UNDERGRADUATE HANDBOOK

/ NEW STUDENT ORIENTATION
SUMMER 2020

FIRST YEAR ADVISORS
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Introduction

Chemistry is central to the sciences, the understanding of the physical world, and the study of biological systems. Chemistry is the science of transformations and energetics of materials at the molecular level. Chemistry has applications from the nanoscale to the macroscopic. Chemists use their training and creativity to improve the quality of life by creating new drugs, inventing new materials, improving the efficiency of processes, developing new energy systems, and providing critical data for policy decisions. A chemistry degree provides a solid foundation to pursue a range of career directions spanning fundamental research, applied research tied closely to engineering or health professions, chemical education, and technical areas in business and law. Virginia Tech offers four course curricula leading to undergraduate degrees in Chemistry, the Bachelor of Science (B.S.) in Chemistry, the B.S. in Medicinal Chemistry, the B.S. in Polymer Chemistry, and the Bachelor of Arts (B.A.) in Chemistry:

The B.S. in Chemistry Curriculum

The curriculum leading to the B.S. degree in chemistry prepares students for careers as professional chemists in industry or government or to continue their academic training in graduate study in chemistry or related fields. It is also suitable to prepare for pre-professional school or high school teaching. The B.S. degree meets the guidelines of the American Chemical Society (ACS) for an ACS-certified degree in chemistry.

The B.S. in Medicinal Chemistry Curriculum

The curriculum leading to the B.S. degree in medicinal chemistry also prepares students for careers as professional chemists in industry or government or to continue their academic training in graduate study in chemistry or related fields. Specifically, students in this curriculum are interested in the pharmaceutical field or plan to attend pharmacy, medical, dental, or other health-related professional programs after graduation.

The B.S. in Polymer Chemistry Curriculum

The curriculum leading to the B.S. degree in chemistry prepares students for careers as professional chemists in industry or government or to continue their academic training in graduate study in chemistry or related fields. This curriculum gives the student additional expertise in the critically important field of polymer chemistry with additional courses in this area.

The B.A. in Chemistry Curriculum

The B.A. curriculum allows greater flexibility to include more elective courses for students who wish to tailor a program to their individual goals, including pursuing a double major. It is also suitable for students interested in pursuing graduate study in an area related to chemistry, professional school, high school teaching with multiple endorsements, or business. In deciding to start either the B.A. vs. the B.S. degrees, one major difference for freshman year is the different math courses in the four curricula. Due to the greater math requirements of the three B.S. degrees, it is easier to start on a B.S. degree and switch to the B.A. rather than vice versa.
This handbook outlines the requirements to complete the Chemistry B.S. and B.A. degrees and provides answers to common questions that students have about choosing and completing a degree at Virginia Tech. There are two important notes to the information presented here: (1) the Virginia Tech Undergraduate Catalog is the official reference source on academic policies, and (2) this handbook includes the most current checksheets, however degree requirements can change and you should obtain the appropriate checksheet from the Chemistry Department website for your graduation term.

Thank you for choosing chemistry! For more information contact

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Amy Kokkinakos
Undergraduate Program Coordinator
117B Davidson Hall
Email: amyk@vt.edu

or visit the Chemistry Department’s Undergraduate Programs website:

http://www.chem.vt.edu/undergrad
Minimum grade requirements for Progress Towards Degree

For students who start at Virginia Tech as chemistry majors

**General Chemistry for Chemistry Majors CHEM 1055-1056**

First year chemistry majors are scheduled to take CHEM 1055-1056, General Chemistry for Majors lecture sequence, and the corresponding labs, CHEM 1065-1066. All chemistry majors must earn a “C” (2.0) or better in CHEM 1055 in the fall to take CHEM 1056 in the spring.

If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, he or she must either retake this class (and earn the minimum grade) or take CHEM 1035-1036, General Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards a chemistry degree. A chemistry major may not take CHEM 1035/1036 in place of CHEM 1055/1056 unless the minimum grade of “C” is not earned in CHEM 1055.

**Principles of Organic Chemistry CHEM 2565-2566**

All chemistry (B.A. and B.S.) majors take the Principles of Organic Chemistry lecture sequence, CHEM 2565-2566. Chemistry majors must earn a “C” (2.0) or better in CHEM 1056 to take CHEM 2565. Chemistry majors must earn a “C” (2.0) or better in CHEM 2565. A chemistry major may not take CHEM 2535/2536 in place of CHEM 2565/2566.

For students who transfer in or start at Virginia Tech as a major other than Chemistry – Substituting “Non-Majors” credits

**General Chemistry CHEM 1035-1036**

Non-chemistry majors at Virginia Tech who have taken CHEM 1035-1036 and wish to transfer into chemistry to pursue a B.A or a B.S. must have earned a “B” (2.0) or better in each course to count them as General Chemistry for Chemistry Majors lectures CHEM 1055-1056.

There is no minimum grade requirement for non-chemistry majors to count credit for General Chemistry labs CHEM 1045-1046 as General Chemistry for Chemistry Majors labs CHEM 1065-1066.

Non-chemistry majors at Virginia Tech who have taken CHEM 2535 and wish to transfer into chemistry to pursue a B.A. or a B.S. must have earned a “B” (3.0) or better in this course to count it as Principles of Organic Chemistry lecture CHEM 2565.
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*An alternative to CHEM 4404/4414 is CHEM 4534/4074
PART 1: PATHWAYS TO GENERAL EDUCATION REQUIREMENTS

Pathways requirements and approved courses are available online:
https://www.pathways.prov.vt.edu

I. **Discourse** (9 credits required)
   - ENGL 1105-1106 14 First-Year Writing (3) _____, (3) _____
   - Advanced/Applied Writing or Speaking Course (3) _____
   - & ViEWS requirement 15

II. **Critical Thinking in the Humanities** (6 credits required)
   - (Select from approved Pathways courses) (3) _____, (3) _____

III. **Reasoning in the Social Sciences** (6 credits required)
   - (Select from approved Pathways courses) (3) _____, (3) _____

IV. **Reasoning in the Natural Sciences** 16

V. **Quantitative and Computational Thinking** 17

VI. **Critique in Design and the Arts** (6 credits required)
   - (Select from approved Pathways courses) (3) _____, (3) _____

VII. **Critical Analysis of Identity and Equity in the U.S.** (3 credits required)
   - (Select from approved Pathways courses) (3) _____

PART 1: Pathways credit hour requirement: 30 credits

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

I. **Chemistry Core Courses** (22 credits)
   - CHEM 1004 First Year Experience in Chemistry (1) _____
   - CHEM 1055-1056 1 General Chemistry for Majors (4) _____, (4) _____
   - CHEM 1065-1066 7, 8 General Chemistry for Majors lab (1) _____, (1) _____
   - CHEM 2154 Analytical Chemistry for Majors (4) _____
   - CHEM 2164 Analytical Chemistry for Majors lab (1) _____
   - CHEM 2565 2, 9-2566 Principles of Organic Chemistry (3) _____, (3) _____

II. **Additional Required courses** (5 credits)
   - CHEM 2555-2556 10 Organic Synthesis & Techniques Lab (2) _____, (2) _____
   - CHEM 4014 Survey of Chemical Literature (1) _____

III. **Major Specific Required Course** (26 credits)
   - CHEM 2424 Descriptive Inorganic Chemistry (3) _____
   - CHEM 3615-3616 Physical Chemistry (3) _____, (3) _____
   - CHEM 3625-3626 Physical Chemistry lab (1) _____, (1) _____
   - CHEM 4114 Instrumental Analysis (3) _____
   - CHEM 4124 Instrumental Analysis Lab (1) _____
   - CHEM 4404 Physical Inorganic Chemistry (3) _____
   - CHEM 4414 Inorganic Synthesis & Techniques lab (2) _____
   - CHEM 4534, 4634, or 4424 11, 12 Polymer chemistry elective (3) _____
   - CHEM 4584 Bioorganic Chemistry (3) _____

IV. **Mathematics Courses** (16 credits)
   - MATH 1114 Elementary Linear Algebra (2) _____
   - MATH 1225-1226 Calculus of a Single Variable (4) _____, (4) _____
   - MATH 2204 Introduction to Multivariable Calculus (3) _____
   - MATH 2214 Introduction to Differential Equations (3) _____

V. **Physics Courses** (8 credits)
   - PHYS 2305-2306 Foundations of Physics I & II (incl. lab) (4) _____, (4) _____

VI. **Restricted Elective** (6 credits)
   - STAT 3005 or STAT 3615 Statistics elective (3) _____
   - CHEM 4xxx 13 CHEM/BCHM/CHE elective (3) _____

VII. **FREE ELECTIVES** (7 credits)
   - (___) ____________ (___) ____________ (___) ____________ (___) ____________
   - (___) ____________ (___) ____________ (___) ____________ (___) ____________

PART 2: College and department credit hour requirement: 90 credits
Minimum Grade Requirement:
Chemistry majors must earn a grade of “C” (2.0) or better in CHEM 1055, 1056, and 2565.

1 If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, the student must either retake this class (and earn the minimum grade) or take CHEM 1035-1036, General Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards the B.S. degree.

2 If a chemistry major fails to earn a “C” (2.0) or better in CHEM 2565, the student must either retake this class (and earn the minimum grade) or take CHEM 2535, Organic Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 2535, a minimum grade of “B” (3.0) is required to count CHEM 2535 as CHEM 2565 for the CHEM degree.

Prerequisites:
3 This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. The checksheet for 2024 will be approved by the University Registrar in 2022. Please see your advisor or consult the Undergraduate Course Catalog for more information. Please note: Chemistry majors are expected to be “calculus ready” upon the start of their curriculum.

Graduation Requirements:
4 Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes Chemistry in Context and Lab (CHEM 1015, 1016, 1025, 1026), Chemistry First-Year Experience (CHEM 1004), and Calculations in Chemistry (CHEM 1014). No more than 6 hours of CHEM 2974, 4974, and 4994 will be included in a student’s in-major GPA.

Foreign Language Requirement:
5 Students who did not successfully complete at least two years of a single foreign language or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog of details.

Satisfactory Progress Towards Degree:
6 Upon having attempted 72 credits, students must have completed CHEM 1055-1056, CHEM 1065-1066, CHEM 1004, CHEM 2565-2566, CHEM 2555-2556, PHYS 2305-2306, and MATH 1225-1226. Chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Acceptable Substitutions:
7 Prior credit for CHEM 1045 may be substituted for CHEM 1056.
8 Prior credit for CHEM 1046 may be substituted for CHEM 1066.
9 If a student has taken CHEM 2535 prior to adding a degree in chemistry, a minimum grade of “B” (3.0) or better is required in order to substitute CHEM 2535 as CHEM 2565.
10 As CHEM 2545-2546 does not satisfy the prerequisite for CHEM 2556 (due to training on specific instrumentation), if a student adds a CHEM BS degree after completing CHEM 2545-2546, two or more credits of CHEM 4994 may substitute for CHEM 2556 to meet the requirement; the student will be directed toward a CHEM 4994 project that emphasizes the missing training.
11 CHEM 4424 is cross-listed with SBIO 4424 Polysaccharide Chemistry. Students may also substitute SBIO 3444 Sustainable Biomaterials & Bioenergy for CHEM 4424 (SBIO 4424) to meet this requirement.
12 SBIO 3444 Sustainable Biomaterials & Bioenergy or CHEM 4424 (SBIO 4424) Polysaccharide Chemistry may substitute for the Restricted Elective if not already used to satisfy the polymer course requirement in Section III (Major Required Courses).
13 A biochemistry or chemical engineering student should not double-count coursework required for that major towards that chemistry upper-level (restricted) elective.
14 COMM 1015-1016 may substitute for ENGL 1105-1106.
15 Fulfilled by CHEM 4014 and CHEM 3626.
16 Fulfilled by PHYS 2305 and PHYS 2306.
17 Fulfilled by MATH 1225, MATH 1226, and MATH 2214.
# B.A. CHEMISTRY RECOMMENDED SCHEDULE

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<td>CHEM 4XXX CHEM/BCHM/CHE Electives, 3000-level or higher</td>
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<td>Pathways Critique and Practice in Design and the Arts</td>
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<td>Pathways Critical Analysis of Identity and Equity in the US</td>
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<td>Pathways Quantitative and Computational Thinking – Advanced (unless STAT 3615 was used to fulfill this Learning Outcome) OR Free Elective</td>
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</table>
PART 1: PATHWAYS TO GENERAL EDUCATION REQUIREMENTS
Pathways requirements and approved courses are available online:
https://www.pathways.prov.vt.edu  
(credit hours in parentheses)

I.  Discourse (9 credits)
   ENGL 1105-1106 First-Year Writing  
   (3) _____, (3) _____
   Advanced/Applied Writing or Speaking course  
   (3) _____
   (Select from approved Pathways courses)  
   & ViEWS requirement 8  
   (3) _____

II. Critical Thinking in the Humanities (6 credits required)
   (Select from approved Pathways courses)  
   (3) _____, (3) _____

III. Reasoning in the Social Sciences (6 credits required)
   (Select form approved Pathways courses)  
   (3) _____, (3) _____

IV. Reasoning in the Natural Sciences 9

V.  Quantitative and Computational Thinking 10
   Advanced/Applied Quantitative and Computational Thinking course 11  
   (Select from approved Pathways courses)  
   (3) _____

VI. Critique in Design and the Arts (6 credits required)
   (Select from approved Pathways courses)  
   (3) _____, (3) _____

VII. Critical Analysis of Identity and Equity in the U.S.  (3 credits required)
   (Select from approved Pathways courses)  
   (3) _____

PART 1: Pathways credit hour requirement: 36 credits

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

I. Chemistry Core Courses (22 credits)
   CHEM 1004  Chemistry First-Year Experience  
   (1) _____
   CHEM 1055-1056 1 General Chemistry for Majors  
   (4) _____, (4) _____
   CHEM 1065-1066 12, 13 General Chemistry for Majors lab  
   (1) _____, (1) _____
   CHEM 2154  Analytical Chemistry for Majors  
   (4) _____
   CHEM 2164  Analytical Chemistry for Majors lab  
   (1) _____
   CHEM 2565-2566 14 Principles of Organic Chemistry  
   (3) _____, (3) _____

II. Additional Required Courses (3 credits)
   CHEM 2545 -2546  Organic Chemistry lab  
   (1) _____, (1) _____
   CHEM 4014  Survey of Chemical Literature.  
   (1) _____

III. Major Specific Required Courses (10 credits)
   CHEM 2424  Descriptive Inorganic Chemistry  
   (3) _____
   CHEM 4615-4616 15, 16 Physical Chemistry for Life Sciences  
   (3) _____, (3) _____
   CHEM 3625  Physical Chemistry lab  
   (1) _____

IV. Mathematics Courses (9 credits)
   MATH 1025-1026 17, 18 Elementary Calculus  
   (3) _____, (3) _____
   MATH 2024 19 Intermediate Calculus  
   (3) _____

V. Physics Courses (8 credits)
   PHYS 2205 20 - 2206 21 General Physics  
   (3) _____, (3) _____
   PHYS 2215 – 2216 General Physics Lab  
   (1) _____, (1) _____

VI. Restricted Electives (9 credits)
   STAT 3005 or 361511, 22 Statistics Elective  
   (3) _____
   CHEM 3xxx-4xxx 23, 24 CHEM/BCHM/CHE electives  
   (3) _____, (3) _____
PART 2: College and department credit hour requirement: 84 credits

Minimum Grade Requirement: Chemistry majors must earn a grade of “C” (2.0) or better in CHEM 1055, 1056, and 2565.

1. If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, the student must either retake this class (and earn the minimum grade) or take CHEM 1035-1036, General Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards the B.S. degree.

2. If a chemistry major fails to earn a “C” (2.0) or better in CHEM 2565, the student must either retake this class (and earn the minimum grade) or take CHEM 2535, Organic Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 2535, a minimum grade of “B” (3.0) is required to count CHEM 2535 as CHEM 2565 for the CHEM degree.

Prerequisites

3. This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. The checksheet for 2024 will be approved by the University Registrar in 2022. Please see your advisor or consult the Undergraduate Course Catalog for more information. Please note: Chemistry majors are expected to be “calculus ready” upon the start of their curriculum.

Graduation Requirements

4. Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes Chemistry in Context and Lab (CHEM 1015, 1016, 1025, 1026), Chemistry First-Year Experience (CHEM 1004), and Calculations in Chemistry (CHEM 1014). No more than 6 hours of CHEM 2974, 4974, and 4994 will be included in a student’s in-major GPA.

Foreign language requirement

5. Students who did not successfully complete at least two years of a single foreign language or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog of details.

Satisfactory Progress Towards Degree

6. Upon having attempted 72 credits, students must have completed CHEM 1055-1056, CHEM 1065-1066, CHEM 1004, CHEM 2565-2566, CHEM 2555-2556, PHYS 2305-2306, and MATH 1225-1226.

Chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Acceptable Substitutions:

7. COMM 1015 – 1016 may substitute for ENGL 1105 – 1106.
8. CHEM 4014 satisfies part of the chemistry ViEWS (Visual Expression, Writing and Speaking) requirement, taking ENGL 3764 Technical Writing or COMM 2004 Public Speaking satisfies the other part of the ViEWS requirement.
9. Fulfilled by PHYS 2205, 2206, 2215, and 2216 or by PHYS 2305-2306.
10. Fulfilled by MATH 1025 and 1026.
11. STAT 3005 or STAT 3615 can be used to fulfill this requirement and the STAT requirement.
12. Prior credit for CHEM 1045 may be substituted for CHEM 1065.
13. Prior credit for CHEM 1046 may be substituted for CHEM 1066.
14. If a student has taken CHEM 2535 prior to adding a degree in chemistry, a minimum grade of “B” (3.0) or better is required in order to substitute CHEM 2535 as CHEM 2565.
15. CHEM 3615 may be substituted for CHEM 4615.
16. CHEM 3616 may be substituted for CHEM 4616.
17. MATH 1225 may be substituted for MATH 1025.
18. MATH 1226 (MATH 1225 prerequisite) may be substituted for MATH 1026.
19. MATH 2204 (MATH 1226 prerequisite) may be substituted for MATH 2024.
20. PHYS 2305 (MATH 1225 prerequisite) may be substituted for PHYS 2205 and PHYS 2215.
21. PHYS 2306 (MATH 1266 prerequisite) may be substituted for PHYS 2206 and PHYS 2216.
22. Options include STAT 3005 or STAT 3615.
23. SBIO 3444 or SBIO 4424 (cross-listed with CHEM 4424) may substitute for the Restrictive Elective.
24. A biochemistry or chemical engineering student should not double-count course work required for that major towards the chemistry upper-level elective.
# B.S. MEDICINAL CHEMISTRY RECOMMENDED SCHEDULE

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<td>ENGL 1106 First-Year Writing (Pathways Discourse – Foundational)</td>
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<td>CHEM 2566 Principles of Organic Chemistry</td>
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<td>CHEM 2164 Majors Analytical Chemistry Lab</td>
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<td>CHEM 2555 Organic Synthesis &amp; Techniques Lab</td>
<td>2</td>
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<td>CHEM 2565 Principles of Organic Chemistry</td>
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<td>CHEM 4014 Survey of the Chemical Literature</td>
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<td>PHYS 2205 General Physics (Pathways Reasoning in the Natural Sciences)</td>
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<td>PHYS 2206 General Physics (Pathways Reasoning in the Natural Sciences)</td>
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<td>PHYS 2215 General Physics Laboratory (Pathways Reasoning in the Natural Sciences)</td>
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<td>PHYS 2216 General Physics Laboratory (Pathways Reasoning in the Natural Sciences)</td>
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<td>Pathways Critical Analysis of Identity and Equity in the US</td>
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<td>CHEM 4616 Physical Chemistry for Life Sciences</td>
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<td>CHEM 4615 Physical Chemistry for Life Sciences</td>
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<td>STAT 3005 or 3615 (Pathways Quantitative and Computational Thinking- Advanced)</td>
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<td>CHEM 4584 Bioorganic Chemistry</td>
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<td>Pathways Critical Thinking in the Humanities</td>
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<td>Pathways Critical Thinking in the Humanities</td>
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<td>Pathways Reasoning in the Social Sciences (PSYC 1004 is recommended for health science careers)</td>
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<td>Pathways Discourse – Advanced</td>
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<td>CHEM 4544 Medicinal Chemistry Capstone Laboratory</td>
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<td>CHEM 4514 or 4554 or 4424</td>
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</table>
PART 1: PATHWAYS TO GENERAL EDUCATION REQUIREMENTS
Pathways requirements and approved courses are available online:
https://www.pathways.prov.vt.edu

I. Discourse (9 credits required)
ENGL 1105-1106 First-Year Writing (3) ___, (3) ___
Advanced/Applied Writing or Speaking Course (3) ___
(Select from approved Pathways courses)
& VIEWS requirement (3) ___

II. Critical Thinking in the Humanities (6 credits required)
(Select from approved Pathways courses) (3) ___, (3) ___

III. Reasoning in the Social Sciences (6 credits required)
(Select from approved Pathways courses) (3) ___, (3) ___

IV. Reasoning in the Natural Sciences

V. Quantitative and Computational Thinking
Advanced/Applied Quantitative and Computational Thinking Course (Select STAT 3005 or STAT 3615) (3) ___

VI. Critique in Design and the Arts (6 credits required)
(Select from approved Pathways courses) (3) ___, (3) ___

VII. Critical Analysis of Identity and Equity in the U.S. (3 credits required)
(Select from approved Pathways courses) (3) ___

PART 1: Pathways credit hour requirement: 33 credits

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

I. Chemistry Core Courses (22 credits)
CHEM 1004 First Year Experience in Chemistry (1) ___
CHEM 1055-1056 General Chemistry for Majors (4) ___, (4) ___
CHEM 1065-1066 General Chemistry for Majors lab (1) ___, (1) ___
CHEM 2154 Analytical Chemistry for Majors (4) ___
CHEM 2164 Analytical Chemistry for Majors lab (1) ___
CHEM 2565-2566 Principles of Organic Chemistry (3) ___, (3) ___

II. Additional Required courses (5 credits)
CHEM 2555-2556 Organic Synthesis & Techniques Lab (2) ___, (2) ___
CHEM 4014 Survey of Chemical Literature (1) ___

III. Major Specific Required Course (19 credits)
BIOL 1105, 1006 Principles of Biology (3) ___, (3) ___
BIOL 1115, 1116 Principles of Biology Lab (1) ___, (1) ___
CHEM 4615 16 – 4616 17 Physical Chemistry for Life Sciences (3) ___, (3) ___
CHEM 4544 Medicinal Chemistry Capstone Lab (2) ___
CHEM 4584 Bioorganic Chemistry (3) ___

IV. Mathematics Courses (8 credits)
MATH 1225-1226 Calculus of a Single Variable (4) ___, (4) ___

V. Physics Courses (8 credits)
PHYS 2205 18 – 2206 19 General Physics (3) ___, (3) ___
PHYS 2215 - 2216 General Physics Lab (1) ___, (1) ___

VI. Restricted Elective (6 credits – Choose 2 of the following)
CHEM 4524 Identification of Organic Compounds (3) ___
CHEM 4514 Green Chemistry (3) ___
CHEM 4554 Drug Chemistry (3) ___
CHEM 4444 Bioinorganic Chemistry (3) ___
CHEM 4424/SBIO 4424 Polysaccharide Chemistry (3) ___

VII. FREE ELECTIVES (19 credits)
( ___ ) __________ ( ___ ) __________ ( ___ ) __________ ( ___ ) __________
( ___ ) __________ ( ___ ) __________ ( ___ ) __________ ( ___ ) __________

PART 2: College and department credit hour requirement: 87 credits
Minimum Grade Requirement:
Chemistry majors must earn a grade of “C” (2.0) or better in CHEM 1055, 1056, and 2565.

1 If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, the student must either retake this class and earn the minimum grade or take CHEM 1035-1036, General Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards the B.S. degree.

2 If a chemistry major fails to earn a “C” (2.0) or better in CHEM 2565, the student must either retake this class and earn the minimum grade or take CHEM 2535, Organic Chemistry, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 2535, a minimum grade of “B” (3.0) is required to count CHEM 2535 as CHEM 2565 for the CHEM degree.

Prerequisites:
3 This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. The checksheet for 2024 will be approved by the University Registrar in 2022. Please see your advisor or consult the Undergraduate Course Catalog for more information. Please note: Chemistry majors are expected to be “calculus ready” upon the start of their curriculum.

Graduation Requirements:
4 Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes Chemistry in Context and Lab (CHEM 1015, 1016, 1025, 1026), Chemistry First-Year Experience (CHEM 1004), and Calculations in Chemistry (CHEM 1014). No more than 6 hours of CHEM 2974, 4974, and 4994 will be included in a student’s in-major GPA.

Foreign Language Requirement:
5 Students who did not successfully complete at least two years of a single foreign language or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog of details.

Satisfactory Progress Towards Degree:
6 Upon having attempted 72 credits, students must have completed CHEM 1055-1056, CHEM 1065-1066, CHEM 1004, CHEM 2565-2566, CHEM 2555-2556, PHYS 2205/2215-2206/2216, and MATH 1225-1226. Medicinal chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Acceptable Substitutions:
7 Prior credit for CHEM 1045 may be substituted for CHEM 1065.
8 Prior credit for CHEM 1046 may be substituted for CHEM 1066.
9 If a student has taken CHEM 2535 prior to adding a degree in chemistry, a minimum grade of “B” (3.0) or better is required in order to substitute CHEM 2535 as CHEM 2565.
10 As CHEM 2545-2546 does not satisfy the prerequisite for CHEM 2556 (due to training on specific instrumentation), if a student adds a CHEM BS degree after completing CHEM 2545-2546, two or more credits of CHEM 4994 may substitute for CHEM 2556 to meet the requirement; the student will be directed toward a CHEM 4994 project that emphasizes the missing training.
11 CHEM 4014 satisfies part of the chemistry ViEWS (Visual Expression, Writing and Speaking) requirement, taking ENGL 3764 Technical Writing or COMM 2004 Public Speaking satisfies the other part of the ViEWS requirement.
12 COMM 1015-1016 may substitute for ENGL 1105-1106.
13 Fulfilled by PHYS 2205/2215-2206/2216 or PHYS 2305 and PHYS 2306
14 Fulfilled by MATH 1225 and MATH 1226
15 STAT 3005 or STAT 3615 can be used to fulfill this requirement.
16 CHEM 3615 may be substituted for CHEM 4615.
17 CHEM 3616 may be substituted for CHEM 4616.
18 PHYS 2305 (MATH 1225 prerequisite) may be substituted for PHYS 2205 and PHYS 2215.
19 PHYS 2306 (MATH 1226 prerequisite) may be substituted for PHYS 2206 and PHYS 2216.
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<td>CHEM 4014 Survey of the Chemical Literature</td>
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<td>MATH 2204 Introduction to Multivariable Calculus</td>
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<td><strong>Spring Semester Senior 2023</strong></td>
<td>CHEM 4424 or CHEM 4634 Elective*</td>
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<td></td>
<td>CHEM 4524 or CHE 4104 or PHYS 4564 Elective*</td>
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<td></td>
<td>Pathways Critique and Practice in Design and the Arts</td>
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*Must choose a total of three courses (9 credits)
PART 1: PATHWAYS TO GENERAL EDUCATION REQUIREMENTS
Pathways requirements and approved courses are available online:
https://www.pathways.prov.vt.edu  
(credit hours in parentheses)

I. Discourse (9 credits required)
ENGL 1105-1106 7 First-Year Writing     (3) _____, (3) _____
Advanced/Applied Writing or Speaking Course     (3) _____
(Select from approved Pathways courses)
& ViEWS requirement 8     (3) _____

II. Critical Thinking in the Humanities (6 credits required)
(Select from approved Pathways courses)
(3) _____, (3) _____

III. Reasoning in the Social Sciences (6 credits required)
(Select from approved Pathways courses)
(3) _____, (3) _____

IV. Reasoning in the Natural Sciences 9

V. Quantitative and Computational Thinking 10
Advanced/Applied Quantitative and Computational Thinking Course 11 (3) _____
(Select STAT 3005 or STAT 3615 or STAT 4604)

VI. Critique in Design and the Arts (6 credits required)
(Select from approved Pathways courses)
(3) _____, (3) _____

PART 1: Pathways credit hour requirement: 33 credits

PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS

I. Chemistry Core Courses (22 credits)
CHEM 1004 First Year Experience in Chemistry     (1) _____
CHEM 1055-1056 1 General Chemistry for Majors     (4) _____, (4) _____
CHEM 1065-1066 12, 13 General Chemistry for Majors lab     (1) _____, (1) _____
CHEM 2154 Analytical Chemistry for Majors     (4) _____
CHEM 2164 Analytical Chemistry for Majors lab     (1) _____
CHEM 2565 2, 14-2566 Principles of Organic Chemistry     (3) _____, (3) _____

II. Additional Required courses (5 credits)
CHEM 2555-2556 13 Organic Synthesis & Techniques Lab     (2) _____, (2) _____
CHEM 4014 Survey of Chemical Literature     (1) _____

III. Major Specific Required Course (12 credits)
CHEM 3615 Physical Chemistry     (3) _____
CHEM 3625 Physical Chemistry lab     (1) _____
CHEM 4114 Instrumental Analysis     (3) _____
CHEM 4534 Organic Chemistry of Polymers     (3) _____
CHEM 4074/MSE 4544 Laboratory in Polymer Science     (2) _____

IV. Mathematics Courses (11 credits)
MATH 1225-1226 Calculus of a Single Variable     (4) _____, (4) _____
MATH 2204 Introduction to Multivariable Calculus     (3) _____

V. Physics Courses (8 credits)
PHYS 2305-2306 Foundations of Physics I & II (incl. lab)     (4) _____, (4) _____

VI. Restricted Elective (9 credits – Choose 3 of the following)
CHEM 4524 Identification of Organic Compounds     (3) _____
CHEM 4634/MSE 4534 Polymer and Surface Chemistry     (3) _____
CHEM 4424/SBIO 4424 Polysaccharide Chemistry     (3) _____
CHE 4104 Process Materials     (3) _____
PHYS 4564 Polymer Physics     (3) _____

VII. FREE ELECTIVES (20 credits)
(_____)  (_____)  (_____)  (_____)
(_____)  (_____)  (_____)

PART 2: College and department credit hour requirement: 87 credits
**Minimum Grade Requirement:**
Chemistry majors must earn a grade of “C” (2.0) or better in CHEM 1055, 1056, and 2565.

1. If a chemistry major fails to earn a “C” (2.0) or better in CHEM 1055, the student must either retake this class (and earn the minimum grade) or take CHEM 1035-1036, *General Chemistry*, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 1035-1036, a minimum grade of “B” (3.0) is required in both in order to enroll in CHEM 2565 and progress towards the B.S. degree.

2. If a chemistry major fails to earn a “C” (2.0) or better in CHEM 2565, the student must either retake this class (and earn the minimum grade) or take CHEM 2535, *Organic Chemistry*, to remain in good standing for a chemistry degree. If the chemistry major elects to take CHEM 2535, a minimum grade of “B” (3.0) is required to count CHEM 2535 as CHEM 2565 for the CHEM degree.

**Prerequisites:**
This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. The checksheet for 2023 will be approved by the University Registrar in 2021. Please see your advisor or consult the Undergraduate Course Catalog for more information. Please note: Chemistry majors are expected to be “calculus ready” upon the start of their curriculum.

**Graduation Requirements:**
Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes Chemistry in Context and Lab (CHEM 1015, 1016, 1025, 1026), Chemistry First-Year Experience (CHEM 1004), and Calculations in Chemistry (CHEM 1014). No more than 6 hours of CHEM 2974, 4974, and 4994 will be included in a student’s in-major GPA.

**Foreign Language Requirement:**
Students who did not successfully complete at least two years of a single foreign language or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

**Satisfactory Progress Towards Degree:**
Upon having attempted 72 credits, students must have completed CHEM 1055-1056, CHEM 1065-1066, CHEM 1004, CHEM 2565-2566, CHEM 2555-2556, PHYS 2305-2306, and MATH 1225-1226.

Chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

**Acceptable Substitutions:**
7. COMM 1015-1016 may substitute for ENGL 1105-1106.
8. CHEM 4014 satisfies part of the chemistry ViEWS (Visual Expression, Writing and Speaking) requirement, taking ENGL 3764 Technical Writing or COMM 2004 Public Speaking satisfies the other part of the ViEWS requirement.
9. Fulfilled by PHYS 2305 and PHYS 2306
10. Fulfilled by MATH 1225 and MATH 1226
11. STAT 3005 or STAT 3615 or STAT 4604 can be used to fulfill this requirement.
12. Prior credit for CHEM 1045 may be substituted for CHEM 1065.
13. Prior credit for CHEM 1046 may be substituted for CHEM 1066.
14. If a student has taken CHEM 2535 prior to adding a degree in chemistry, a minimum grade of “B” (3.0) or better is required in order to substitute CHEM 2535 as CHEM 2565.
15. As CHEM 2545-2546 does not satisfy the prerequisite for CHEM 2565 (due to training on specific instrumentation), if a student adds a CHEM BS degree after completing CHEM 2545-2546, two or more credits of CHEM 4994 may substitute for CHEM 2556 to meet the requirement; the student will be directed toward a CHEM 4994 project that emphasizes the missing training.
CHEMISTRY MINOR CHECKSHEET
For students graduating in calendar year 2023

I. Required Courses (19 hours)
   CHEM 1035 1-1036 2 General Chemistry (3) (3)
   CHEM 1045 3-1046 4 General Chemistry Labs (1) (1)
   CHEM 2535-2536 Organic Chemistry (3) (3)
   CHEM 2545-2546 Organic Chemistry Labs (1) (1)
   CHEM 4615 or 4616 Physical Chemistry for Life Sciences 5 (3)
   (Additional prerequisites: MATH 1026, PHYS 2206)

II. Elective course (3 hours)
   Choose one course from this list:
   or BCHM 3114  Biochem for Biotech
   or BCHM 4115  General Biochemistry
   or CHEM/SBIO 4424  Polysaccharide Chemistry
   or CHEM 4514  Green Chemistry
   or CHEM 4534  Organic Chemistry of Polymers
   or CHEM 4554  Drug Chemistry
   or CHEM 4616  Physical Chemistry for Life Sciences
   or CHEM 4634  Polymer and Surface Chemistry
   or CHEM/CSES/ENSC 4734  Environmental Soil Chemistry
   (Additional prerequisites: CSES 3114, CSES 3124, CHEM 2114 or instructor approval)
   or CHEM 4994 Undergraduate Research (3 credits)
   (Requires permission of faculty research advisor and undergraduate research eligibility requirements)
   or SBIO 3444  Sustainable Biomaterials & Bioenergy

III. Total Credits Required
   A minimum of 22 credit hours in chemistry courses must be completed.

IV. Minimum GPA
   All courses used to fulfill the minor will count toward the minor GPA, and the student’s overall GPA for these courses must be a 2.0 or higher.

Notes:
Acceptable substitutions are as follows:

1 CHEM 1055 or CHEM 1055H may be substituted for CHEM 1035.
2 CHEM 1056 or CHEM 1056H may be substituted for CHEM 1036.
3 CHEM 1065 may be substituted for CHEM 1045.
4 CHEM 1066 may be substituted for CHEM 1046.
5 CHEM 3615 (Pre: CHEM 1036 OR 1056 OR 1056H; PHYS 2306; and MATH 1205, 1206 & 2224) may be substituted for CHEM 4615.
IMPORTANT WAYPOINTS TO GRADUATION

Freshman year
- attend Orientation, choose math sequence
- attend advising sessions (Fall, Spring) and meet your academic advisor (Spring)

Sophomore year
- choose B.A. or B.S. organic lab sequence

Beginning of Junior Year
- Download degree checksheet for your graduation year
- Apply for Degree on Hokie SPA
- Request DARS Report on Hokie SPA and review with your advisor

End of Junior Year
- add any minors or second majors before being within 30 credits of graduation
- Begin making hotel arrangements for out-of-town guests to attend graduation

Beginning of Senior Year
- Request a new DARS Report on Hokie SPA and review with your advisor

Senior Year (graduation semester)
- Request a new DARS Report on Hokie SPA and review with your advisor

Senior Year (2 months before Graduation)
- Review http://www.vt.edu/commencement for commencement dates, times and locations
- Visit Bookstore to purchase cap and gown, announcements, etc.

IMPORTANT EVENTS EACH SEMESTER

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of week 1</td>
<td>last day to add classes</td>
</tr>
<tr>
<td>End of week 6</td>
<td>last day to drop classes</td>
</tr>
<tr>
<td>Tuesday of week 9</td>
<td>course request opens for the next semester</td>
</tr>
<tr>
<td>Tuesday of week 10</td>
<td>course request closes for the next semester</td>
</tr>
<tr>
<td>Monday of week 14</td>
<td>Drop/Add opens for the next semester</td>
</tr>
<tr>
<td>Wednesday of week 15</td>
<td>last day to apply late withdrawal policy</td>
</tr>
<tr>
<td>Wednesday of week 15</td>
<td>end of classes</td>
</tr>
<tr>
<td>Thursday of week 15</td>
<td>reading day</td>
</tr>
<tr>
<td>Friday of week 15</td>
<td>final exams begin</td>
</tr>
</tbody>
</table>

!!! Check the calendar on the Registrar's website (http://www.registrar.vt.edu) for exact dates each semester.
Advising
As future colleagues, the Chemistry Faculty wants and expects to know every chemistry major personally. You should, as you move through the program, make an effort to meet and know your professors; they are available for help and guidance. A complete and current faculty listing is found on the department website (www.chem.vt.edu). In addition, in their second semester at Virginia Tech, all undergraduate chemistry majors are assigned to a faculty member who serves as their permanent academic advisor. Students may schedule appointments directly with their advisors whenever questions or issues arise. Additionally, it is the student’s responsibility to contact their advisor during course request for each upcoming semester. For "emergency" advice when the advisor cannot be located, students should feel free to contact any other advisor from the list below:

ADVISORS

<table>
<thead>
<tr>
<th>Advisor</th>
<th>Office Location</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Patricia Amateis</td>
<td>109F Davidson Hall</td>
<td>231-6629</td>
<td><a href="mailto:pamateis@vt.edu">pamateis@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Shamindri Arachchige</td>
<td>109C Davidson Hall</td>
<td>231-4878</td>
<td><a href="mailto:arachsm@vt.edu">arachsm@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Michael Berg</td>
<td>109A Davidson Hall</td>
<td>231-6837</td>
<td><a href="mailto:bergm@vt.edu">bergm@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Maggie Bump</td>
<td>109D Davidson Hall</td>
<td>231-4675</td>
<td><a href="mailto:mbump@vt.edu">mbump@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Jeannine Eddleton</td>
<td>117A Davidson Hall</td>
<td>231-8228</td>
<td><a href="mailto:jeddleto@vt.edu">jeddleto@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Alan Esker</td>
<td>480C Davidson Hall</td>
<td>231-4601</td>
<td><a href="mailto:aesker@vt.edu">aesker@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Gary Long</td>
<td>409 Davidson Hall</td>
<td>231-7575</td>
<td><a href="mailto:long@vt.edu">long@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Andrew Lowell</td>
<td>3101 Hahn Hall South</td>
<td>231-6842</td>
<td><a href="mailto:alowell@vt.edu">alowell@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Joe Merola</td>
<td>3109 Hahn Hall South</td>
<td>231-4510</td>
<td><a href="mailto:jmerola@vt.edu">jmerola@vt.edu</a></td>
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<tr>
<td>Dr. Amanda Morris</td>
<td>321 Davidson Hall</td>
<td>231-5585</td>
<td><a href="mailto:ajmorris@vt.edu">ajmorris@vt.edu</a></td>
</tr>
<tr>
<td>Dr. John Morris</td>
<td>117D Davidson Hall</td>
<td>231-2472</td>
<td><a href="mailto:jrmorris@vt.edu">jrmorris@vt.edu</a></td>
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<tr>
<td>Dr. Brian Tissue</td>
<td>1105 Hahn Hall South</td>
<td>231-3786</td>
<td><a href="mailto:tissue@vt.edu">tissue@vt.edu</a></td>
</tr>
<tr>
<td>Dr. Gordon Yee</td>
<td>2103 Hahn Hall South</td>
<td>231-3090</td>
<td><a href="mailto:gyee@vt.edu">gyee@vt.edu</a></td>
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In addition to your assigned academic advisor, the Department provides advisors for special programs:

- Freshman Advising: Dr. Patricia Amateis and Dr. Jeannine Eddleton
- General Student Advising: Amy Kokkinakos (Davidson 117B)
- Career Advisor**: Dr. Gordon Yee
- Honors Advisors: Dr. Patricia Amateis and Dr. Gordon Yee
- Pre-Med, Dental, and Veterinary: Dr. Michael Berg
- Teacher Certification: Dr. Jeannine Eddleton

*All advisors’ telephone numbers are area code (540).

**All chemistry majors should interact at least once a year with Dr. Yee. However, it is especially critical that rising juniors and seniors discuss their goals and aspirations early in the Fall Semester. Successfully finding the right position after graduation requires proper planning and a coordinated campaign.

A final note on advising: Advice is just that - advice to you to help you make decisions. Your advisor will provide advice on what he or she thinks will serve you best. Our advisors have been through what you are going through so listen to them and then make decisions that are best for you. You will find that life is a journey full of expected and unexpected curves with many different paths - all different and none of them right or wrong.
PROGRAM OPTIONS FOR CHEMISTRY MAJORS

CHEMISTRY TEACHER CERTIFICATION
The teacher certification advisor for chemistry majors is Dr. Jeannine Eddleton. Dr. Eddleton’s office is in 117A Davidson Hall, her email address is jeddeleto@vt.edu, and her phone number is (540) 231-8228.

Students wishing to become high school chemistry teachers should pursue a B.A. degree in chemistry and then enter the fifth-year secondary science education licensure program offered by the School of Education: http://www.soe.vt.edu/scied

OFFICE OF HEALTH PROFESSIONS ADVISING
Students interested in a health profession career should visit the Office of Health Professions Advising (HPA) in the Smith Career Services building and should also consult their web page: https://career.vt.edu/advising/hpa.html
The pre-med, pre-dental, and pre-vet advisor for chemistry majors is Dr. Mike Berg.

Students who wish to go to medical or dental school will meet minimum admission requirements for most schools with the BS Medicinal Chemistry degree program or by adding Principles of Biology (BIOL 1105/1105/1106/1116) to either the BA or BS Chemistry degree programs. However, most students take additional biology and biochemistry courses. For an orderly progression through these courses, it is important that pre-med and pre-dental students take biology in their freshman year.

The following shows a suggested program of study for chemistry students who plan to go to medical school. A pre-dentistry program of study would be very similar.

CHEMISTRY B.A. for PRE-MEDICAL PROFESSIONAL Students

SUGGESTED COURSE SEQUENCE

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Students desiring a second major in biochemistry should refer to the biochemistry department website for updated information (http://www.biochem.vt.edu/undergraduate/index.html).

Other electives should be chosen after consultation with the Office of Health Professions Advising. Students interested in pharmacy school can follow this sequence being sure to take other required electives, e.g., microeconomics and public speaking, per admission requirements of the pharmacy school(s) of interest.

**Useful Information from the Undergraduate Catalog**

The following information is a general summary of many academic policies. Refer to the complete text in the Undergraduate Course Catalog (https://www.undergradcatalog.registrar.vt.edu/) for full details.

**ACADEMIC ELIGIBILITY POLICY**

A GPA of 2.0 (a C average) overall and in-major is required for graduation. Any time your overall GPA falls below 2.0 you are placed on academic probation. A student on probation may take no more than 16 credits per semester. Probation is lifted when the cumulative GPA rises to 2.0. If your overall GPA remains above a 2.0 but your one-semester GPA is below a 2.0, you are placed on academic warning. See the Undergraduate Catalog (linked above) for full requirements and conditions leading to academic warning, probation, and suspension.

**REGISTRATION FOR CLASSES**

Course Request (pre-registration) is a period in the middle of each semester during which students enrolled currently may select classes for the following semester. Prior to, or during, course request, you should plan your schedule, consult with your advisor, and utilize course request in Hokie SPA.
COURSE LOADS
A student is classified as "full-time" if enrolled for 12 credit hours in fall and spring semesters and/or 6 credits during a summer session. A normal course load is 15-17 hours per semester. Overloads (more than 19 hours per semester, 9 each summer session) require permission of your Academic Dean's office. Unless such permission has been obtained in advance, you will not be able to add more than the maximum number of credits per semester/summer session.

LATE ADDS
Adding a course to your schedule after the deadline requires permission of your Academic Dean.

CLASS LEVEL
A student must have received credit for at least 30 hours to be classified as a sophomore, at least 60 hours to be classified as a junior, and at least 90 hours to be classified as a senior.

ENROLLMENT IN GRADUATE COURSES
With permission of the instructor, chemistry majors may enroll in 5000-level chemistry courses. Chemistry majors wishing to take 5000-level courses in other departments must have the approval of the instructor and the Dean of the Graduate School.

PASS-FAIL GRADE OPTIONS
Students may take certain courses on a pass-fail basis, according to the following regulations:

1. No Pathways to General Education requirements or departmental requirements may be taken under the pass-fail option for chemistry majors.
2. Minimum credit hours already passed on graded courses must equal 30 with a minimum GPA = 2.50. (Does not apply for courses offered only on a pass-fail basis.)
3. Maximum number of pass-fail credits allowed = 10% of the requirements for graduation taken at Virginia Tech. For example, if a student takes 120 credits at Virginia Tech, 12 hours may be taken Pass-Fail. If a student takes only 90 credit hours at Virginia Tech (with 30 transfer credits), then only 9 (10% of 90) credits may be taken Pass-Fail.
4. For courses taken pass-fail, P or F is recorded on the student's transcript and credit is given if the grade is P. If the course is failed, the "F" is considered as an "F" received under the "A-F" grading system and is included in calculation of the GPA.
5. Pass-fail courses are normally non-transferable to other institutions.
6. No more than 2 courses may be taken pass-fail in any semester unless courses are offered only pass-fail.
COURSE WITHDRAWAL POLICY

Dropping a course: Students may drop courses prior to the drop deadline; the dropped course is removed from your transcript. The drop deadline is announced in each semester’s Timetable.

Course Withdrawal: A maximum of three (3) courses may be dropped beyond the normal drop deadline date during a student’s academic career at Virginia Tech, subject to the following stipulations:

1. Students must formally request to withdraw from a course by the last day of classes in that academic term.
2. Courses from which a student withdraws under the terms of this policy will appear on their transcript with a W. The W signifies that this policy was invoked; the reasons for its use are the (private) responsibility of the student.
3. A student’s decision to invoke this policy is irrevocable and unappealable.
4. Withdrawals may not be employed to reduce or obviate any penalty otherwise accruing to students under the University Honor System.
5. Students may request withdrawal from any course, irrespective of the grade earned up to the point of the request.

To withdraw from a course, you must fill out a Course Withdrawal Form available from the College of Science administrative office, or from https://www.science.vt.edu/content/dam/science_vt_edu/updatedforms/2019-forms/Withdrawal%20Form_Jan19.pdf. The form must be signed by you, your advisor, and your academic dean.

REPEATED AND DUPLICATED COURSES

A course that partially or wholly duplicates another (already taken) course does not count toward graduation. Duplication of two courses does not necessarily mean that they are equivalent; rather, it means that there is sufficient material overlap that credit is not allowed for both. No credit will be given toward graduation for duplicated courses nor may duplicate courses be used for GPA enhancement, unless the grade in the course already taken is a C- or less. Students may repeat courses in which they received grades of C- or below. Both grades stay on the record and figure into the overall and in-major GPA, but the course hours count only once toward graduation. Transcripts will display all hours attempted whether or not they count toward graduation.

TRANSFER CREDIT

Students transferring to Virginia Tech from a community college may transfer as many as 60 credits. Those who transfer from a four-year college have no such limitation. However, all students graduating from Virginia Tech must complete at least 27 hours in residence. A student must take at least 27 of their last 45 hours at Virginia Tech. Also, chemistry majors and minors must take at least 25% of the required chemistry courses at Virginia Tech.

More information is available online at the University Registrar’s website: http://www.registrar.vt.edu. Transfer students should also review the information in the online Transfer Guide: (http://www.transferguide.registrar.vt.edu/).

Students frequently wish to take summer school courses at other institutions for transfer back to Virginia Tech. The student should contact the college or university they wish to attend to determine what courses will be offered. An "Authorization to Take Courses Elsewhere" form should be obtained from the student’s advisor or primary major’s academic dean’s office. For students whose (primary) major is chemistry, the form may be found in the College of Science’s administrative office or from the College’s undergraduate forms webpage:

https://www.science.vt.edu/content/dam/science_vt_edu/new-website/student-forms/take-courses-elsewhere.pdf
The form must be returned to the Dean's office at least three weeks before matriculation at the other institution. Students who wait until the last part of the Spring semester to file this form may experience some delay. The transcript evaluator will determine whether the desired courses will transfer as expected, and you will receive an email when the request form has been reviewed. After the courses are completed, the student must request that an official transcript be sent to the University Registrar at Virginia Tech.

DOUBLE MAJORS and SECOND DEGREES

Students who complete the requirements for two majors within the same academic term are considered Double Majors. Students receive a diploma for the primary major (degree) and a double major certificate for the secondary major (double major).

Students may complete the requirements for a Second Degree in a different academic term. Students pursuing a Second Degree must complete an additional 30 credits over the minimum required for their first degree. Students will receive a separate diploma for each degree.

You should indicate on your Application for Degree on Hokie SPA if your secondary major should be a double major or a second degree.

MINORS

Any department that offers a major may offer a minor. If you desire a minor in a particular subject, contact the appropriate department for their requirements or ask your advisor. Note that Majors and Minors are supposed to be added before senior year.

GRADUATION

You should apply for your Degree on Hokie Spa during your junior year. You may then generate a Degree Audit Report System (DARS) report in Hokie Spa to review your record to see what requirements remain to be completed for graduation. Applying for your degree early ensures that you will have time to take courses that you may have overlooked, and it allows you and your advisor to correct the Registrar's analysis if errors are present. Finally, you should be advised that the Registrar's graduation analysis is not a binding contract. Do not assume that you are excused from a required course on the basis of error in DARS; the Registrar will eventually find the mistake and you will not graduate.

PATHWAYS TO GENERAL EDUCATION & UNIVERSITY AND COLLEGE OF SCIENCE REQUIREMENTS

1. No more than 60 hours in the major may be counted towards the total number of hours required for graduation.

2. Proficiency in a foreign language equivalent to one year of university instruction. This requirement can be met in several ways:
   2.1. Completing the third year (Level III) of a language in high school.
   2.2. Completing two years each of two different foreign languages in high school (for College of Science majors).
   2.3. Completing the 1106 course in Chinese, French, German, Greek, Italian, Japanese, Latin, Portuguese, Russian, or Spanish, including any prerequisites.
   NOTE: Students who have not completed foreign language requirements in high school may not count these hours toward the 120 required for graduation.
   2.4. Passing an oral examination in a language not taught at Virginia Tech.
   2.5. Documenting that English is not your primary language (see Department of Foreign Languages & Literatures for obtaining documentation).

3. Nine (9) hours of Discourse. Successful completion of English 1105 and 1106. Students who receive Advanced Standing (with credit) for 1105 take only 1106. Successful completion of an Advanced/Applied Writing or Speaking course.

4. Six (6) hours Critical Thinking in the Humanities.
5. Six (6) hours of Reasoning in the Social Sciences.

1. Three (3) hours of an Advanced/Applied Quantitative and Computational Thinking course (this is Math 2214 for BS majors and either STAT 3005 or STAT 3615 for the BA Chemistry, BS Medicinal Chemistry, and BS Polymer Chemistry degrees).

7. Six (6) hours of Critique in Design and the Arts.

8. Three (3) hours of Critical Analysis of Identity and Equity in the US. (May be double-counted with another core concept.)

9. Virginia Tech’s Pathways to General Education yearly guides are available online
   https://www.pathways.prov.vt.edu/about/course-catalog.html

HONORS COLLEGE

The Chemistry Department has faculty members who are active participants in the Honors College at Virginia Tech. We offer honors sections of several lecture courses to all students of the University, and we encourage our majors who are eligible to apply to the Honors College and pursue an Honors Laureate Diploma.

Additional information on the Honors College at Virginia Tech can be found here (http://www.honorscollege.vt.edu/), or by calling the Honors College office to speak with someone or to schedule an appointment – (540) 231-4591.

Miscellaneous Student Information

UNDERGRADUATE RESEARCH (CHEM 4994)

Chemistry majors are strongly encouraged to undertake a research project in collaboration with at least one faculty member. Credit for this activity is obtained by enrolling in CHEM 4994 for those semesters (potentially including summers) in which the work is to be performed. Chemistry faculty can suggest either short-term (one semester) or long-term projects; in every case, undergraduate research projects are designed to meet the individual interests and needs of the student. An interested student should consult with a prospective research mentor at least several weeks prior to the academic term in which s/he wants to register for undergraduate research. The student and research mentor must complete the “Undergraduate Research” form, which is available on the College of Science forms web page (cos.vt.edu). Students need a minimum 2.0 in-major GPA, a minimum 2.5 overall GPA, and a minimum of 28 credit hours completed at Virginia Tech to enroll in CHEM4994.

ALPHA CHI SIGMA & CHEMISTRY CLUB

There are two student groups affiliated with the Chemistry Department at Virginia Tech: Alpha Chi Sigma, the co-ed professional chemistry fraternity; and the Chemistry Club, a student affiliate chapter of the American Chemical Society. All chemistry majors are encouraged to join one and/or both of these groups. Activities include meetings, socials, tutoring, and hosting “illusion shows” and an end-of-the-year picnic for the department. For further information, please visit

   https://chem.vt.edu/academics/undergraduate/student-organizations.html
AFTER GRADUATION?

After receiving the B.S. or B.A. degree in chemistry, some students continue their education in professional or graduate school, and some take an entry-level job in chemistry or a related discipline.

Professional School Opportunities. Chemistry graduates may choose to pursue careers in dentistry, law, medicine, optometry, pharmacy, veterinary medicine, etc. Your academic advisor can direct you to numerous sources of information concerning professional school.

Graduate School. Many companies prefer to hire scientists with advanced degrees.

B.S. and B.A. chemistry majors are qualified to enter graduate school and pursue the M.S. or Ph.D. degree in a surprisingly large number of areas, some of which we have listed here:

<table>
<thead>
<tr>
<th>Chemistry</th>
<th>Biochemistry</th>
<th>Chemical Engineering</th>
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<tbody>
<tr>
<td>Textiles</td>
<td>Paper Chemistry</td>
<td>Environmental Engineering</td>
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<tr>
<td>Food Science</td>
<td>Toxicology</td>
<td>Medicinal Chemistry</td>
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<tr>
<td>Pharmacology</td>
<td>Pharmacy</td>
<td>Materials Engineering</td>
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<td>Polymer Chemistry</td>
<td>Virology</td>
<td>Forensic Chemistry</td>
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<tr>
<td>Oceanography</td>
<td>Clinical Chemistry</td>
<td>Secondary Education</td>
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Your academic advisor should be able to advise you concerning graduate school, particularly in chemistry. If you are interested in an area unfamiliar to your advisor, s/he should be able to direct you to someone knowledgeable. Students wishing to go to graduate school should plan to take the Graduate Record Exam (GRE) in the fall of their senior year and should complete their application in mid-January.

Employment. Finding a job requires work, perseverance, and a little luck, so you should plan to spend considerable time and effort in your search. If you sit back and wait for employers to come to you, you will not find a job! There are three primary sources of help for students interested in finding employment opportunities: your academic advisor; the departmental career advisor; and the Office of Career and Professional Development(www.career.vt.edu), which offers a variety of useful options such as mock interviews, résumé critique sessions, group meetings and seminars, and on-campus interviewing opportunities.

UNIVERSITY COUNSELING CENTER (www.ucc.vt.edu)

The Cook Counseling Center offers short-term individual, couples, and group counseling for a variety of concerns. Students come in for counseling to help them with issues such as stress, depression, anxiety, loneliness, sexual concerns, academic motivation, and relationship problems.

The Cook Counseling Center office and phoneline are open Monday-Friday, 8:00 am to 5:00 pm, at 540-231-6557. If you need emergency counseling outside normal business hours, assistance is available by calling 540-231-6444.

STUDENT SUCCESS CENTER (http://www.studentsuccess.vt.edu/)

The Student Success Center at Virginia Tech offers free academic support – such as tutoring and a wide variety of seminars and information sessions (including seminars on time management, honing test-taking and note-taking skills, and how to stay focused through the semester) – to undergraduate students.
VIRGINIA TECH POLICE DEPARTMENT (www.police.vt.edu)

The Virginia Tech Police Department is nationally accredited by the Commission on Accreditation for Law Enforcement Agencies Incorporated. Our police department strives to enhance the safety and quality of life for students, faculty, staff and visitors through effective law enforcement and proactive crime prevention in partnership with the university community.

Several programs are offered by the department, free of charge, to Virginia Tech students. Programs include the Student’s Police Academy, Self-Defense/Rape Aggression Defense System course, and VT C-CERT (Campus Community Emergency Response Team) training. Please visit the department’s website (www.police.vt.edu) for more information.

SAFE RIDE

The police department also sponsors a nighttime campus safety escort service known as Safe Ride. Safe Ride operates from dusk until dawn and provides transportation or a walking escort upon request. To use this service, call (540) 231-SAFE.

Undergraduate Course Descriptions (CHEM)

1004: FIRST YEAR EXPERIENCE IN CHEMISTRY
Orientation to the Chemistry Department and to the discipline of chemistry for chemistry majors and for individuals considering CHEM as a major, including transfer students. Resources for success, both generally as a college student and specifically as a chemistry major. Opportunities for mentoring, individual research and community involvement across the university and within the Chemistry Department. Exploration of career pathways for chemistry majors. Interconnections among professional practice, disciplinary progress, accepted standards for ethical use of information, principles of diversity and inclusion, and individual or personal value systems. Scientific communication, professional networking, and chemistry in the public eye. (1H,1C)

1014: CALCULATIONS IN CHEMISTRY

1015,1016: CHEMISTRY IN CONTEXT
Survey of chemistry across areas of specialization for students enrolled in curricula other than science and engineering. History and fundamental concepts and theories of chemistry, including the consequences of changes in parameters on chemical systems. Impact of chemistry in the context of areas of public concern and policy, including best practices for sustainability, rational decision-making, ethical use of scientific information, product and process stewardship. Chemistry as a basis for decision-making in the context of individual values and beliefs, and the roles of values and beliefs in the progress of chemistry as a human endeavor. The foregoing to be based on the concepts of chemistry as follows: 1015: Periodicity and atomic structure; nuclear chemistry; chemical bonding and reactivity; organic chemistry, polymer chemistry, and medicinal chemistry. 1016: Chemical stoichiometry including conservation of matter and energy; acid-base and oxidation-reduction chemistry of solutions; stoichiometry and thermodynamics, agricultural and environmental chemistry, chemistry of household and personal care products (3H,3C)

1025,1026: INTRODUCTION TO CHEMISTRY LABORATORY
Virtual laboratory exercises and reading and writing assignments designed to accompany 1015 and 1016, as applicable. Illustrates and elaborates on principles addressed in lecture, including history and fundamental concepts, theories, contexts, with an emphasis on sustainability issues and ethical
consequences of decision-making in chemistry. Students will identify foundational concepts in chemistry, enumerate parameters likely to influence the outcome of an experiment, analyze the ways that values and beliefs influence progress in the discipline and communicate chemical concepts to a lay audience. (3L,1C)

1034: GENERAL CHEMISTRY RECITATION
A companion course for students needing supplemental help with mathematical and problem-solving skills required for CHEM 1035 General Chemistry. Manipulation of algebraic formulas. Application of problem-solving techniques to chemical processes and reactions. Quantitative methods applied to unit conversions, reaction yields, energy of reactions, and gas properties. Examination of atomic structure, periodicity, and molecular bonding. May not count towards degree requirements; consult advisor. Pass/Fail only. Co: 1035. (1H,1C)

1035-1036: GENERAL CHEMISTRY
First chemistry course for students in science curricula. Applications of reasoning in the natural sciences using chemical laws in an applied context and in the student’s own discipline. Overview of the universal aspects of chemistry and of application of chemistry to address global challenges. 1035: Problem-solving, elements and periodic table, stoichiometry of chemical reactions, gas phase of matter, energy flow and chemical change, atomic structure, and theories of chemical bonding. 1036: Kinetics, equilibrium, thermodynamics, electrochemistry, transition elements, nuclear chemistry. (Duplicates 1015-1016.) Co: MATH 1025 or MATH 1225. (3H,3C)

1045-1046: GENERAL CHEMISTRY LABORATORY
Hands-on, real-world activities that illustrate and elaborate on concepts taught in general chemistry lecture (1035-1036), including acids and bases, heat capacity, ideal gases, states of matter, concentration, mixtures, energy flow and spontaneity in processes, equilibrium, kinetics, colligative properties, and electrochemistry. Use of instrumentation to analyze water and soil contaminants, biofuel mixtures, nanoparticles, and polymer properties. Laboratory safety, chemical hygiene, hazard mitigation, waste management, and the influence of procedure on experimental outcomes. Global challenges, including recycling and sustainable energy sources, water resource management, global warming, and environmentally friendly reagents in chemical contexts. Use of computers in data analysis, collaboration, and report-writing. Co: 1035 for 1045; 1036 for 1046. (3L,1C)

1055-1056: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor. Co: MATH 1025 or 1225 and CHEM 1065 for 1055. Co: 1065 for 1055; 1066, 1066 for 1056. (4H,4C)

1055H-1056H: HONORS GENERAL CHEM FOR MAJORS
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. Co: MATH 1025 or 1225 and CHEM 1065 for 1055. Co: 1065 for 1055H; 1066, 1066 for 1056H. (4H,4C)

1065-1066: GENERAL CHEMISTRY FOR CHEMISTRY MAJORS LAB
Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor. Co: 1055 for 1065; 1056 for 1066. (3L,1C)

2114: ANALYTICAL CHEMISTRY
A first course in analytical chemistry. Topics covered include volumetric and gravimetric analysis, and elementary spectroscopy. Pre: 1036 or 1056 or 1056H. Co: 2124. (3H,3C)
2124: ANALYTICAL CHEMISTRY LABORATORY TECHNIQUES AND PRACTICE
Practical introduction to wet methods of quantitative chemical analysis based on fundamental chemical principles. Prior credit for OR concurrent registration of 2114 lecture is required for 2124 lab. Pre: (1046 or 1066). Co: 2114. (3L,1C)

2154: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS
A one-semester course in analytical chemistry emphasizing the principles of equilibrium with examples from acid-base, complexation, solubility, and redox chemistry. The course also introduces the principles of spectroscopic, electrochemical, and chromatographic instrumentation. Pre: 1036 or 1056 or 1056H. Co: 2164. (4H,4C)

2164: ANALYTICAL CHEMISTRY FOR CHEMISTRY MAJORS LAB
A one-semester laboratory course in analytical chemistry that provides practical training in wet chemical methods, atomic and molecular spectroscopy, electrochemistry, and separations. Pre: 1046 or 1066. Co: 2154. (3L,1C)

2424: DESCRIPTIVE INORGANIC CHEMISTRY
Application of fundamental principles in a systematic study of bonding and reactivity of the elements and their compounds. Pre: 1036 or 1056. (3H,3C)

2514: SURVEY OF ORGANIC CHEMISTRY
Short course in fundamentals of organic chemistry with emphasis on nomenclature, isomerism, and properties of organic compounds. Compounds of importance to biology and biochemistry stressed. (Prior credit for 2535 precludes credit for this course.) One year of Chemistry required. Pre: (1035 or 1055 or 1055H), (1036 or 1056 or 1056H), (1045 or 1065), (1046 or 1066). (3H,3C)

2535-2536: ORGANIC CHEMISTRY
Structure, stereochemistry, reactions, and synthesis of organic compounds. Pre: 1036 or 1056 or 1056H or ISC 1106 or ISC 1106H for 2535; 2535 or (2565 or 2565H) for 2536. (3H,3C)

2545-2546: ORGANIC CHEMISTRY LABORATORY
The laboratory accompanies lectures in organic chemistry 2535 and 2536. Pre: 1046 or 1066 or ISC 1116 for 2545; 2545 for 2546. Co: 2565, 2535 for 2545; 2536 for 2546. (3L,1C)

2555-2556: ORGANIC SYNTHESIS AND TECHNIQUES LAB
Synthesis and characterization of organic compounds using modern laboratory techniques. Pre: 2565 for 2555; 2555 for 2556. (6L,2C)

2565-2566: PRINCIPLES OF ORGANIC CHEMISTRY
Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses. Pre: 1036 or 1056 or 1036H or 1056H for 2565; 2565 for 2566. (3H,3C)

2964: FIELD STUDY
Pass/Fail only. Variable credit course.

2974: INDEPENDENT STUDY
Variable credit course.

2974H: INDEPENDENT STUDY
Honors section. Variable credit course.

2984: SPECIAL STUDY
Variable credit course.
3615-3616: PHYSICAL CHEMISTRY
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partly duplicates 4615, cannot receive credit for both 3615 and 4615. Pre: (1035 or 1055 or 1055H), (1036 or 1056 or 1056H), PHYS 2306, (MATH 2204 or MATH 2204H or MATH 2224) for 3615; MATH 2214, (CHEM 3615 or CHEM 3615H), (CHEM 3615, MATH 2214 or CHEM 3615H) for 3616. (3H,3C)

3615H-3616H: HONORS PHYSICAL CHEMISTRY
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partially duplicates 4615, cannot receive credit for both 3615H and 4615. 3615H requires additional work; consult the instructor. Pre: (1035 or 1055 or 1055H), (1036 or 1056 or 1056H), PHYS 2306, (MATH 2204 or MATH 2204H or MATH 2224) for 3615H; MATH 2214, (CHEM 3615 or CHEM 3615H), (CHEM 3615, MATH 2214 or CHEM 3615H) for 3616H. (3H,3C)

3625-3626: PHYSICAL CHEMISTRY LABORATORY
Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed. Pre: 3615 or 3615H or 4615 for 3625; (3616 or 3616H or 4616), 3625, 4014 for 3626. (3L,1C)

4014: SURVEY OF CHEMICAL LITERATURE
Use of the chemical literature as an aid to professional activities. Pre: Junior Major Standing. (1H,1C)

4054: CAPSTONE IN MATERIALS AND SOCIETY
Capstone course for the Materials and Society Pathways Minor. Synthesizes the students’ preparation in social equity, policy, and fundamental materials science to critically analyze concepts in the modern scientific materials landscape, including the evaluation of scientific information, the reciprocal impact of science and society, and the ethics of extraction & mining, manufacturing & use, and disposal of materials. Cultivates skills in teamwork, written and oral presentations, and proposal development. (3H,3C)

4074 (MSE 4544): LABORATORY IN POLYMER SCIENCE
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems. Pre: 3616, 4534. (1H,3L,2C)

4114: INSTRUMENTAL ANALYSIS
Principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the corequisite lab 4124. Pre: (3615 or 3615H), 2154. Co: 4124. (3H,3C)

4114H: HONORS INSTRUMENTAL ANALYSIS
Pre: (3615 or 3615H), 2154. Co: 4124. (3H,3C)

4124: INSTRUMENTAL ANALYSIS LABORATORY
Hands-on experience with modern instrumental methods of analysis. Experiments use spectroscopy, electrochemistry, and separations. Co: 4114. (3L,1C)

4404: PHYSICAL INORGANIC CHEMISTRY
A study of spectroscopic, bonding, and structural properties of inorganic compounds. Pre: (3616 or 3616H), 2424. (3H,3C)

4414: INORGANIC CHEMISTRY LAB Synthesis and characterization of inorganic compounds using modern laboratory techniques. Pre: 2424, (3616 or 3616H), 4404. Co: 4424, 3616. (6L,2C)
4424 (SBIO 4424): POLYSACCHARIDE CHEMISTRY
Structure, properties, and applications of natural polysaccharides. Natural sources and methods of isolation. Synthetic chemistry and important polysaccharide derivatives. Relation of structure and properties to performance in critical applications including pharmaceuticals, coatings, plastics, rheology control, and films. Conversion by chemical and biochemical methods of polysaccharide biomass to fuels and materials. Pre: 2536 or 2566. (3H,3C)

4434: ORGANOMETALLIC CHEMISTRY
Synthesis, structure, properties, and reactivity patterns of main-group and transitionmetal organometallic compounds. Applications of organometallic compounds in chemical synthesis and catalysis. Pre: 2424, 2565, 2566, 4404. (3H,3C)

4444: BIOINORGANIC CHEMISTRY
Principles underpinning the study of metal ions in biological systems. Review of basic coordination chemistry. Evolution of the distribution of metal ions in biology. Uptake of metal ions from the environment into living organisms. Regulation of metal ion concentrations in cells. Central functions of metal ions in biological systems including modulation of structure, electron transfer reactions, substrate binding and activation, and selective transfer of atoms and groups. Roles of biopolymers in the binding, regulation, and function of metal ions. Physical methods of analysis relevant to bioinorganic chemical research questions. Senior standing. Pre: (2566 or BCHM 4115), BIOL 1105, BIOL 1106. (3H,3C)

4514: GREEN CHEMISTRY
Sustainability, waste prevention, conservation of energy resources, avoidance of toxins, pollutants, and hazards in chemical processes and products. Life-cycle analysis applied to case studies involving process development and product stewardship. Applications in chemical industry, process and product design, and public policy. Pre: 2536 or 2566. (3H,3C)

4524: IDENTIFICATION OF ORGANIC COMPOUNDS
Structure determination of organic compounds by spectroscopic methods, with an emphasis on mass spectrometry and nuclear magnetic resonance. Course will emphasize problem-solving skills. Pre: (2536 or 2566), (3616 or 3616H or 4616). (3H,3C)

4534: ORGANIC CHEMISTRY OF POLYMERS
Structure, synthesis, and basic characteristics of the major classes of polymerization reactions including step-growth (condensation) and chain growth (addition), free radical, and ionic mechanisms. Pre: 2536 or 2566. (3H,3C)

4544: MEDICINAL CHEMISTRY CAPSTONE LABORATORY
Laboratory experience tracing a standard pathway that potential drug targets follow in many medicinal chemistry laboratories. Synthesis of potential drug compounds and verification of their purity and structural identity primarily using mass spectrometry and nuclear magnetic resonance (NMR) spectroscopy. Optimization of conditions for a biochemical assay and verification of its reproducibility. Use of an optimized assay to measure the potency of potential drug compounds to achieve a desired biochemical effect. Application of structure-activity relationships to propose new chemical structures that might show further improvements in potency. Best practices in laboratory safety, chemical hygiene, note-taking, and professional report-writing. Senior standing. Pre: 4584, BIOL 1105, BIOL 1106. (6L,2C)

4554: DRUG CHEMISTRY
Structure, synthesis, and physiological effects of major classes of pharmaceutical agents including CNS depressants and stimulants, analgesics, anesthetics, cardiovascular agents, chemotherapeutic drugs, and oral contraceptives. Pre: 2536 or 2566. (3H,3C)

4584: BIOORGANIC CHEMISTRY
The organic chemistry underlying the structure and properties of amino acids, peptides, and nucleic acids. Mechanisms of enzyme catalysis and coenzyme-mediated reactions. Mechanisms and thermodynamics of
catabolism and anabolism of fats, carbohydrates, and proteins, and of other key biological reactions. Principles of solid-phase synthesis applied to peptides and nucleic acids. Biosynthesis of lipids, sugars, and terpenoids. Pre: 2536 or 2566. (3H,3C)

4615-4616: PHYSICAL CHEMISTRY FOR THE LIFE SCIENCES
Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3615, cannot receive credit for 3615 and 4615. Pre: (1036 or 1056 or 1056H), (MATH 1026 or MATH 1226), (PHYS 2206 or PHYS 2306) for 4615; 4615 for 4616. (3H,3C)

4634 (MSE 4534): POLYMER AND SURFACE CHEMISTRY
Physical chemical fundamentals of polymers and surfaces including adhesives and sealants. Pre: 3615 or 4615. (3H,3C)

4734 (CSES 4734) (ENSC 4734): ENVIRONMENTAL SOIL CHEMISTRY
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes. Pre: CSES 3114, CSES 3124, (CHEM 2514 or CHEM 2535), (CHEM 2114 or CHEM 2154), (MATH 2016 or MATH 1026 or MATH 1226). (3H,3C)

4964: FIELD STUDY
Pass/Fail only. Variable credit course.

4974: INDEPENDENT STUDY
Variable credit course.

4974H: INDEPENDENT STUDY
Honors section. Variable credit course.

4984: SPECIAL STUDY
Variable credit course. X-grade allowed.

4994: UNDERGRADUATE RESEARCH
Variable credit course.

4994H: UNDERGRADUATE RESEARCH
Honors section. Variable credit course.