

Chemistry/Biological Chemistry Track, B.S.

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B.S. in Chemistry/Biological Chemistry Track

The B.S. in Chemistry/Biological Chemistry is ideal for students preparing for graduate work in biochemistry, molecular biology, or biomedical fields, or for those pursuing careers in pharmaceuticals, healthcare, or biotechnology. This degree combines the rigorous core of the B.S. in Chemistry with expanded study in biology and biochemistry.

In addition to the standard chemistry curriculum, students complete biology and biochemistry courses and a novel laboratory course that models the drug discovery process. The program emphasizes research readiness and interdisciplinary thinking at the intersection of chemistry and the life sciences.

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/Biological Chemistry track requires early and careful planning. Students are strongly encouraged to complete required technical courses at the earliest opportunity to ensure timely progress through the curriculum. Some flexibility exists to postpone certain courses in favor of electives, especially when coordinating a minor or additional major. However, such adjustments must take into account the sequencing and availability of key chemistry courses, which are often 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
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.

Note: Unlike the standard B.A. in Chemistry and the B.S. in Chemistry, students in the Biological Chemistry track are **required** to take 03-121 Modern Biology to satisfy the MCS biology requirement. Alternatives such as 03-231 Honors Biochemistry or 03-232 Biochemistry I do not substitute for this requirement in the core as they are also required for this degree path.

Non-Technical General Education Requirements

All students in the Mellon College of Science (MCS) must complete a set of non-technical breadth requirements (<http://coursecatalog.web.cmu.edu/schools-colleges/melloncollegeofscience/general-education/>) 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 are 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, only 09-403 Hooked: The Chemical Basis of Drug Addiction will count as a biological chemistry elective.

- Cultural/Global Understanding :
 - 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 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
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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 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
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Planning Tip: Chemistry majors who place out of 09-106 Modern Chemistry II can take 09-348 Inorganic Chemistry 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. Please note that 09-291 Environmental Systems on a Changing Planet does not count toward chemistry electives.

In the B.S. Chemistry track, students are given the option of taking 09-510 Chemistry and Sustainability as a chemistry elective. Students interested in sustainability should certainly consider this course, as it fulfills both a chemistry elective and the MCS Science and Society requirement. In the B.S. in Chemistry/Biological Chemistry track, however, 09-510 Chemistry and Sustainability does not count toward the biological chemistry elective requirement. Instead, 09-403 Hooked: The Chemical Basis of Drug Addiction fulfills both a biological chemistry elective and the Science and Society requirement. If a student takes both 09-510 Chemistry and Sustainability and 09-403 Hooked: The Chemical Basis of Drug Addiction, only one may be used to fulfill the Science and Society requirement. 09-403 Hooked: The Chemical Basis of Drug Addiction is offered in the Fall semesters.

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.

Second 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 Course is a prerequisite for 09-331, normally taken in the spring of the junior year	9
03-220 Genetics	9
xx-xxx Arts, Humanities and Social Science Course I	9
	50
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
03-232 Biochemistry I	9
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.

Third Year

Fall	Units
09-301 Undergraduate Seminar III	1
09-231 Mathematical Methods for Chemists	9
09-344 Physical Chemistry (Quantum): Microscopic Principles of Physical Chemistry	9
09-323 Bioorganic Chemistry Laboratory	12
38-330 ENGAGE in Wellness: Looking Outward	1
xx-xxx Arts, Humanities and Social Sciences Course 4	9
	41
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
	46-49

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

Fourth Year

Fall		Units
09-401	Undergraduate Seminar V	1
09-518	Bioorganic Chemistry: Nucleic Acids and Carbohydrates	9
or 09-718	Bioorganic Chemistry: Nucleic Acids and Carbohydrates	
or 09-519	Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	
or 09-719	Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	
09-xxx	Biological 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	21
		44
Spring		Units
09-402	Undergraduate Seminar VI	3
09-348	Inorganic Chemistry	10
09-xxx	Biological Chemistry Elective (see notes on electives)	18
xx-xxx	Free Electives	18
		49

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/Biological Chemistry Track

Chemistry Requirements

A minimum of 187 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
03-231 Honors Biochemistry	9
or 03-232 Biochemistry I	
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
09-323 Bioorganic Chemistry Laboratory	12
09-322 Laboratory IV: Molecular Spectroscopy and Dynamics	12
09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates	9
or 09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	
09-xxx Chemistry Seminars	8

09-xxx	Biological Chemistry Electives	27
		187

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.

Biological Chemistry Electives (minimum 27 units required)

A list of currently approved biological chemistry electives is provided below. Students must complete at least three courses totaling 27 units or more. Of these, **at least two must be chemistry courses**; a maximum of one course may be taken in biology or physics. Exceptions must be approved by the Director of Undergraduate Studies.

With prior approval, **one semester of 09-445 Undergraduate Research** may be used to fulfill one biological chemistry elective, provided it is part of a sustained research experience that demonstrates depth of engagement in the area.

	Units
09-403 Hooked: The Chemical Basis of Drug Addiction	9
09-518 Bioorganic Chemistry: Nucleic Acids and Carbohydrates	9
or 09-718 Bioorganic Chemistry: Nucleic Acids and Carbohydrates	
or 09-519 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	
or 09-719 Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry	
09-522 Kinetics and Mechanisms of Chemical and Enzymatic Reactions	9
09-530 Chemistry of Gene Expression	9
or 09-730 Chemistry of Gene Expression	
09-538 Exposure and Risk Assessment for Environmental Pollutants	9
or 09-738 Exposure and Risk Assessment for Environmental Pollutants	
09-737 Medicinal Chemistry and Drug Development	12
03-220 Genetics	9
03-221 Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis	9
03-230 Human Anatomy and Physiology	9
03-344 Experimental Biochemistry	12
03-362 Cellular Neuroscience	9
03-366 Neuropharmacology: Drugs, Brain and Behavior	9
03-390 Molecular and Cellular Immunology	9
03-391 Microbiology	9
03-435 Cancer Biology	9
03-439 Introduction to Biophysics	10
03-442 Molecular Biology	9
03-729 Entrepreneurship and protein-based drug development	6
03-740 Advanced Biochemistry	12
03-871 Structural Biophysics	12
33-441 Introduction to Biophysics	10

Chemistry courses required for the B.S. (numbered 09-2xx or higher) must be taken at Carnegie Mellon. Exceptions are granted only under unusual or extenuating circumstances, with prior approval from the Director of Undergraduate Studies.

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	38
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)
- 09216 - Chemistry Tech II to Lab II Transition (for 09-208 Techniques for Organic Synthesis and Analysis)