

Chemistry, B.S.

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B.S. in Chemistry (and requirements for additional major in chemistry)

The Bachelor of Science (B.S.) in Chemistry is the most commonly awarded undergraduate degree in the department. It provides strong preparation for graduate study or for employment in research, development, or analytical roles in industry. The curriculum includes foundational coursework in organic, physical, inorganic, and analytical chemistry, and it emphasizes hands-on laboratory training using modern instrumentation.

Curriculum Planning and Course Scheduling

The curriculum and sample schedule presented here are intended for students who matriculate in Fall 2025. Students who entered in prior years should consult their degree audit and speak with the Director of Undergraduate Studies to confirm the requirements that apply to them.

The B.S. in Chemistry curriculum offers flexibility, allowing students to tailor their schedules to include electives, minors, or an additional major. While it is recommended that core technical courses be completed early, students may choose to delay some requirements to accommodate other interests or programs.

When planning your schedule, be aware that many required chemistry courses are offered only once per academic year. For example:

Fall-only courses:

- 09-219 Modern Organic Chemistry
- 09-321 Laboratory III: Molecular Design and Synthesis
- 09-323 Bioorganic Chemistry Laboratory
- 09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry

Spring-only courses:

- 09-220 Modern Organic Chemistry II
- 09-331 Modern Analytical Instrumentation
- 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry
- 09-348 Inorganic Chemistry

Course Scheduling Note: Occasionally, a course that is typically offered in the fall may be shifted to the spring (or vice versa) due to departmental curriculum changes or faculty availability. Students are encouraged to consult the department and their advisor each semester to confirm course timing and build a long-term plan that anticipates such changes and accommodates personal goals such as study abroad, research, or double majoring.

Technical and Non-Technical Requirements

MCS Core Technical Requirements

Chemistry majors must complete a minimum of four technical courses outside of chemistry to satisfy the MCS core technical breadth requirement. These include courses in physics, biology, computer science, and mathematics:

Technical Breadth Requirements	Units
33-121 Physics I for Science Students	12
33-122 Physics II for Biological Sciences and Chemistry Students	9
03-121 Modern Biology	9
or 03-231 Honors Biochemistry	
or 03-232 Biochemistry I	

15-110	Principles of Computing	10
or 15-112	Fundamentals of Programming and Computer Science	
or 02-120	Programming for Scientists	
21-120	Differential and Integral Calculus	10
21-122	Integration and Approximation	10
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Students are encouraged to complete these technical core requirements by the end of their fifth semester. AP credit may not be used to fulfill the core technical breadth requirements, though it can satisfy prerequisites for chemistry courses. If a student fulfills an entire category (e.g., physics or biology) solely through AP credit, they must take an approved upper-level course in that area to meet the core requirement.

Non-Technical General Education Requirements

All students in the Mellon College of Science (MCS) must complete a set of non-technical breadth requirements totaling a minimum of 75 units. These include communication, humanities and social sciences, global and cultural perspectives, and wellness:

Required Courses:

- 76-101 Interpretation and Argument (9 units)
- Arts, Humanities, and Social Sciences: Four courses totaling a minimum of 36 units
- Cultural/Global Understanding: One approved course (minimum 9 units)
- Science and Society: One approved course (minimum 6 units)
- Engage Sequence (5 total):
 - ENGAGE in Wellness
 - 38-230 ENGAGE in Wellness: Looking Inward (1 unit)
 - 38-330 ENGAGE in Wellness: Looking Outward (1 unit)
 - 38-430 ENGAGE in Wellness: Looking Forward (1 unit)
 - 38-110 ENGAGE in Service (1 unit)
 - 38-220 ENGAGE in the Arts (2 units)
- First-Year Seminars
 - 38-101 EUREKA!: Discovery and Its Impact (6 units)
 - 99-101 Core@CMU (3 units)

Important Notes:

- The Science and Society and ENGAGE requirements must be completed no later than the penultimate semester.
- Students may not double count courses across general education categories. For example, a course used to fulfill the Science and Society requirement may not also count toward the Cultural/Global Understanding category or the 36 units required in Arts, Humanities, and Social Sciences.

Overlap with Chemistry Electives:

Some chemistry courses approved for general education requirements may also count as chemistry electives. For example:

- Science and Society + Chemistry Elective:
 - 09-510 Chemistry and Sustainability (or graduate version, 09-710 Chemistry and Sustainability)
 - 09-381 Environmental Systems on a Changing Planet
 - 09-403 Hooked: The Chemical Basis of Drug Addiction

(Only one of these may count toward the 18 units of chemistry electives.)

- Cultural/Global Understanding + Chemistry Elective:
 - 09-227 The Culture of Color: Dyes, Chemistry, and Sustainability

A current list of approved courses in these categories is maintained by the MCS Dean's Office:

<https://www.cmu.edu/mcs/undergrad/advising/hss-finearts/index.html>
(<https://www.cmu.edu/mcs/undergrad/advising/hss-finearts/>)

Sample Schedule by Year (First-Senior)

First Year

Fall		Units
09-105	Introduction to Modern Chemistry I	10

or 09-107	Honors Chemistry: Fundamentals, Concepts and Applications	
09-115	Introduction to Undergraduate Research in Chemistry	2
21-120	Differential and Integral Calculus	10
33-121	Physics I for Science Students	12
76-101	Interpretation and Argument	9
38-101	EUREKA!: Discovery and Its Impact	6
99-101	Core@CMU	3

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Planning Tip: Students interested in majoring in chemistry who have a strong chemistry background should enroll in 09-107 Honors Chemistry: Fundamentals, Concepts and Applications rather than 09-105 Introduction to Modern Chemistry I. Students who complete 09-107 with an A grade will be exempted from the requirement to take 09-106 Modern Chemistry II via a prerequisite waiver.

There are some elective laboratory courses offered for MCS students in the first year including 03-117 Frontiers, Analysis, and Discovery in Biological Sciences or 09-101 Introduction to Experimental Chemistry and 09-115 Introduction to Undergraduate Research in Chemistry. While not required for the major, we strongly encourage students who are interested in early research engagement to register for 09-115 Introduction to Undergraduate Research in Chemistry. This course introduces students to research within the department and includes laboratory safety and hazardous waste training, which are often necessary for working in scientific labs at CMU. It is included in the sample schedule above to highlight this opportunity.

The maximum units allowed during the first semester is 54; therefore, students wishing to take a lab should take an alternate technical course to Physics I such as 15-110 Principles of Computing or 03-121 Modern Biology so that their unit total is lower.

Spring		Units
09-106	Modern Chemistry II	10
09-116	Undergraduate Research Shadowing in Chemistry	2
or 09-101	Introduction to Experimental Chemistry	
21-122	Integration and Approximation	10
33-121	Physics I for Science Students	12
or 03-121	Modern Biology	
or 15-110	Principles of Computing	
xx-xxx	Arts, Humanities and Social Sciences Course 1	9
xx-xxx	Free Elective	9

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Planning Tip: Chemistry majors who place out of 09-106 Modern Chemistry II can take 09-348 Inorganic Chemistry, 09-510 Chemistry and Sustainability or 09-381 Environmental Systems on a Changing Planet as a chemistry elective. 09-381 Environmental Systems on a Changing Planet is especially recommended for students pursuing the Environmental and Sustainability Studies minor. 09-510 Chemistry and Sustainability will serve as both a Chemistry elective as well as a MCS Science and Society requirement. Please note that 09-291 Environmental Systems on a Changing Planet does not count toward chemistry electives.

The sample schedule above also includes laboratory electives. Students wishing to actively engage in research should take 09-116 Undergraduate Research Shadowing in Chemistry, which pairs them with a research group in the department for half a semester. With a faculty mentor's recommendation, students may continue in the same lab through 09-445 Undergraduate Research. Those who want focused hands-on experience in a chemistry lab environment may consider 09-101 Introduction to Experimental Chemistry. Students interested in biology-based lab work may also take 03-117 Frontiers, Analysis, and Discovery in Biological Sciences.

Sophomore Year

Fall		Units
09-201	Undergraduate Seminar I	1
09-219	Modern Organic Chemistry	10
09-221	Laboratory I: Introduction to Chemical Analysis	12
33-122	Physics II for Biological Sciences and Chemistry Students	9
	Course is a prerequisite for 09-331, normally taken in the spring of the junior year	
xx-xxx	Arts, Humanities and Social Sciences Course 2	9

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Spring		Units
09-202	Undergraduate Seminar II: Safety and Environmental Issues for Chemists	1
09-220	Modern Organic Chemistry II	10
09-222	Laboratory II: Organic Synthesis and Analysis	12
09-348	Inorganic Chemistry	10
38-230	ENGAGE in Wellness: Looking Inward	1
xx-xxx	Arts, Humanities and Social Sciences Course 3	9

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Planning Tip: Students pursuing careers in the health professions or following the Biological Chemistry Track may wish to take 03-232 Biochemistry I in the Spring semester and delay 09-348 Inorganic Chemistry to the spring of their senior year.

Junior Year

Fall		Units
09-301	Undergraduate Seminar III	1
09-231	Mathematical Methods for Chemists	9
09-321	Laboratory III: Molecular Design and Synthesis	12
or 09-323	Bioorganic Chemistry Laboratory	
09-344	Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
38-330	ENGAGE in Wellness: Looking Outward	1
xx-xxx	Arts, Humanities and Social Sciences Course 4	9

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Spring		Units
09-302	Undergraduate Seminar IV	1
09-322	Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-345	Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
09-331	Modern Analytical Instrumentation	9
xx-xxx	Cultural/Global Understanding Requirement	9
xx-xxx	Approved Science and Society elective. This course can be scheduled at any point during your studies but prior to your final semester..	6-9

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Planning Tip:

- 09-231 Mathematical Methods for Chemists is a co-requisite for 09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry and a prerequisite for 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry.
- 09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry is a prerequisite for 09-322 Laboratory IV: Molecular Spectroscopy and Dynamics.
- While 09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry and 09-331 Modern Analytical Instrumentation are often taken alongside 09-322 Laboratory IV: Molecular Spectroscopy and Dynamics, they are **not** required co-requisites. Students should consult with an advisor if they plan to shift any of these courses to senior year.
- Students pursuing careers in the health professions or following the Biological Chemistry Track may wish to take 09-403 Hooked: The Chemical Basis of Drug Addiction in the Fall semester of their Junior year. It will fulfill both a Chemistry elective as well as a Science and Society elective.

Students may spread out junior-level courses across the junior and senior years to balance their academic load and research commitments. Work closely with your academic advisor to map out a schedule that fits your goals.

Senior Year

Fall		Units
09-401	Undergraduate Seminar V	1
09-xxx	Chemistry Elective (see notes on electives)	9
38-110	ENGAGE in Service	1
38-220	ENGAGE in the Arts	2
38-430	ENGAGE in Wellness: Looking Forward	1
xx-xxx	Free Electives	30

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Spring		Units
09-402	Undergraduate Seminar VI	3
09-xxx	Chemistry Elective (see notes on electives)	9
xx-xxx	Free Electives	27
		39

Planning Tip: The senior year is designed to provide maximum flexibility. Use this time to deepen your training through electives, conduct independent research, or prepare for graduate school, professional programs, or job applications. Be mindful of not overloading your final semester and aim to complete general education requirements, including all ENGAGE courses, before your last term.

Unit Summary and Graduation Requirements for the B.S. in Chemistry (and Additional Major)

Chemistry Requirements

A minimum of 160 units must come from chemistry-specific courses:

Required Chemistry Courses*	Units
09-105 Introduction to Modern Chemistry I	10
or 09-107 Honors Chemistry: Fundamentals, Concepts and Applications	
09-106 Modern Chemistry II	10
09-219 Modern Organic Chemistry	10
09-220 Modern Organic Chemistry II	10
09-231 Mathematical Methods for Chemists	9
09-331 Modern Analytical Instrumentation	9
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
09-348 Inorganic Chemistry	10
09-221 Laboratory I: Introduction to Chemical Analysis	12
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-321 Laboratory III: Molecular Design and Synthesis	12
or 09-323 Bioorganic Chemistry Laboratory	
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-xxx Chemistry Seminars	8
09-xxx Chemistry Electives	18
160	

Note: These courses, along with 33-121 Physics I for Science Students and 33-122 Physics II for Biological Sciences and Chemistry Students, are also required for students pursuing an additional major in chemistry.

Chemistry Electives (minimum 18 units required)

Chemistry electives are intended to enhance a student's technical knowledge in chemistry. These may include:

- 09-445 Undergraduate Research
- Most 09-3xx or higher chemistry courses (undergraduate or graduate)
- 03-231 Honors Biochemistry or 03-232 Biochemistry I

09-435 Independent Study Chemistry may only be used with permission of the Director of Undergraduate Studies.

Some interdisciplinary courses (e.g., 39-xxx) may count toward chemistry electives only if they have significant chemical content and are approved in advance by the Director of Undergraduate Studies.

In some cases, chemistry electives may also satisfy general education requirements such as Science and Society or Cultural/Global Understanding, but students should consult with an advisor to confirm eligibility and avoid double-counting within the same category.

Students should check with the chemistry department and the course-offering department each semester to confirm which courses are available and approved for elective credit.

Quick Guide: Choosing Chemistry Electives by Interest Area

Chemistry electives give you the flexibility to explore topics that align with your interests, deepen your technical training, or prepare you for specific career paths. Below are some common focus areas and electives that support them.

Interest Area	Suggested Chemistry Electives
Sustainability and Environmental Chemistry	09-510 Chemistry and Sustainability, 09-381 Environmental Systems on a Changing Planet, 09-529 Introduction to Sustainable Energy and Science
Biological and Health Applications	03-231 Biochemistry I or 03-232 Biochemistry I, 09-403 Hooked: The Chemical Basis of Drug Addiction, 09-737 Medicinal Chemistry and Drug development
Computational Chemistry and Modeling	09-563 Molecular Modeling and Computational Chemistry, 09-615 Computational Modeling. Statistical Analysis and Machine Learning in Science, 09-616 Neural Networks & Deep Learning in Science
Materials and Nanoscience	09-509 Physical Chemistry of Macromolecules, 09-507 Nanoparticles, 09-760 The Molecular Basis of Polymer Mechanics

Residency Requirement for Chemistry Courses

All chemistry courses required for the B.S. that are numbered 09-2xx or higher must be taken at Carnegie Mellon University. Exceptions must be requested in advance and approved by the Director of Undergraduate Studies. Approval is typically granted only under unusual or extenuating circumstances.

To plan your electives effectively, consult with your academic advisor and check semester availability with the chemistry department.

Other Required Courses and Electives

Other Requirements	Units
Biology (Modern Biology or Biochemistry)	9
Computer Science	10
Mathematics	20
Physics	21
Interpretation and Argument	9
Arts, Humanities and Social Sciences Courses	36
Cultural/Global Understanding	9
EUREKA! (First-year seminar)	6
Science and Society requirement	6
ENGAGE in Service	1
ENGAGE in Wellness Courses (three courses)	3
ENGAGE in the Arts	2
Core@CMU	3
Free Electives	65
Minimum number of units required for the degree:	360

Free Electives

Free electives include any Carnegie Mellon course, except those in science or engineering that are specifically intended for non-majors.

A maximum of 9 units total from the following categories may count toward the free elective requirement:

- Physical Education (P.E.)
- StuCo (Student College)
- ROTC

Students are encouraged to use free electives to pursue minors, deepen technical training, explore other disciplines, or prepare for future academic and career goals.

There is no separate "technical elective" requirement in the B.S. in Chemistry curriculum. However, students may choose to take advanced technical courses in chemistry or related fields as part of their free electives.

Additional Notes on Degree Requirements

Minimum Total Units

The B.S. in Chemistry degree requires a minimum of 360 units. Most students complete this requirement within 41–50 units per semester. Students are strongly encouraged to take additional electives in subjects of personal or professional interest to enrich their undergraduate experience.

AP Credit and Unit Overlap

Some students may need to complete more than 360 units to graduate, especially if they repeat coursework for which they received AP credit. For example, a student who received AP credit for but takes 09-105 or 09-107 at CMU will only receive 10 units toward the requirement — not 20. The duplicate units will not count toward the degree total.

Transfer Students and Course Substitutions

Students who transfer into the department and have taken 09-217 Organic Chemistry I and/or 09-218 Organic Chemistry II must complete 09-435 Independent Study Chemistry (1 unit per course) under the supervision of the 09-219 Modern Organic Chemistry and/or 09-220 Modern Organic Chemistry II instructor(s) to cover missing content.

Students who have taken 09-207 Techniques in Quantitative Analysis and/or 09-208 Techniques for Organic Synthesis and Analysis must enroll in a 3-unit transition course:

- 09-215 Chemistry Tech I to Lab I Transition (for 09-207 Techniques in Quantitative Analysis)
- 09-216 Chemistry Tech II to Lab II Transition (for 09-208 Techniques for Organic Synthesis and Analysis)

Options for the Bachelor's Degrees in Chemistry

The Bachelor of Science in Chemistry allows students to take a range of elective courses, particularly in the junior and senior years, in chemistry and other disciplines. Students may choose to focus these electives in a particular area of interest by completing one of several recommended **options**. Each option provides a structured group of electives that complements the B.S. in Chemistry and offers additional depth in a specialized area not covered by the standard curriculum.

Options are **noted on the student's transcript** (but not on the diploma) and are recognized with a certificate awarded by the Department of Chemistry at Commencement.

For each option, students should refer to the Bachelor of Science or Bachelor of Arts degree requirements described earlier in the catalog. The **core chemistry requirements remain unchanged**. However, the option-specific courses should be taken as electives and are listed within each option's description.

Chemistry courses taken as part of an option may also count toward the chemistry elective requirement for the B.S. degree. In some cases, option courses may fulfill MCS technical core requirements or, for example, nontechnical core requirements in the Management Option. However, students should note that there is **very limited ability to count a course toward both an option and a minor or additional major in a closely related field**.

Students are encouraged to **consult with their academic advisor** or the advisor for the relevant department to clarify any potential overlap or restrictions.

BIOCHEMISTRY OPTION		Units
03-231/232	Honors Biochemistry (or Biochemistry)	9
09-518/718	Bioorganic Chemistry: Nucleic Acids and Carbohydrates	9
or 09-519	Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	
or 09-719	Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	
xx-xxx	2 Electives in Biochemistry	
Elective courses may be chosen from the following list. (Other courses listed as electives for the Biological Chemistry Track may be possible with permission.)		
03-344	Experimental Biochemistry	12

09-445	Undergraduate Research	Var.
9 units of 09-445 can count towards this option if part of a longer term immersion in a relevant area and approved by the Director of Undergraduate Studies		
09-530	Chemistry of Gene Expression	9
or 09-730	Chemistry of Gene Expression	
09-737	Medicinal Chemistry and Drug Development	12
03-439	Introduction to Biophysics	10
09-519/719	Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	9
or 09-518	Bioorganic Chemistry: Nucleic Acids and Carbohydrates	
or 09-718	Bioorganic Chemistry: Nucleic Acids and Carbohydrates	
03-740	Advanced Biochemistry	12

POLYMER SCIENCE OPTION		Units
09-502/741	Organic Chemistry of Polymers	9
09-760	The Molecular Basis of Polymer Mechanics	12
Two Electives in Polymer Science		9
Elective courses may be chosen from the following list		
09-445	Undergraduate Research	9
9 units of 09-445 can count towards this option if part of a longer term immersion in a relevant area and approved by the Director of Undergraduate Studies		
09-509/715	Physical Chemistry of Macromolecules	9
09-736	Metal Mediated Chemical Reactions	12
27-477	Introduction to Polymer Science and Engineering	9

Other upper level courses in chemistry, biomedical engineering, materials science engineering or the colloids, polymers and surfaces program may be used with permission of the Director of Undergraduate Studies

MATERIALS CHEMISTRY OPTION		Units
27-100	Engineering the Materials of the Future	12
27-201	Structure of Materials	9
Two Elective Courses of at least 9 units each from the list below		
27-202	Defects in Materials	9
09-445	Undergraduate Research	9
9 units of 09-445 can count towards this option if part of a longer term immersion in a relevant area and approved by the Director of Undergraduate Studies		
09-502/741	Organic Chemistry of Polymers	9
09-507/707	Nanoparticles	9
09-509/715	Physical Chemistry of Macromolecules	9
27-xxx	MSE course approved by Director of Undergraduate Studies	

ENVIRONMENTAL CHEMISTRY OPTION		Units
09-510/710	Chemistry and Sustainability	9
or 09-381	Environmental Systems on a Changing Planet	
09-524	Environmental Chemistry	9
or 09-724	Environmental Chemistry	
Two elective courses of at least 9 units each from the list below		
09-445	Undergraduate Research	Var.
9 units of 09-445 can count towards this option if part of a longer term immersion in a relevant area and approved by the Director of Undergraduate Studies		
09-225	Climate Change: Chemistry, Physics and Planetary Science	9
09-529/729	Introduction to Sustainable Energy Science	9
09-538/738	Exposure and Risk Assessment for Environmental Pollutants	9
19-440	Combustion and Air Pollution Control	9
12-651	Air Quality Engineering	9
12-657	Water Resource Systems Engineering	9

MANAGEMENT OPTION		Units
70-100	Global Business Global Business is intended for first-year and sophomore students only. Juniors and seniors interested in pursuing the management option must replace the course with a constrained elective as defined for the Minor in Business Administration.	9
73-102	Principles of Microeconomics	9
70-122	Introduction to Accounting	9
Tepper Constrained Elective: As defined in the 2024-25 Undergraduate Catalog these must be one of the following courses: 70-311, 70-371, 70-381, or 70-391		9
COMPUTATIONAL CHEMISTRY OPTION		Units
15-112	Fundamentals of Programming and Computer Science	12
15-122 or 15-150	Principles of Imperative Computation Principles of Functional Programming	12
21-127	Concepts of Mathematics	12
09-563/763	Molecular Modeling and Computational Chemistry	9
xx-xxx	One Upper Level Computational Elective Course of at least 9 units from the list below	
09-615	Computational Modeling, Statistical Analysis and Machine Learning in Science	12
09-621	Welcome to the Future Lab - Science in the Cloud Must be taken with 09-623	6
15-210	Parallel and Sequential Data Structures and Algorithms	12
15-213	Introduction to Computer Systems	12
33-241	Introduction to Computational Physics	9
02-250	Introduction to Computational Biology	12

Honors B.S./M.S. Program in Chemistry

The Honors B.S./M.S. Program in Chemistry offers students the opportunity to earn both a Bachelor of Science in Chemistry with Departmental Honors and a Master of Science in Chemistry, typically within four years. This program is distinctively research-intensive and is best suited for students who have made significant progress on an independent research project early in their undergraduate career. Students admitted to this program are expected to demonstrate initiative, deep engagement with the scientific literature, and the ability to work at a level comparable to a beginning graduate student.

Only students pursuing the B.S. in Chemistry or the B.S. in Chemistry/Biological Chemistry Track (<http://coursecatalog.web.cmu.edu/schools-colleges/melloncollegeofscience/departments/chemistry/chemistry-biological-chemistry-track-bs/>) are eligible for this program. It is not open to students in the B.A. program. Applications are typically submitted in the second half of the sophomore year but must be received no later than the first semester of the junior year. Later applications are only considered under exceptional circumstances and may require an extension into a fifth year.

Eligibility and Application

To be eligible for admission to the Honors B.S./M.S. program, students must:

- Have a QPA of 3.2 or higher
- Demonstrate significant and sustained progress in undergraduate research
- Have a faculty research advisor in place
- Show evidence that their research has the potential to lead to a master's thesis. This may include a novel method or technique, the discovery of a new phenomenon, or a study that advances understanding in a particular field.

Students apply by submitting the BS/MS Honors Program application form, available on the Chemistry undergraduate Canvas site. This form requires:

- A brief description (1000 words or fewer) of the student's research accomplishments and goals for the thesis
- A projected timeline for completion of the thesis work and writing
- A statement of support from the research advisor

Once submitted, applications are reviewed by a subset of the Undergraduate Program Committee. If the written application is deemed competitive, the student will be invited to deliver an oral presentation. This oral presentation is a key component of the application process. It should be at least 30 minutes long and include:

- A clear explanation of the research question or purpose
- Background literature and scientific context
- Results to date
- A detailed plan and timeline for completion

Presentations must include appropriate visual materials. After the presentation and discussion, the committee will confer privately to evaluate whether the student is prepared to meet the expectations of the program. Students are typically notified of the committee's decision within 48 hours. While most students are accepted after this stage, the committee may, in rare cases, recommend deferral or alternative research pathways (such as the Departmental Honors track) if the project is not yet sufficiently developed.

Thesis Committee

Upon acceptance, the student must form a Thesis Committee to oversee their academic and research progress. This committee will replace the Undergraduate Program Committee for the remainder of the student's degree. The committee must include:

- The student's research advisor
- One member of the Undergraduate Program Committee, appointed by the Director of Undergraduate Studies
- A third faculty member selected jointly by the student and their advisor (this individual may be from another department or institution and may hold a tenure-track, teaching-track, or research-track position)

The student is responsible for securing the participation of the third member and notifying the Director of Undergraduate Studies and Undergraduate Academic Program Coordinator. A shared Box folder will be created for each student to store key documents, including the application materials, written reports, and thesis drafts.

Coursework Requirements

The B.S./M.S. Honors degree requires the completion of **five** graduate-level chemistry courses. These are typically 12-unit courses numbered 09-7xx or 09-8xx. Two 6-unit minis at these levels may also be combined to fulfill one course requirement.

While 09-6xx courses are sometimes offered at the graduate level, some (such as 09-611 Chemical Thermodynamics) are considered remedial and do not count toward the B.S./M.S. requirement, due to significant overlap with undergraduate content. Others, such as those associated with the M.S. in Science or Engineering and Public Policy or the Future Lab initiative, may be accepted with approval from the Director of Undergraduate Studies. Examples include:

- 09-615 Computational Modeling, Statistical Analysis and Machine Learning in Science
- 09-616 Neural Networks & Deep Learning in Science

To support interdisciplinary study, up to three of the five required graduate courses may be fulfilled using advanced undergraduate chemistry electives (09-5xx). These courses must be 9 units each and approved by the Director of Undergraduate Studies. While 09-5xx courses can be appropriate in some contexts, the 09-7xx versions are generally preferred, as they include additional assignments or projects that build skills important for graduate-level work.

Students must:

- Earn a **grade of C or better** in each of the five qualifying courses and in 09-455 Honors Thesis.
- Maintain a minimum QPA of 3.2 overall and 3.0 average across the five graduate (or approved 09-5xx) courses, 09-445 Undergraduate Research and 09-455 Honors Thesis.

Research and Progress Expectations

Students in the B.S./M.S. program are expected to maintain a level of rigor, independence, and productivity that exceeds the Departmental Honors requirements. This includes:

- A minimum of 30 units of 09-445 Undergraduate Research (most students exceed this requirement)
- Active participation in research group meetings and departmental seminars
- Summer research after the sophomore and junior years (10 weeks each summer is strongly encouraged). Students are typically supported

by their research group or through competitive programs such as the Summer Undergraduate Research Fellowship (SURF) (<https://www.cmu.edu/uro/summer%20research%20fellowships/SURF/>)

- Presentation of research at Meeting of the Minds, typically during the junior year

In addition, students are expected to meet with their Thesis Committee regularly, at least once every three months and at the start of their final semester. One week before each meeting, students must submit the following materials:

- A 3–5 page written summary of research progress
- A one-page outline of remaining work
- Presentation slides for discussion

These meetings serve as formal checkpoints to assess progress, identify challenges, and support the student in achieving timely completion of the thesis.

Thesis and Defense

Students in the B.S./M.S. program must complete a formal thesis based on original research that meets the standards of a Master of Science degree in chemistry. The thesis should demonstrate independence, technical rigor, and depth of understanding in a specific field. While publication is not required, the research should be of a quality and scope that could reasonably lead to publication in a peer-reviewed scientific journal.

To support timely and successful completion, students are expected to follow the timeline below:

Late Junior Year and Summer (prior to final year):

- Students should have completed a substantial portion of their research by the end of the junior year.
- A thorough literature review should be conducted over the summer in preparation for the thesis introduction.
- Preliminary organization of thesis chapters (e.g., outlining sections, figures, tables) is encouraged.

Semester Before Final Semester:

- Continue research and begin assembling thesis materials, including figures, data, and chapter outlines, in preparation for formal writing.
- Draft a full literature review and begin writing the thesis introduction.
- A progress meeting must be scheduled with the Thesis Committee during the first two weeks of the final semester.

This meeting is used to assess whether the project is on track for a Master's-level thesis. If the committee determines that sufficient progress has not been made, students may either extend their timeline for completion, or transition to the Departmental Honors track, provided those requirements are met.

Start of Final Semester:

- Submit a draft of the thesis introduction and a detailed outline of the methods, results, and discussion sections to the Thesis Committee and Undergraduate Program Coordinator.
- Use committee feedback to guide final writing and remaining experimental work.

Two Months Before Intended Defense Date:

- Submit a full draft or substantial sections of the thesis to the research advisor for feedback. This should allow time for revision before sharing with the full committee.

At Least One Week Before Defense:

- Submit the advisor-approved final version of the thesis to all committee members. Missing this deadline will result in the defense being rescheduled.

Defense:

- Deliver a public oral presentation (30–40 minutes), followed by audience Q&A.
- Participate in a private defense with the Thesis Committee immediately after the presentation.

The thesis should follow a formal scientific structure (abstract, introduction, methods, results, discussion, conclusion) and adhere to ACS Style Guide formatting. While publication is not a graduation requirement, the work must reflect sustained effort, critical thinking, and mastery of the research topic.

Note: While defenses are commonly scheduled in April for May graduates, alternate timelines apply for August or December graduation. The Undergraduate Academic Program Coordinator will work with each student and their committee to ensure timely scheduling and degree certification.

Graduation with Honors

Students who successfully complete all academic, research, and thesis requirements for the program will receive two degrees:

1. A Bachelor of Science in Chemistry with Departmental Honors
2. A Master of Science in Chemistry

Both degrees are awarded at the same time, and students will receive a separate diploma for each. Departmental Honors and MCS College Honors will be noted on the official transcript but do not appear on the diploma. Only University Honors, which are based on overall academic performance, are printed on the diploma.

Failure to maintain satisfactory progress in research or coursework, or violations of professional or academic standards, may result in removal from the M.S. portion of the program. In such cases, students may still complete the B.S. or Departmental Honors degree, provided they meet the respective requirements.

Curriculum Planning for the Honors B.S./M.S. in Chemistry

The curriculum and sample schedule presented here are intended for students who matriculate in Fall 2025. Students who entered in prior years should consult their degree audit and speak with the Director of Undergraduate Studies to confirm the requirements that apply to them.

Technical and Non-Technical Requirements

MCS Core Technical Requirements

Chemistry majors must complete a minimum of four technical courses outside of chemistry to satisfy the MCS core technical breadth requirement. These include courses in physics, biology, computer science, and mathematics:

Technical Breadth Requirements		Units
33-121	Physics I for Science Students	12
33-122	Physics II for Biological Sciences and Chemistry Students	9
03-121	Modern Biology	9
or 03-231	Honors Biochemistry	
or 03-232	Biochemistry I	
15-110	Principles of Computing	10
or 15-112	Fundamentals of Programming and Computer Science	
or 02-120	Programming for Scientists	
21-120	Differential and Integral Calculus	10
21-122	Integration and Approximation	10
		60

Students are encouraged to complete these technical core requirements by the end of their fifth semester. AP credit may not be used to fulfill the core technical breadth requirements, though it can satisfy prerequisites for chemistry courses. If a student fulfills an entire category (e.g., physics or biology) solely through AP credit, they must take an approved upper-level course in that area to meet the core requirement.

Non-Technical General Education Requirements

All students in the Mellon College of Science (MCS) must complete a set of non-technical breadth requirements totaling a minimum of 75 units. These include communication, humanities and social sciences, global and cultural perspectives, and wellness:

Required Courses:

- 76-101 Interpretation and Argument (9 units)
- Arts, Humanities, and Social Sciences: Four courses totaling a minimum of 36 units
- Cultural/Global Understanding: One approved course (minimum 9 units)
- Science and Society: One approved course (minimum 6 units)
- Engage Sequence (5 total):

- ENGAGE in Wellness
 - 38-230 ENGAGE in Wellness: Looking Inward (1 unit)
 - 38-330 ENGAGE in Wellness: Looking Outward (1 unit)
 - 38-430 ENGAGE in Wellness: Looking Forward (1 unit)
- 38-110 ENGAGE in Service (1 unit)
- 38-220 ENGAGE in the Arts (2 units)
- First-Year Seminars
 - 38-101 EUREKA!: Discovery and Its Impact (6 units)
 - 99-101 Core@CMU (3 units)

Important Notes:

- The Science and Society and ENGAGE requirements must be completed no later than the penultimate semester.
- Students may not double count courses across general education categories. For example, a course used to fulfill the Science and Society requirement may not also count toward the Cultural/Global Understanding category or the 36 units required in Arts, Humanities, and Social Sciences.

Overlap with Chemistry Courses:

Some chemistry courses approved for general education requirements. For example:

- Science and Society :
 - 09-510 Chemistry and Sustainability (or graduate version, 09-710 Chemistry and Sustainability)
 - 09-381 Environmental Systems on a Changing Planet
 - 09-403 Hooked: The Chemical Basis of Drug Addiction

(Of this list, 09-710 Chemistry and Sustainability can count both towards the MCS Science and Society requirements and the graduate course requirement for the B.S./M.S. program)

- Cultural/Global Understanding + Chemistry Elective:
 - 09-227 The Culture of Color: Dyes, Chemistry, and Sustainability

A current list of approved courses in these categories is maintained by the MCS Dean's Office:

<https://www.cmu.edu/mcs/undergrad/advising/hss-finearts/index.html>
<https://www.cmu.edu/mcs/undergrad/advising/hss-finearts/>

Sample Schedule by Year (First–Senior)

The suggested schedule below is designed for students pursuing the B.S./M.S. program. Students should consult with the Director of Undergraduate Studies and their research advisor to customize their timeline based on research progress, course availability, and personal goals.

First Year

Fall	Units
09-105 Introduction to Modern Chemistry I or 09-107 Honors Chemistry: Fundamentals, Concepts and Applications	10
09-115 Introduction to Undergraduate Research in Chemistry	2
21-120 Differential and Integral Calculus	10
33-121 Physics I for Science Students	12
76-101 Interpretation and Argument	9
38-101 EUREKA!: Discovery and Its Impact	6
99-101 Core@CMU	3
	52

Planning Tip: Students interested in majoring in chemistry who have a strong chemistry background should enroll in 09-107 Honors Chemistry: Fundamentals, Concepts and Applications rather than 09-105 Introduction to Modern Chemistry I. Students who complete 09-107 with an A grade will be exempted from the requirement to take 09-106 Modern Chemistry II via a prerequisite waiver.

There are some elective laboratory courses offered for MCS students in the first year including 03-117 Frontiers, Analysis, and Discovery in Biological Sciences or 09-101 Introduction to Experimental Chemistry and 09-115 Introduction to Undergraduate Research in Chemistry. While not required for the major, we strongly encourage students who are interested in early research engagement to register for 09-115 Introduction to Undergraduate Research in Chemistry. This course introduces students to research within the department and includes laboratory safety and hazardous waste

training, which are often necessary for working in scientific labs at CMU. It is included in the sample schedule above to highlight this opportunity.

The maximum units allowed during the first semester is 54; therefore, students wishing to take a lab should take an alternate technical course to Physics I such as 15-110 Principles of Computing or 03-121 Modern Biology so that their unit total is lower.

Spring	Units
09-106 Modern Chemistry II	10
09-116 Undergraduate Research Shadowing in Chemistry or 09-101 Introduction to Experimental Chemistry	2
21-122 Integration and Approximation	10
33-121 Physics I for Science Students or 03-121 Modern Biology or 15-110 Principles of Computing	12
xx-xxx Arts, Humanities and Social Sciences Course 1	9
xx-xxx Free Elective	9.0
	52

Planning Tip: Chemistry majors who place out of 09-106 Modern Chemistry II can take 09-348 Inorganic Chemistry, 09-510 Chemistry and Sustainability or 09-381 Environmental Systems on a Changing Planet as a chemistry elective. 09-381 Environmental Systems on a Changing Planet is especially recommended for students pursuing the Environmental and Sustainability Studies minor. 09-510 Chemistry and Sustainability will serve as both a Chemistry elective as well as a MCS Science and Society requirement. Please note that 09-291 Environmental Systems on a Changing Planet does not count toward chemistry electives.

The sample schedule above also includes laboratory electives. Students wishing to actively engage in research should take 09-116 Undergraduate Research Shadowing in Chemistry, which pairs them with a research group in the department for half a semester. With a faculty mentor's recommendation, students may continue in the same lab through 09-445 Undergraduate Research. Those who want focused hands-on experience in a chemistry lab environment may consider 09-101 Introduction to Experimental Chemistry. Students interested in biology-based lab work may also take 03-117 Frontiers, Analysis, and Discovery in Biological Sciences.

Sophomore Year

Fall	Units
09-219 Modern Organic Chemistry	10
09-221 Laboratory I: Introduction to Chemical Analysis	12
09-201 Undergraduate Seminar I	1
33-122 Physics II for Biological Sciences and Chemistry Students	9
09-445 Undergraduate Research	9
xx-xxx Arts, Humanities and Social Science Course I	9
	50
Spring	Units
09-220 Modern Organic Chemistry II	10
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-202 Undergraduate Seminar II: Safety and Environmental Issues for Chemists	1
09-348 Inorganic Chemistry	10
38-230 ENGAGE in Wellness: Looking Inward	1
xx-xxx Arts, Humanities and Social Science Course I	9
	43

Summer **10 weeks of full-time research is strongly encouraged. Students may apply for funding through their research advisor or SURF.**

Junior Year

Fall	Units
09-301 Undergraduate Seminar III	1
09-231 Mathematical Methods for Chemists	9
09-321 Laboratory III: Molecular Design and Synthesis or 09-323 Bioorganic Chemistry Laboratory	12
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-445 Undergraduate Research	9

38-330	ENGAGE in Wellness: Looking Outward	1
xx-xxx	Arts, Humanities and Social Science Course I	9
		50
Spring		Units
09-302	Undergraduate Seminar IV	1
09-322	Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-445	Undergraduate Research	6
09-xxx	Graduate Chemistry Course 1	9
09-345	Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
09-331	Modern Analytical Instrumentation	9
xx-xxx	Arts, Humanities and Social Science Course I	6-9
		52-55
Summer	10 weeks of full-time research is strongly encouraged to ensure adequate progress toward the M.S. thesis.	

Planning Tips:

The junior year is often when chemistry majors encounter some of the most conceptually rich and mathematically engaging material in the curriculum, including physical chemistry and advanced laboratory techniques. For many students, this is also when research becomes a central focus.

To make the most of this experience, consider how your schedule can support both depth and balance. The senior year includes a number of free electives and flexible space, which can be used to redistribute coursework across semesters. Spreading out junior year requirements over four semesters, instead of concentrating them in just two, is a great way to maintain momentum and quality in both academics and research.

Students should consult with their advisor to discuss an individualized plan to meet their academic goals.

Senior Year

Fall		Units
09-401	Undergraduate Seminar V	1
09-445	Undergraduate Research	9
38-430	ENGAGE in Wellness: Looking Forward	1
38-110	ENGAGE in Service	1
99-xxx	Graduate Chemistry Course 2	12
99-xxx	Graduate Chemistry Course 3	12
xx-xxx	Cultural/Global Understanding	9
		45
Spring		Units
09-402	Undergraduate Seminar VI	3
09-455	Honors Thesis	15
38-220	ENGAGE in the Arts	2
09-xxx	Graduate Chemistry Course 4	9
09-xxx	Graduate Chemistry Course 5	9
xx-xxx	Free Elective	9
		47

Note for Students in the B.S. in Chemistry/Biological Chemistry Track

Students pursuing the B.S./M.S. program through the Biological Chemistry Track should follow the same curriculum structure shown above. However, they must ensure that the following core courses are included in their schedule:

- 03-232 Biochemistry I
- 09-323 Bioorganic Chemistry Laboratory
- 09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates or 09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry.

In place of the chemistry electives normally required in the B.S., students should register for graduate-level chemistry courses that satisfy both the Biological Chemistry Track and the M.S. requirements. Approved substitutions include:

- 09-718 Bioorganic Chemistry: Nucleic Acids and Carbohydrates in place of 09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates
- 09-719 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry in place of 09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry
- 09-730 Chemistry of Gene Expression in place of 09-530 Chemistry of Gene Expression
- 09-738 Exposure and Risk Assessment for Environmental Pollutants in place of 09-538 Exposure and Risk Assessment for Environmental Pollutants

These substitutions help students meet the **graduate course requirement** for the M.S. degree without disrupting the overall B.S. Chemistry/Biological Chemistry Track structure. Research and thesis expectations in the senior year are the same for both the standard Chemistry and the Biological Chemistry Track.

Unit Summary and Graduation Requirements for the B.S./M.S. in Chemistry program

Chemistry Requirements

A minimum of 238 units must come from chemistry-specific courses:

Required Chemistry Courses*	Units
09-105 Introduction to Modern Chemistry I	10
or 09-107 Honors Chemistry: Fundamentals, Concepts and Applications	
09-106 Modern Chemistry II	10
09-219 Modern Organic Chemistry	10
09-220 Modern Organic Chemistry II	10
09-231 Mathematical Methods for Chemists	9
09-331 Modern Analytical Instrumentation	9
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-345 Physical Chemistry (Thermo): Macroscopic Principles of Physical Chemistry	9
09-348 Inorganic Chemistry	10
09-221 Laboratory I: Introduction to Chemical Analysis	12
09-222 Laboratory II: Organic Synthesis and Analysis	12
09-321 Laboratory III: Molecular Design and Synthesis	12
or 09-323 Bioorganic Chemistry Laboratory	
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-xxx Chemistry Seminars	8
09-445 Undergraduate Research	30
09-xxx Graduate Chemistry Courses	51-60
09-455 Honors Thesis	15
238-247	

Residency Requirement for Chemistry Courses

All chemistry courses required for the B.S./M.S. degree that are numbered 09-2xx or higher must be taken at Carnegie Mellon University. Exceptions must be requested in advance and approved by the Director of Undergraduate Studies. Approval is typically granted only under unusual or extenuating circumstances.

To plan your electives effectively, consult with your academic advisor and check semester availability with the chemistry department.

Other Required Courses and Electives

Other Requirements	Units
Biology (Modern Biology or Biochemistry)	9
Computer Science	10
Mathematics	20
Physics	21
Interpretation and Argument	9
Arts, Humanities and Social Sciences Courses	36
Cultural/Global Understanding	9
EUREKA! (First-year seminar)	6
Science and Society requirement	6
ENGAGE in Service	1

ENGAGE in Wellness Courses (three courses)	3
ENGAGE in the Arts	2
Core@CMU	3
Free Electives	6-15
Minimum number of units required for the degree:	388

Free Electives

Free electives include any Carnegie Mellon course, except those in science or engineering that are specifically intended for non-majors.

A maximum of 9 units total from the following categories may count toward the free elective requirement:

- Physical Education (P.E.)
- StuCo (Student College)
- ROTC

Students are encouraged to use free electives to pursue minors, deepen technical training, explore other disciplines, or prepare for future academic and career goals.

There is no separate "technical elective" requirement in the B.S. in Chemistry curriculum. However, students may choose to take advanced technical courses in chemistry or related fields as part of their free electives.

Additional Notes on Degree Requirements

Minimum Total Units

The B.S. /M.S. degree requires a minimum of 388 units. Most students complete this requirement within 41-55 units per semester. Students are strongly encouraged to take additional electives in subjects of personal or professional interest to enrich their undergraduate experience.

AP Credit and Unit Overlap

Some students may need to complete more than 388 units to graduate, especially if they repeat coursework for which they received AP credit. For example, a student who received AP credit for but takes 09-105 or 09-107 at CMU will only receive 10 units toward the requirement — not 20. The duplicate units will not count toward the degree total.

Transfer Students and Course Substitutions

Students who transfer into the department and have taken 09-217 Organic Chemistry I and/or 09-218 Organic Chemistry II must complete 09-435 Independent Study Chemistry (1 unit per course) under the supervision of the 09-219 Modern Organic Chemistry and/or 09-220 Modern Organic Chemistry II instructor(s) to cover missing content.

Students who have taken 09-207 Techniques in Quantitative Analysis and/or 09-208 Techniques for Organic Synthesis and Analysis must enroll in a 3-unit transition course:

- 09-215 Chemistry Tech I to Lab I Transition (for 09-207 Techniques in Quantitative Analysis)
- 09-216 Chemistry Tech II to Lab II Transition (for 09-208 Techniques for Organic Synthesis and Analysis)