without concentration) and an MEd in Curriculum and Instruction (concentration in secondary education chemistry) in an accelerated time frame after completion of 149 credits. See AP.6.7 Bachelor's/Accelerated Master's Degree for policies related to this program.

This accelerated option is offered jointly by the Department of Chemistry and Biochemistry and the Graduate School of Education.

Students in an accelerated degree program must fulfill all university requirements for the master's degree. For policies governing all graduate degrees, see AP.6 Graduate Policies.

**Application Requirements**

Applicants to all graduate programs at George Mason University must meet the admission standards and application requirements for graduate study as specified in Graduate Admissions Policies. For information specific to this accelerated master's program, see Application Requirements and Deadlines (<https://cehd.gmu.edu/bachelors-accelerated-masters-program>).

**Accelerated Option Requirements**

Students complete the following courses in their senior year:

| <b>Senior</b> |         |                 |         |
|---------------|---------|-----------------|---------|
| Fall Semester | Credits | Spring Semester | Credits |
| EDCI 573      | 3       | EDCI 673        | 3       |
| EDUC 672      | 3       | EDRD 619        | 3       |
|               |         | 6               | 6       |

Total Credits 12

While undergraduate students, accelerated master's students are able to apply two of the courses listed above to both the bachelor's and master's degrees. These courses are considered advanced standing for the MEd. A minimum grade of B must be earned to be eligible to count as advanced standing. The other two courses are taken as reserve graduate credit and do not apply to the undergraduate degree. Early in their final undergraduate semester, students must submit the Bachelor's/

Accelerated Master's Transition Form to the CEHD Admissions Office and specify which of the four courses are to be designated as advanced standing and reserve graduate credit.

## **Chemistry, BS/Chemistry, Accelerated MS Overview**

This bachelor's/accelerated master's degree program allows academically strong undergraduates with a commitment to research to obtain both the Chemistry, BS and the Chemistry, MS degrees within an accelerated timeframe. Upon completion of this 144 credit program, students will be exceptionally well prepared for entry into a professional school or a PhD program in chemistry or a related discipline. Students are eligible to enter this program and enroll in graduate courses after successfully completing 90 undergraduate credits, inclusive of prerequisites, toward the Chemistry, BS degree. This flexibility makes it possible for students to complete graduate coursework during their final year.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

### **Application Requirements**

Applicants to all graduate programs at George Mason University must meet the admission standards and application requirements for graduate study as specified in the Graduate Admission Policies section of this catalog. Application information for this accelerated master's program can be found here (<https://www2.gmu.edu/admissions-aid/how-apply/accelerated-masters>).

Successful applicants will have an overall undergraduate GPA of at least 3.00. Additionally, they will have completed 36 credits of CHEM courses with a GPA of at least 3.00.

### **Accelerated Option Requirements**

At the beginning of the student's final undergraduate semester, students must submit a bachelor's/accelerated master's transition form (available from the Office of the University Registrar (<http://registrar.gmu.edu>)) to the College of Science's Office of Academic and Student Affairs (<https://cos.gmu.edu/about/contact-us>). Students must begin their master's program in the semester immediately following conferral of the bachelor's degree.

Students must maintain an overall GPA of 3.00 or higher in graduate coursework and should consult with their faculty advisor to coordinate their academic goals within the chemistry and biochemistry concentrations.

### **Reserve Graduate Credit**

While still in undergraduate status, a maximum of 6 additional graduate credits may be taken as reserve graduate credit and applied to the master's program. Reserve graduate credits do not apply to the undergraduate degree.