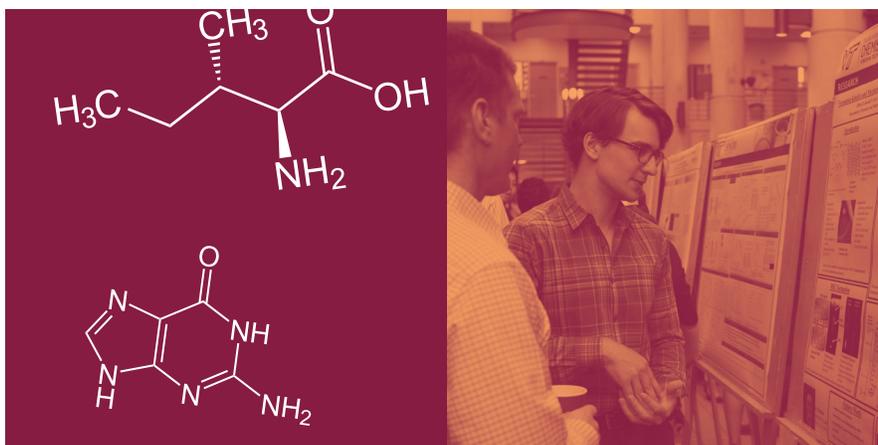




COLLEGE OF SCIENCE  
**CHEMISTRY**  
VIRGINIA TECH.

# ***UNDERGRADUATE HANDBOOK***

**/ NEW STUDENT ORIENTATION  
SUMMER 2020**



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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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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

## B.S. CHEMISTRY – RECOMMENDED SCHEDULE

Fall Semester Freshman 2020		Credits	Spring Semester Freshman 2021		Credits
CHEM 1004 First Year Experience in Chemistry	1		CHEM 1056 General Chemistry for Majors	4	
CHEM 1055 General Chemistry for Majors	4		CHEM 1066 General Chemistry for Majors Lab	1	
CHEM 1065 General Chemistry for Majors Lab	1		ENGL 1106 First-Year Writing (Pathways Discourse – Foundational)	3	
ENGL 1105 First-Year Writing (Pathways Discourse – Foundational)	3		MATH 1226 Calculus of a Single Variable (Pathways Quantitative and Computational Thinking- Foundational)	4	
MATH 1225 Calculus of a Single Variable (Pathways Quantitative and Computational Thinking - Foundational)	4		MATH 1114 Elementary Linear Algebra	2	
Pathways Reasoning in the Social Sciences	3				
<b>TOTAL</b>	<b>16</b>		<b>TOTAL</b>	<b>14</b>	
Fall Semester Sophomore 2021		Credits	Spring Semester Sophomore 2022		Credits
CHEM 2154 Majors Analytical Chemistry	4		CHEM 2566 Principles of Organic Chemistry	3	
CHEM 2164 Majors Analytical Chemistry Lab	1		CHEM 2555 Organic Synthesis & Techniques Lab	2	
CHEM 2565 Principles of Organic Chemistry	3		CHEM 4014 Survey of the Chemical Literature	1	
MATH 2204 Introduction to Multivariable Calculus	3		CHEM 2424 Descriptive Inorganic Chemistry	3	
PHYS 2305 Foundations of Physics (Pathways Reasoning in the Natural Sciences)	4		MATH 2214 Introduction to Differential Equations (Pathways Quantitative and Computational Thinking – Advanced)	3	
			PHYS 2306 Foundations of Physics (Pathways Reasoning in the Natural Sciences)	4	
<b>TOTAL</b>	<b>15</b>		<b>TOTAL</b>	<b>16</b>	
Fall Semester Junior 2022		Credits	Spring Semester Junior 2023		Credits
CHEM 2556 Organic Synthesis & Techniques Lab	2		CHEM 3616 Physical Chemistry	3	
CHEM 3615 Physical Chemistry	3		CHEM 3625 Physical Chemistry Lab	1	
CHEM 4584 Bioorganic Chemistry	3		CHEM 4114 Instrumental Analysis	3	
Pathways Critical Analysis of Identity and Equity in the US	3		STAT 3005 or STAT 3615	3	
Pathways Critical Thinking in the Humanities	3		Pathways Critical Thinking in the Humanities	3	
			Pathways Reasoning in the Social Sciences	3	
<b>TOTAL</b>	<b>14</b>		<b>TOTAL</b>	<b>16</b>	
Fall Semester Senior 2023		Credits	Spring Semester Senior 2024		Credits
CHEM 3626 Physical Chemistry Lab	1		CHEM 4414 Inorganic Synthesis Laboratory *	2	
CHEM 4124 Instrumental Analysis Lab	1		CHEM 4534/4634/4424 (Polymer Chemistry Elective) OR CHEM 4xxx (CHEM/BCHM/CHE elective, 3000-level or higher)	3	
CHEM 4404 Physical Inorganic Chemistry *	3		Pathways Critique and Practice in Design and Arts	3	
CHEM 4534/4634/4424 (Polymer Chemistry Elective) OR CHEM 4xxx (CHEM/BCHM/CHE elective, 3000-level or higher)	3		Free Electives	7	
Pathways Critique and Practice in Design and the Arts	3				
Pathways Discourse – Advanced	3				
<b>TOTAL</b>	<b>14</b>		<b>TOTAL</b>	<b>15</b>	
*An alternative to CHEM 4404/4414 is CHEM 4534/4074					

**College of Science  
Department of Chemistry**

Bachelor of Science in Chemistry  
**Major in Chemistry**

**Tentative Checksheet for students graduating in Calendar Year 2024** <sup>1, 2, 3, 4, 5, 6</sup>

**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)*

- |   |  |                      |
|---|--|----------------------|
| <b>I. Discourse</b> (9 credits required)  |  |                      |
| ENGL 1105-1106 <sup>14</sup> First-Year Writing                                       |  | (3) _____, (3) _____ |
| Advanced/Applied Writing or Speaking Course   |  | (3) _____            |
| (Select from approved Pathways courses)   |  |                      |
| <b>&amp; ViEWS</b> requirement <sup>15</sup>  |  |                      |
| <b>II. Critical Thinking in the Humanities</b> (6 credits required)                   |  |                      |
| (Select from approved Pathways courses)   |  | (3) _____, (3) _____ |
| <b>III. Reasoning in the Social Sciences</b> (6 credits required)                     |  |                      |
| (Select from approved Pathways courses)   |  | (3) _____, (3) _____ |
| <b>IV. Reasoning in the Natural Sciences</b> <sup>16</sup>                            |  |                      |
| <b>V. Quantitative and Computational Thinking</b> <sup>17</sup>                       |  |                      |
| <b>VI. Critique in Design and the Arts</b> (6 credits required)                       |  |                      |
| (Select from approved Pathways courses)   |  | (3) _____, (3) _____ |
| <b>VII. Critical Analysis of Identity and Equity in the U.S.</b> (3 credits required) |  |                      |
| (Select from approved Pathways courses)   |  | (3) _____            |
| <b>PART 1: Pathways credit hour requirement:</b>                                      |  | <b>30 credits</b>    |

**PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS**

- |  |   |                      |           |
|--|---|----------------------|-----------|
| <b>I. Chemistry Core Courses</b> (22 credits)                  |   |                      |           |
| CHEM 1004  | First Year Experience in Chemistry        | (1) _____            |           |
| CHEM 1055-1056 <sup>1</sup>                                    | General Chemistry for Majors              | (4) _____, (4) _____ |           |
| CHEM 1065-1066 <sup>7, 8</sup>                                 | General Chemistry for Majors lab          | (1) _____, (1) _____ |           |
| CHEM 2154  | Analytical Chemistry for Majors           | (4) _____            |           |
| CHEM 2164  | Analytical Chemistry for Majors lab       | (1) _____            |           |
| CHEM 2565 <sup>2, 9</sup> -2566                                | Principles of Organic Chemistry           | (3) _____, (3) _____ |           |
| <b>II. Additional Required courses</b> (5 credits)             |   |                      |           |
| CHEM 2555 -2556 <sup>10</sup>                                  | Organic Synthesis & Techniques Lab        | (2) _____, (2) _____ |           |
| CHEM 4014  | Survey of Chemical Literature             | (1) _____            |           |
| <b>III. Major Specific Required Course</b> (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 <sup>11, 12</sup>                     | Polymer chemistry elective                | (3) _____            |           |
| CHEM 4584  | Bioorganic Chemistry                      | (3) _____            |           |
| <b>IV. Mathematics Courses</b> (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) _____            |           |
| <b>V. Physics Courses</b> (8 credits)                          |   |                      |           |
| PHYS 2305 -2306  | Foundations of Physics I & II (incl. lab) | (4) _____, (4) _____ |           |
| <b>VI. Restricted Elective</b> (6 credits)                     |   |                      |           |
| STAT 3005 or STAT 3615   | Statistics elective                       | (3) _____            |           |
| CHEM 4xxx <sup>13</sup>  | CHEM/BCHM/CHE elective                    | (3) _____            |           |
| <b>VII. FREE ELECTIVES</b> (7 credits)                         |   |                      |           |
| ( ) _____  | ( ) _____                                 | ( ) _____            | ( ) _____ |
| ( ) _____  | ( ) _____                                 | ( ) _____            | ( ) _____ |
| <b>PART 2: College and department credit hour requirement:</b> |   | <b>90 credits</b>    |           |

### **Minimum Grade Requirement:**

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

<sup>1</sup> 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.

<sup>2</sup> 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:**

<sup>3</sup> This checklist has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. The checklist 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:**

<sup>4</sup> 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:**

<sup>5</sup> 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:**

<sup>6</sup> 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:**

<sup>7</sup> Prior credit for CHEM 1045 may be substituted for CHEM 1065.

<sup>8</sup> Prior credit for CHEM 1046 may be substituted for CHEM 1066.

<sup>9</sup> 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.

<sup>10</sup> 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.

<sup>11</sup> 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.

<sup>12</sup> 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).

<sup>13</sup> A biochemistry or chemical engineering student should not double-count coursework required for that major towards that chemistry upper-level (restricted) elective.

<sup>14</sup> COMM 1015-1016 may substitute for ENGL 1105-1106.

<sup>15</sup> Fulfilled by CHEM 4014 and CHEM 3626.

<sup>16</sup> Fulfilled by PHYS 2305 and PHYS 2306.

<sup>17</sup> Fulfilled by MATH 1225, MATH 1226, and MATH 2214.

## B.A. CHEMISTRY RECOMMENDED SCHEDULE

<b>Fall Semester Freshman 2020</b>		<b>Credits</b>			<b>Spring Semester Freshman 2021</b>		<b>Credits</b>
CHEM 1004 First Year Experience in Chemistry	1				CHEM 1056 General Chemistry for Majors	4	
CHEM 1055 General Chemistry for Majors	4				CHEM 1066 General Chemistry for Majors Lab	1	
CHEM 1065 General Chemistry for Majors Lab	1				ENGL 1106 (Pathways Discourse – Foundational)	3	
ENGL 1105 First-Year Writing (Pathways Discourse – Foundational)	3				MATH 1026 Elementary Calculus (Pathways Quantitative and Computational Thinking - Foundational)	3	
MATH 1025 Elementary Calculus (Pathways Quantitative and Computational Thinking - Foundational)	3				Pathways Critical Thinking in the Humanities	3	
Pathways Reasoning in the Social Sciences	3						
<b>TOTAL</b>	<b>15</b>				<b>TOTAL</b>	<b>14</b>	
<b>Fall Semester Sophomore 2021</b>		<b>Credits</b>			<b>Spring Semester Sophomore 2022</b>		<b>Credits</b>
CHEM 2154 Majors Analytical Chemistry	4				CHEM 2566 Principles of Organic Chemistry	3	
CHEM 2164 Majors Analytical Chemistry Lab	1				CHEM 2546 Organic Chemistry Lab	1	
CHEM 2565 Principles of Organic Chemistry	3				CHEM 4014 Survey of the Chemical Literature	1	
CHEM 2545 Organic Chemistry Lab	1				CHEM 2424 Descriptive Inorganic Chemistry	3	
MATH 2024 Intermediate Calculus	3				PHYS 2206 General Physics (Pathways Reasoning in the Natural Sciences)	3	
PHYS 2205 General Physics (Pathways Reasoning in the Natural Sciences)	3				PHYS 2216 General Physics Lab (Pathways Reasoning in the Natural Sciences)	1	
PHYS 2215 General Physics Lab (Pathways Reasoning in the Natural Sciences)	1				Pathways Reasoning in the Social Sciences	3	
<b>TOTAL</b>	<b>16</b>				<b>TOTAL</b>	<b>15</b>	
<b>Fall Semester Junior 2022</b>		<b>Credits</b>			<b>Spring Semester Junior 2023</b>		<b>Credits</b>
CHEM 4615 Physical Chemistry for Life Sciences	3				CHEM 4616 Physical Chemistry for Life Sciences	3	
STAT 3005 or STAT 3625) Statistics Elective (STAT 3615 also satisfies Pathways Quantitative and Computational Thinking - Advanced)	3				CHEM 3625 Physical Chemistry Lab	1	
Pathways Discourse - Advanced	3				Pathways Critique and Practice in Design and the Arts	3	
Pathways Critical Thinking in the Humanities	3				Free Electives	8	
Free Elective	3						
<b>TOTAL</b>	<b>15</b>				<b>TOTAL</b>	<b>15</b>	
<b>Fall Semester Senior 2023</b>		<b>Credits</b>			<b>Spring Semester Senior 2024</b>		<b>Credits</b>
CHEM 4XXX CHEM/BCHM/CHE Electives, 3000-level or higher	3				CHEM 4XXX CHEM/BCHM/CHE Electives, 3000-level or higher	3	
Pathways Critique and Practice in Design and the Arts	3				Pathways Critical Analysis of Identity and Equity in the US	3	
Pathways Quantitative and Computational Thinking – Advanced (unless STAT 3615 was used to fulfill this Learning Outcome) OR Free Elective	3				Free Electives	9	
Free Electives	6						
<b>TOTAL</b>	<b>15</b>				<b>TOTAL</b>	<b>15</b>	

**College of Science**  
**Department of Chemistry**  
 Bachelor of Arts in Chemistry  
**Major in Chemistry**

**Tentative Checksheet for students graduating in Calendar Year 2024** <sup>1, 2, 3, 4, 5, 6</sup>

**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)*

- |  |  |  |
|--|--|--|
| <b>I.</b>  | <b>Discourse</b> (9 credits)<br>ENGL 1105-1106 <sup>7</sup> First-Year Writing<br>Advanced/Applied Writing or Speaking course<br>(Select from approved Pathways courses)<br>& ViEWS requirement <sup>8</sup> | (3) _____, (3) _____<br>(3) _____<br>(3) _____ |
| <b>II.</b>                                       | <b>Critical Thinking in the Humanities</b> (6 credits required)<br>(Select from approved Pathways courses)   | (3) _____, (3) _____                           |
| <b>III.</b>                                      | <b>Reasoning in the Social Sciences</b> (6 credits required)<br>(Select from approved Pathways courses)  | (3) _____, (3) _____                           |
| <b>IV.</b>                                       | <b>Reasoning in the Natural Sciences</b> <sup>9</sup>  | (3) _____, (3) _____                           |
| <b>V.</b>  | <b>Quantitative and Computational Thinking</b> <sup>10</sup><br>Advanced/Applied Quantitative and Computational Thinking course <sup>11</sup><br>(Select from approved Pathways courses)                     | (3) _____                                      |
| <b>VI.</b>                                       | <b>Critique in Design and the Arts</b> (6 credits required)<br>(Select from approved Pathways courses)   | (3) _____, (3) _____                           |
| <b>VII.</b>                                      | <b>Critical Analysis of Identity and Equity in the U.S.</b> (3 credits required)<br>(Select from approved Pathways courses)  | (3) _____                                      |
| <b>PART 1: Pathways credit hour requirement:</b> |  | <b>36 credits</b>                              |

**PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS**

- |             |  |   |
|-------------|--|---|
| <b>I.</b>   | <b>Chemistry Core Courses</b> (22 credits)<br>CHEM 1004 Chemistry First-Year Experience<br>CHEM 1055-1056 <sup>1</sup> General Chemistry for Majors<br>CHEM 1065-1066 <sup>12, 13</sup> General Chemistry for Majors lab<br>CHEM 2154 Analytical Chemistry for Majors<br>CHEM 2164 Analytical Chemistry for Majors lab<br>CHEM 2565-2566 <sup>14</sup> Principles of Organic Chemistry | (1) _____<br>(4) _____, (4) _____<br>(1) _____, (1) _____<br>(4) _____<br>(1) _____<br>(3) _____, (3) _____ |
| <b>II.</b>  | <b>Additional Required Courses</b> (3 credits)<br>CHEM 2545 -2546 Organic Chemistry lab<br>CHEM 4014 Survey of Chemical Literature.  | (1) _____, (1) _____<br>(1) _____   |
| <b>III.</b> | <b>Major Specific Required Courses</b> (10 credits)<br>CHEM 2424 Descriptive Inorganic Chemistry<br>CHEM 4615-4616 <sup>15, 16</sup> Physical Chemistry for Life Sciences<br>CHEM 3625 Physical Chemistry lab  | (3) _____<br>(3) _____, (3) _____<br>(1) _____  |
| <b>IV.</b>  | <b>Mathematics Courses</b> (9 credits)<br>MATH 1025-1026 <sup>17, 18</sup> Elementary Calculus<br>MATH 2024 <sup>19</sup> Intermediate Calculus  | (3) _____, (3) _____<br>(3) _____   |
| <b>V.</b>   | <b>Physics Courses</b> (8 credits)<br>PHYS 2205 <sup>20</sup> - 2206 <sup>21</sup> General Physics<br>PHYS 2215 – 2216 General Physics Lab   | (3) _____, (3) _____<br>(1) _____, (1) _____  |
| <b>VI.</b>  | <b>Restricted Electives</b> (9 credits)<br>STAT 3005 or 3615 <sup>11, 22</sup> Statistics Elective<br>CHEM 3xxx-4xxx <sup>23, 24</sup> CHEM/BCHM/CHE electives   | (3) _____<br>(3) _____, (3) _____   |

**VII. FREE ELECTIVES (23 credits)**

( ) \_\_\_\_\_ ( ) \_\_\_\_\_ ( ) \_\_\_\_\_ ( ) \_\_\_\_\_  
( ) \_\_\_\_\_ ( ) \_\_\_\_\_ ( ) \_\_\_\_\_ ( ) \_\_\_\_\_

**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.

<sup>1</sup> 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.

<sup>2</sup> 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

<sup>3</sup> 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

<sup>4</sup> 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

<sup>5</sup> 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

<sup>6</sup> 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:

<sup>7</sup> COMM 1015 – 1016 may substitute for ENGL 1105 – 1106.

<sup>8</sup> 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.

<sup>9</sup> Fulfilled by PHYS 2205, 2206, 2215, and 2216 or by PHYS 2305-2306.

<sup>10</sup> Fulfilled by MATH 1025 and 1026.

<sup>11</sup> STAT 3005 or STAT 3615 can be used to fulfill this requirement and the STAT requirement.

<sup>12</sup> Prior credit for CHEM 1045 may be substituted for CHEM 1065.

<sup>13</sup> Prior credit for CHEM 1046 may be substituted for CHEM 1066.

<sup>14</sup> 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.

<sup>15</sup> CHEM 3615 may be substituted for CHEM 4615.

<sup>16</sup> CHEM 3616 may be substituted for CHEM 4616.

<sup>17</sup> MATH 1225 may be substituted for MATH 1025.

<sup>18</sup> MATH 1226 (MATH 1225 prerequisite) may be substituted for MATH 1026.

<sup>19</sup> MATH 2204 (MATH 1226 prerequisite) may be substituted for MATH 2024.

<sup>20</sup> PHYS 2305 (MATH 1225 prerequisite) may be substituted for PHYS 2205 and PHYS 2215.

<sup>21</sup> PHYS 2306 (MATH 1266 prerequisite) may be substituted for PHYS 2206 and PHYS 2216.

<sup>22</sup> Options include STAT 3005 or STAT 3615.

<sup>23</sup> SBIO 3444 or SBIO 4424 (cross-listed with CHEM 4424) may substitute for the Restrictive Elective.

<sup>24</sup> 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

<b>Fall Semester Freshman 2019</b>		<b>Credits</b>	<b>Spring Semester Freshman 2020</b>		<b>Credits</b>
CHEM 1004 First Year Experience in Chemistry	1		CHEM 1056 General Chemistry for Majors	4	
CHEM 1055 General Chemistry for Majors	4		CHEM 1066 General Chemistry for Majors Lab	1	
CHEM 1065 General Chemistry for Majors Lab	1		ENGL 1106 First-Year Writing (Pathways Discourse – Foundational)	3	
ENGL 1105 First-Year Writing (Pathways Discourse – Foundational)	3		MATH 1226 Calculus of a Single Variable (Pathways Quantitative and Computational Thinking- Foundational)	4	
MATH 1225 Calculus of a Single Variable (Pathways Quantitative and Computational Thinking - Foundational)	4		BIOL 1106 Principles of Biology	3	
BIOL 1105 Principles of Biology	3		BIOL 1116 Principles of Biology Laboratory	1	
BIOL 1115 Principles of Biology Laboratory	1				
<b>TOTAL</b>	<b>17</b>		<b>TOTAL</b>	<b>16</b>	
<b>Fall Semester Sophomore 2020</b>		<b>Credits</b>	<b>Spring Semester Sophomore 2021</b>		<b>Credits</b>
CHEM 2154 Majors Analytical Chemistry	4		CHEM 2566 Principles of Organic Chemistry	3	
CHEM 2164 Majors Analytical Chemistry Lab	1		CHEM 2555 Organic Synthesis & Techniques Lab	2	
CHEM 2565 Principles of Organic Chemistry	3		CHEM 4014 Survey of the Chemical Literature	1	
PHYS 2205 General Physics (Pathways Reasoning in the Natural Sciences)	3		PHYS 2206 General Physics (Pathways Reasoning in the Natural Sciences)	3	
PHYS 2215 General Physics Laboratory (Pathways Reasoning in the Natural Sciences)	1		PHYS 2216 General Physics Laboratory (Pathways Reasoning in the Natural Sciences)	1	
Pathways Reasoning in the Social Sciences (SOC 1004 is recommended for health science careers)	3		Pathways Critical Analysis of Identity and Equity in the US	3	
<b>TOTAL</b>	<b>15</b>		<b>TOTAL</b>	<b>13</b>	
<b>Fall Semester Junior 2021</b>		<b>Credits</b>	<b>Spring Semester Junior 2022</b>		<b>Credits</b>
CHEM 2556 Organic Synthesis & Techniques Lab	2		CHEM 4616 Physical Chemistry for Life Sciences	3	
CHEM 4615 Physical Chemistry for Life Sciences	3		STAT 3005 or 3615 (Pathways Quantitative and Computational Thinking- Advanced)	3	
CHEM 4584 Bioorganic Chemistry	3		Pathways Critical Thinking in the Humanities	3	
Pathways Critical Thinking in the Humanities	3		Pathways Reasoning in the Social Sciences (PSYC 1004 is recommended for health science careers)	3	
Pathways Critique and Practice in Design and the Arts	3		Pathways Discourse – Advanced	3	
<b>TOTAL</b>	<b>14</b>		<b>TOTAL</b>	<b>15</b>	
<b>Fall Semester Senior 2022</b>		<b>Credits</b>	<b>Spring Semester Senior 2023</b>		<b>Credits</b>
CHEM 4524 or CHEM 4444	3		CHEM 4544 Medicinal Chemistry Capstone Laboratory	2	
Pathways Critique and Practice in Design and the Arts	3		CHEM 4514 or 4554 or 4424	3	
Free Electives	10		Free Electives	9	
<b>TOTAL</b>	<b>16</b>		<b>TOTAL</b>	<b>14</b>	

College of Science  
Department of Chemistry

Bachelor of Science in Chemistry  
Major in Medicinal Chemistry

Tentative Checklist for students graduating in Calendar Year 2024 <sup>1, 2, 3, 4, 5, 6</sup>

**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 <sup>12</sup> First-Year Writing (3) \_\_\_\_\_, (3) \_\_\_\_\_  
Advanced/Applied Writing or Speaking Course (3) \_\_\_\_\_  
(Select from approved Pathways courses)  
& ViEWS requirement <sup>11</sup> (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** <sup>13</sup>
- V. Quantitative and Computational Thinking** <sup>14</sup>  
Advanced/Applied Quantitative and Computational Thinking Course <sup>15</sup> (3) \_\_\_\_\_  
(Select STAT 3005 or STAT 3615)
- 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 <sup>1</sup> General Chemistry for Majors (4) \_\_\_\_\_, (4) \_\_\_\_\_  
CHEM 1065-1066 <sup>7, 8</sup> General Chemistry for Majors lab (1) \_\_\_\_\_, (1) \_\_\_\_\_  
CHEM 2154 Analytical Chemistry for Majors (4) \_\_\_\_\_  
CHEM 2164 Analytical Chemistry for Majors lab (1) \_\_\_\_\_  
CHEM 2565 <sup>2, 9</sup> -2566 Principles of Organic Chemistry (3) \_\_\_\_\_, (3) \_\_\_\_\_
- II. Additional Required courses** (5 credits)  
CHEM 2555 -2556 <sup>10</sup> 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 <sup>16</sup> – 4616 <sup>17</sup> 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 <sup>18</sup> - 2206 <sup>19</sup> 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**

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### **Minimum Grade Requirement:**

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

<sup>1</sup> 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.

<sup>2</sup> 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:**

<sup>3</sup> 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:**

<sup>4</sup> 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:**

<sup>5</sup> 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:**

<sup>6</sup> 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:**

<sup>7</sup> Prior credit for CHEM 1045 may be substituted for CHEM 1065.

<sup>8</sup> Prior credit for CHEM 1046 may be substituted for CHEM 1066.

<sup>9</sup> 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.

<sup>10</sup> 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.

<sup>11</sup> 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.

<sup>12</sup> COMM 1015-1016 may substitute for ENGL 1105-1106.

<sup>13</sup> Fulfilled by PHYS 2205/2215-2206/2216 or PHYS 2305 and PHYS 2306

<sup>14</sup> Fulfilled by MATH 1225 and MATH 1226

<sup>15</sup> STAT 3005 or STAT 3615 can be used to fulfill this requirement.

<sup>16</sup> CHEM 3615 may be substituted for CHEM 4615.

<sup>17</sup> CHEM 3616 may be substituted for CHEM 4616.

<sup>18</sup> PHYS 2305 (MATH 1225 prerequisite) may be substituted for PHYS 2205 and PHYS 2215.

<sup>19</sup> PHYS 2306 (MATH 1226 prerequisite) may be substituted for PHYS 2206 and PHYS 2216.

## B.S. POLYMER CHEMISTRY – RECOMMENDED SCHEDULE

<b>Fall Semester Freshman 2019</b>		<b>Credits</b>	<b>Spring Semester Freshman 2020</b>		<b>Credits</b>
CHEM 1004 First Year Experience in Chemistry	1		CHEM 1056 General Chemistry for Majors	4	
CHEM 1055 General Chemistry for Majors	4		CHEM 1066 General Chemistry for Majors Lab	1	
CHEM 1065 General Chemistry for Majors Lab	1		ENGL 1106 First-Year Writing (Pathways Discourse – Foundational)	3	
ENGL 1105 First-Year Writing (Pathways Discourse – Foundational)	3		MATH 1226 Calculus of a Single Variable (Pathways Quantitative and Computational Thinking- Foundational)	4	
MATH 1225 Calculus of a Single Variable (Pathways Quantitative and Computational Thinking - Foundational)	4		Pathways Critical Thinking in the Humanities	3	
Pathways Reasoning in the Social Sciences	3				
<b>TOTAL</b>	<b>16</b>		<b>TOTAL</b>	<b>15</b>	
<b>Fall Semester Sophomore 2020</b>		<b>Credits</b>	<b>Spring Semester Sophomore 2021</b>		<b>Credits</b>
CHEM 2154 Majors Analytical Chemistry	4		CHEM 2566 Principles of Organic Chemistry	3	
CHEM 2164 Majors Analytical Chemistry Lab	1		CHEM 2555 Organic Synthesis & Techniques Lab	2	
CHEM 2565 Principles of Organic Chemistry	3		CHEM 4014 Survey of the Chemical Literature	1	
MATH 2204 Introduction to Multivariable Calculus	3		PHYS 2306 Foundations of Physics (Pathways Reasoning in the Natural Sciences)	4	
PHYS 2305 Foundations of Physics (Pathways Reasoning in the Natural Sciences)	4		Pathways Critical Analysis of Identity and Equity in the US	3	
			Free Elective	3	
<b>TOTAL</b>	<b>15</b>		<b>TOTAL</b>	<b>16</b>	
<b>Fall Semester Junior 2021</b>		<b>Credits</b>	<b>Spring Semester Junior 2022</b>		<b>Credits</b>
CHEM 2556 Organic Synthesis & Techniques Lab	2		CHEM 3625 Physical Chemistry Lab	1	
CHEM 3615 Physical Chemistry	3		STAT 3005 or 3615 or 4604 (Pathways Quantitative and Computational Thinking-	3	
CHEM 4534 Organic Chemistry of Polymers	3		CHEM 4074 Laboratory in Polymer Science	2	
Pathways Critical Thinking in the Humanities	3		Pathways Reasoning in the Social Sciences	3	
Free Electives	3		Free Electives	6	
<b>TOTAL</b>	<b>14</b>		<b>TOTAL</b>	<b>15</b>	
<b>Fall Semester Senior 2023</b>		<b>Credits</b>	<b>Spring Semester Senior 2023</b>		<b>Credits</b>
CHEM 4524 or CHE 4104 or PHYS 4564 Elective*	3		CHEM 4424 or CHEM 4634 Elective*	3	
CHEM 4524 or CHE 4104 or PHYS 4564 Elective*	3		Pathways Critique and Practice in Design and the Arts	3	
Pathways Critique and Practice in Design and the Arts	3		Free Electives	8	
Pathways Discourse – Advanced	3				
Free Electives	3				
<b>TOTAL</b>	<b>15</b>		<b>TOTAL</b>	<b>14</b>	

\*Must choose a total of three courses (9 credits)

**College of Science  
Department of Chemistry**

Bachelor of Science in Chemistry  
**Major in Polymer Chemistry**

**Tentative Checklist for students graduating in Calendar Year 2024** <sup>1, 2, 3, 4, 5, 6</sup>

**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)*

- |             |  |                      |
|-------------|--|----------------------|
| <b>I.</b>   | <b>Discourse</b> (9 credits required)  |                      |
|             | ENGL 1105-1106 <sup>7</sup> First-Year Writing   | (3) _____, (3) _____ |
|             | Advanced/Applied Writing or Speaking Course<br>(Select from approved Pathways courses) | (3) _____            |
|             | <b>&amp; ViEWS</b> requirement <sup>8</sup>  | (3) _____            |
| <b>II.</b>  | <b>Critical Thinking in the Humanities</b> (6 credits required)                        |                      |
|             | (Select from approved Pathways courses)  | (3) _____, (3) _____ |
| <b>III.</b> | <b>Reasoning in the Social Sciences</b> (6 credits required)                           |                      |
|             | (Select from approved Pathways courses)  | (3) _____, (3) _____ |
| <b>IV.</b>  | <b>Reasoning in the Natural Sciences</b> <sup>9</sup>                                  |                      |
| <b>V.</b>   | <b>Quantitative and Computational Thinking</b> <sup>10</sup>                           |                      |
|             | Advanced/Applied Quantitative and Computational Thinking Course <sup>11</sup>          | (3) _____            |
|             | (Select STAT 3005 or STAT 3615 or STAT 4604)   |                      |
| <b>VI.</b>  | <b>Critique in Design and the Arts</b> (6 credits required)                            |                      |
|             | (Select from approved Pathways courses)  | (3) _____, (3) _____ |
| <b>VII.</b> | <b>Critical Analysis of Identity and Equity in the U.S.</b> (3 credits required)       |                      |
|             | (Select from approved Pathways courses)  | (3) _____            |
|             | <b>PART 1: Pathways credit hour requirement:</b>                                       | <b>33 credits</b>    |

**PART 2: COLLEGE AND DEPARTMENT REQUIREMENTS**

- |             |  |                      |
|-------------|--|----------------------|
| <b>I.</b>   | <b>Chemistry Core Courses</b> (22 credits)                         |                      |
|             | CHEM 1004 First Year Experience in Chemistry                       | (1) _____            |
|             | CHEM 1055-1056 <sup>1</sup> General Chemistry for Majors           | (4) _____, (4) _____ |
|             | CHEM 1065-1066 <sup>12, 13</sup> General Chemistry for Majors lab  | (1) _____, (1) _____ |
|             | CHEM 2154 Analytical Chemistry for Majors                          | (4) _____            |
|             | CHEM 2164 Analytical Chemistry for Majors lab                      | (1) _____            |
|             | CHEM 2565 <sup>2, 14</sup> -2566 Principles of Organic Chemistry   | (3) _____, (3) _____ |
| <b>II.</b>  | <b>Additional Required courses</b> (5 credits)                     |                      |
|             | CHEM 2555 -2556 <sup>15</sup> Organic Synthesis & Techniques Lab   | (2) _____, (2) _____ |
|             | CHEM 4014 Survey of Chemical Literature                            | (1) _____            |
| <b>III.</b> | <b>Major Specific Required Course</b> (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) _____            |
| <b>IV.</b>  | <b>Mathematics Courses</b> (11 credits)                            |                      |
|             | MATH 1225-1226 Calculus of a Single Variable                       | (4) _____, (4) _____ |
|             | MATH 2204 Introduction to Multivariable Calculus                   | (3) _____            |
| <b>V.</b>   | <b>Physics Courses</b> (8 credits)                                 |                      |
|             | PHYS 2305 -2306 Foundations of Physics I & II (incl. lab)          | (4) _____, (4) _____ |
| <b>VI.</b>  | <b>Restricted Elective</b> (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) _____            |
| <b>VII.</b> | <b>FREE ELECTIVES</b> (20 credits)                                 |                      |
|             | ( ) _____ ( ) _____ ( ) _____                                      | ( ) _____            |
|             | ( ) _____ ( ) _____ ( ) _____                                      | ( ) _____            |
|             | <b>PART 2: College and department credit hour requirement:</b>     | <b>87 credits</b>    |

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**Minimum Grade Requirement:**

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

<sup>1</sup> 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.

<sup>2</sup> 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:**

<sup>3</sup> 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:**

<sup>4</sup> 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:**

<sup>5</sup> 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:**

<sup>6</sup> 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:**

<sup>7</sup> COMM 1015-1016 may substitute for ENGL 1105-1106.

<sup>8</sup> 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.

<sup>9</sup> Fulfilled by PHYS 2305 and PHYS 2306

<sup>10</sup> Fulfilled by MATH 1225 and MATH 1226

<sup>11</sup> STAT 3005 or STAT 3615 or STAT 4604 can be used to fulfill this requirement.

<sup>12</sup> Prior credit for CHEM 1045 may be substituted for CHEM 1065.

<sup>13</sup> Prior credit for CHEM 1046 may be substituted for CHEM 1066.

<sup>14</sup> 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.

<sup>15</sup> 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.

**College of Science  
Department of Chemistry**

**CHEMISTRY MINOR CHECKSHEET**

**For students graduating in calendar year 2023**

**I. Required Courses (19 hours)**

CHEM 1035 <sup>1</sup> -1036 <sup>2</sup> General Chemistry	(3)_____ (3) _____
CHEM 1045 <sup>3</sup> -1046 <sup>4</sup> 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 <sup>5</sup>	(3) _____

*(Additional prerequisites: MATH 1026, PHYS 2206)*

**II. Elective course (3 hours)**

(3)\_\_\_\_\_

Choose one course from this list:

- 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:

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<sup>1</sup> CHEM 1055 or CHEM 1055H may be substituted for CHEM 1035.

<sup>2</sup> CHEM 1056 or CHEM 1056H may be substituted for CHEM 1036.

<sup>3</sup> CHEM 1065 may be substituted for CHEM 1045.

<sup>4</sup> CHEM 1066 may be substituted for CHEM 1046.

<sup>5</sup> 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

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

!!! 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](http://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

Dr. Patricia Amateis	109F Davidson Hall	231-6629*	pamateis@vt.edu
Dr. Shamindri Arachchige	109C Davidson Hall	231-4878	arachsm@vt.edu
Dr. Michael Berg	109A Davidson Hall	231-6837	bergm@vt.edu
Dr. Maggie Bump	109D Davidson Hall	231-4675	mbump@vt.edu
Dr. Jeannine Eddleton	117A Davidson Hall	231-8228	jeddleto@vt.edu
Dr. Alan Esker	480C Davidson Hall	231-4601	aesker@vt.edu
Dr. Gary Long	409 Davidson Hall	231-7575	long@vt.edu
Dr. Andrew Lowell	3101 Hahn Hall South	231-6842	alowell@vt.edu
Dr. Joe Merola	3109 Hahn Hall South	231-4510	jmerola@vt.edu
Dr. Amanda Morris	321 Davidson Hall	231-5585	ajmorris@vt.edu
Dr. John Morris	117D Davidson Hall	231-2472	jrmorris@vt.edu
Dr. Brian Tissue	1105 Hahn Hall South	231-3786	tissue@vt.edu
Dr. Gordon Yee	2103 Hahn Hall South	231-3090	gyee@vt.edu

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 [jeddleto@vt.edu](mailto:jeddleto@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 1105/1115/1106/1116) 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

First Year		Fall	Spring
CHEM 1055, 1056	General Chemistry for Chem Majors	4	4
CHEM 1065, 1066	General Chemistry for Chem Majors Lab	1	1
CHEM 1004	Chemistry First Year Experience	1	-
BIOL 1105, 1106	Principles of Biology	3	3
BIOL 1115, 1116	Principles of Biology Lab	1	1
ENGL 1105, 1106	First-Year Writing	3	3
MATH 1025	Elementary Calculus	3	-
MATH 1026	Elementary Calculus	-	3
	Semester Total	16	15
Second Year			
CHEM 2565, 2566	Principles of Organic Chemistry	3	3
CHEM 2545, 2546	Organic Chemistry Lab	1	1
BIOL 2604	General Microbiology	3	-
BIOL 2004	Genetics	-	3
MATH 2024	Intermediate Calculus	3	-
PHYS 2205, 2206	General Physics	3	3
PHYS 2215, 2216	General Physics Lab	1	1
PSYC 1004	Introductory Psychology	-	3
SOC 1004	Introductory Sociology	3	-
STAT 3615	Biological Statistics	-	3
	Semester Total	17	17

Third Year			
CHEM 2154	Analytical Chemistry for Chem Majors	4	-
CHEM 2164	Analytical Chemistry for Chem Majors Lab	1	-
CHEM 2424	Descriptive Inorganic Chemistry	-	3
CHEM 4014	Survey of Chemical Literature	-	1
CHEM 4554	Drug Chemistry	-	3
BCHM 4115, 4116	General Biochemistry	4	3
	Electives	6	5
	Semester Total	15	15
Fourth Year			
CHEM 4615, 4616	Physical Chemistry for Life Sciences	3	3
CHEM 3625	Physical Chemistry Lab	-	1
	Electives	9	9
	Semester Total	12	13

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](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.tranguide.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](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](http://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 CHEM 4994.

### 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:

Chemistry	Biochemistry	Chemical Engineering
Textiles	Paper Chemistry	Environmental Engineering
Food Science	Toxicology	Medicinal Chemistry
Pharmacology	Pharmacy	Materials Engineering
Polymer Chemistry	Virology	Forensic Chemistry
Oceanography	Clinical Chemistry	Secondary Education

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 (<http://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](http://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.

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](http://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

Mathematical problem solving skills required for success in general chemistry. Manipulation of symbolic algebraic formulas. Dimensional analysis and narrative mathematical exercises. Application of problem solving techniques to chemical processes and reactions. Generation and interpretation of graphs using computer software. Elementary features of atoms, molecules, and the periodic table of the elements. Molar quantities, chemical nomenclature, reaction stoichiometry, and introductory solution chemistry. (3H,3C)

### 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-keeping, 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.