CHEMISTRY

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The wide range of courses offered by the Department of Chemistry reflects the position of chemistry as the foundation of all the molecular sciences. In addition to graduate work in chemistry, biochemistry, or health-related disciplines, the department's graduates find their broad scientific training useful in fields such as technology policy, business management, and law. Chemistry is an especially appropriate major for students interested in energy research or policy and the environment.

COURSES FOR NONMAJORS WITHOUT PREREQUISITES

The Chemistry department offers one-term courses with no prerequisites, which are intended for non–science majors. These courses do not satisfy medical school requirements or the general chemistry requirement for any science major. Courses for nonmajors are numbered CHEM 1000–1090.

PREREQUISITES AND INTRODUCTORY COURSES

Prerequisite courses Required prerequisites for the Chemistry degree programs are: two terms of general chemistry and laboratory; single-variable calculus at the level of MATH 1150 or MATH 1160; and one term of introductory physics numbered 1700 or higher, or advanced placement beyond these levels in math or physics. Students also are encouraged to complete a course in multivariable calculus (MATH 1200, MATH 1210, or ENAS 1510); these courses or more advanced math courses fulfill the math prerequisite. All prerequisite courses must be taken for a letter grade; if they are taken as Audit or Credit/D/Fail they will not satisfy the requirement.

Introductory courses The majority of students begin with the general chemistry sequence CHEM 1610 and 1650 or with CHEM 1700 (note: the general chemistry sequence CHEM 1630 and 1670 is not offered AY 2025-2026). These courses fulfill the prerequisite for general chemistry in the Chemistry major. Students taking CHEM 1610 may be studying chemistry for the first time, perhaps took chemistry as a high school sophomore, or even may have completed AP chemistry but did not fully master the subject at that level. Students in CHEM 1700 have completed a year or two of chemistry later in high school, although motivated students may have last taken chemistry as a high-school sophomore if they have a strong math and physics background. Typically students who complete CHEM 1700 in the fall term complete Organic Chemistry (CHEM 2200 and CHEM 2220L) in the spring term. Regardless of whether a student completes the CHEM 1610 and 1650 sequence or CHEM 1700, the introductory laboratory sequence is CHEM 1340L, 1360L, or CHEM 1710L; each laboratory course is worth one-half course credit.

Students with a sufficiently strong background in chemistry may initiate their studies with courses in organic or physical chemistry after demonstrating proficiency on the department's placement examination. While CHEM 1740 and 1750 are offered only to first-year students, other courses in organic chemistry, including CHEM 2200 and 2210, also are available to qualified first-year students. Students with a strong background in physics and calculus may be eligible for the physical chemistry courses

CHEM 3320 and 3330 in the first year if they have fulfilled the math and physics requirements.

PLACEMENT PROCEDURES

Details about placement and preregistration for chemistry courses can be found on the department website. Information about the different degree programs, advising, and undergraduate research also are available on the department website.

Permission Enrollment in CHEM 1700 or CHEM 1740 through the registration system requires permission from the department. Permission is issued automatically after placement has been completed for entering first-year students. For more information email chemistry.dus@yale.edu.

Upper-level students Upper-level students wishing to take CHEM 1610 or 1630 (note, CHEM 1630 is not offered AY 2025-2026) should confirm their placement on Canvas@Yale by accessing the Chemistry Placement site that corresponds to their year of matriculation. If permission is required in the registration system, upper-level students should write to chemistry.dus@yale.edu. Those wishing to enroll in CHEM 2200 may do so as long as they have satisfied the general chemistry prerequisite.

Section registration in laboratory and lecture courses Information about online registration for laboratory and discussion sections can be found in the description for each laboratory or lecture course in Yale Course Search.

Advanced courses All chemistry advanced lecture courses numbered 4000 and higher are half-semester courses and count for one-half Yale College credits. These courses are held in the first half of the semester or in the second half of the semester. Information about the timing of courses is available in Yale Course Search. Because most advanced courses are offered either in the fall term or have a fall-term course as a prerequisite, students should give consideration to the advanced courses they plan to take in the spring term. For the purpose of degree requirements, all undergraduate Chemistry courses numbered 4010 or higher, approved by the director of undergraduate studies (DUS), typically count as advanced lecture or laboratory courses, as do CHEM 2260L, 2510L, 3310L, 3490L, 3550L, and 3350L. Many graduate-level Chemistry courses (those numbered 5000 and above) also may count toward the advanced-course requirement; consult the DUS for information about eligible courses.

For premedical students Medical schools currently require one year of organic chemistry and laboratory as well as one year of general chemistry and laboratory. The general chemistry requirement may be satisfied by completing CHEM 1610 and 1650, CHEM 1700 (CHEM 1630 and 1670 are not offered AY 2025-2026), or two terms of physical chemistry. Students should consult with the Office of Career Strategy for the most up-to-date premedical course advice.

REQUIREMENTS OF THE MAJOR

See Links to the attributes indicating courses approved for the Chemistry major requirements.

Four degree programs are offered: the B.A., the B.S., an intensive major leading to the B.S., and the combined B.S./M.S. The B.A. degree is intended for students who want solid training in the chemical sciences and who also intend to study other subjects in which chemical training would be an asset, such as technology policy, economics, or the

environment. The B.S. degree is intended to prepare students for graduate study while permitting extensive exploration of other disciplines and is also recommended for those planning to attend graduate school. The B.S. degree with an intensive major provides more focused preparation for a career in chemical research, and requires greater breadth in laboratory courses and electives. The combined B.S./M.S. is designed for students whose advanced preparation qualifies them for graduate-level work in their third and fourth years of college.

The major requires a group of prerequisites or their equivalent in advanced placement, a core of courses common to all four degree programs, advanced courses specific to each degree program, and a senior requirement.

Course requirements common to all Chemistry degree programs All degrees require the following 5 credits with two terms of organic chemistry (CHEM 1740 or 2200, and CHEM 1750, or 2210, or CHEM 2300) with laboratory (CHEM 2220L and 2230L), one term of physical chemistry (CHEM 3320 or 3280), and one term of inorganic chemistry (CHEM 2520).

B.A. degree program The B.A. degree program requires ten course credits beyond the prerequisites. In addition to the common degree requirements and one-term senior requirement, the B.A. degree requires four additional course credits of advanced chemistry lecture or laboratory courses. At least one full credit must be attained through advanced lecture courses in the Chemistry department and at least one must be a Chemistry laboratory course. CHEM 3330 may be counted toward the advanced-course requirement, although not as the sole lecture course.

B.S. degree program The B.S. degree program requires thirteen course credits beyond the prerequisites. In addition to the common degree requirements and two-term senior requirement, the B.S. degree requires completion of a second term of physical chemistry (CHEM 3330), one term of physical chemistry laboratory (CHEM 3300L), and four additional course credits of advanced chemistry lecture or laboratory courses. At least one full credit must be attained through advanced lecture courses in the Chemistry department and at least one must be a Chemistry laboratory course.

B.S. degree program, intensive major The B.S. degree program, intensive major requires fifteen course credits beyond the prerequisites. In addition to the common degree requirements and two-term senior requirement, the B.S. degree with an intensive major requires completion of a second term of introductory physics numbered 1700 or higher, a second term of physical chemistry (CHEM 3330), one term of physical chemistry laboratory (CHEM 3300L), and five additional course credits of advanced chemistry lecture or laboratory courses. At least two full credits must be attained through advanced lecture courses in the Chemistry department and at least one must be a Chemistry laboratory course.

Combined B.S./M.S. degree Exceptionally well-prepared students may complete a course of study leading to the simultaneous award of the B.S. and M.S. degrees after eight terms of enrollment. Formal application for admission to this program must be made no later than the last day of classes in the fifth term of enrollment. To be considered for admission, by the end of their fifth term applicants must have achieved at least two-thirds A or A– grades in all of their course credits as well as in all of the course credits directly relating to the major, including prerequisites. Two terms of

CHEM 4900 must be taken in the fifth and sixth terms with earned grades of A or A– to continue in the program. The B.S./M.S. degree program requires completion of the intensive major requirements, including the senior requirement, which typically is completed in the fifth and sixth terms. The introductory physics requirement must be fulfilled with PHYS 2000 and 2010 or PHYS 2600 and 2610; a term course in physics numbered 4000 or higher and approved by the Chemistry DUS may be substituted for the introductory sequence. In addition, eight credits of graduate courses in chemistry (four of which count toward the B.S.) are required. Four terms of research are required, including two terms of research taken in CHEM 9900. Students in the program must earn grades of A in at least two of their graduate-level term courses (or in one yearlong course) and have at least a B average in other graduate-level courses. B.S./M.S. candidates also are expected to continue their independent research in a summer internship between their junior and senior years. At the end of their eighth semester students are required to write a thesis summarizing their research activities. The thesis must be written under the guidance of the faculty member who supervises the student's research and it must be submitted to their research adviser on the final day of classes of the student's eighth semester. The thesis should be no shorter than twenty-five pages (double-spaced, twelve-point font, excluding figures, tables, and bibliography) and normally should contain the following sections: Introduction, Results and Discussion, Summary and Conclusions, Research Methods, and Bibliography. Students in the B.S./M.S. program, must also present their research in the form of a poster presentation at the end of their sixth semester (to fulfill the requirements of the B.S. degree) and an oral presentation at the end of their eighth semester (to fulfill the requirements of the M.S. degree). Both the poster and oral presentation are coordinated by the instructor of CHEM 4900. For more information, see Academic Regulations, section L, Special Academic Arrangements, “Simultaneous Award of the Bachelor's and Master's Degrees.”

Credit/D/Fail No chemistry course taken Credit/D/Fail may be applied toward the requirements of the major (including substitutions for advanced courses). No prerequisites taken Credit/D/Fail may be applied toward the major.

Outside credit Courses taken at another institution or during an approved summer or term-time study abroad program may count toward the major requirements with DUS approval.

SENIOR REQUIREMENT

For the B.A. degree program Students in the B.A. degree program must complete the senior seminar CHEM 4000, in which they prepare a capstone essay on a chemistry-related topic. The capstone essay is expected to be 15–25 pages in length (double-spaced, twelve-point font, exclusive of figures, tables, and bibliography).

For the B.S. degree program Students in the B.S. degree program may fulfill the senior requirement by completing two terms of the independent research course CHEM 4900 and writing a capstone report under the guidance of a faculty member that describes their research activities. Alternatively, they may complete the senior seminar CHEM 4000, in which they prepare a capstone essay on a chemistry-related topic, and complete one additional course credit of advanced chemistry lecture or laboratory course or CHEM 4900. The capstone report or essay is expected to be 15–25 pages in length (double-spaced, twelve-point font, exclusive of figures, tables, and

bibliography). All students performing research also must present their work in the form of an oral or poster presentation as coordinated by the instructor of CHEM 4900.

For the B.S. degree program with an intensive major Students in the B.S. degree program with an intensive major fulfill the senior requirement by completing two terms of the independent research course CHEM 4900 and writing a capstone report of 15–25 pages in length (double-spaced, twelve-point font, exclusive of figures, tables, and bibliography) under the guidance of a faculty member that describes their research activities. Students in the intensive major program also must present their work in the form of an oral or poster presentation as coordinated by the instructor of CHEM 4900.

ADVISING

Majors are encouraged to begin their programs in the first year to provide the greatest flexibility in scheduling. It is possible, however, to complete the B.S. in as few as six terms if a student has advanced placement. One sample B.S. program follows, but many others are possible:

First-Year	**Sophomore**	**Junior**	**Senior**
CHEM 1610, 1650, 1340L, 1360L, math prereq	CHEM 2200, 2210, 2520, 2220L, 2230L, physics prereq	CHEM 3320, 3330, 3300L, 2510L, 1 elective (1 credit)	2 terms of CHEM 4900, 2 electives (2 credits)

Substitutions for required courses Up to two credits of advanced science courses outside Chemistry may be counted as electives, with the written approval of the DUS. CHEM 4900 may not in any circumstance be substituted for any of the laboratory requirements. The graduate courses CHEM 5620L, 5640L, and 5650L may not be counted toward any requirement of the major.

Programs of study with special emphasis The flexibility of the degree requirements makes it possible for a student's program of study to emphasize a particular area of specialization in chemistry. For example, a program specializing in chemical biology may include CHEM 4190 and biochemistry electives such as MB&B 3000 or 3010. An inorganic chemistry specialization could include CHEM 4020 and 4030. A program with emphasis in physical chemistry and chemical physics would have electives such as CHEM 4660, 4720, or 4960. Students interested in synthetic organic chemistry could complete electives such as CHEM 4160, 4230, or CHEM 5280. An emphasis in biophysical chemistry includes a course in either chemical biology or biochemistry, as well as electives chosen from graduate courses in biophysics or biochemistry. Students may design programs with other areas of emphasis in consultation with the DUS. For a list of graduate courses appropriate for a particular specialization, consult the DUS.

Approval of major programs of study All Chemistry majors in their sophomore, junior, and senior years must have their programs approved by the DUS. A program tailored to each student's goals is created and recorded on a Chemistry Course of Study (COS) form and submitted to chemistry.dus@yale.edu.

STUDY ABROAD

Chemistry majors wishing to study abroad typically find their course of study easier to schedule if the semester abroad is a spring term. Students studying abroad in the spring term of their junior year are required to obtain approval for the project that will fulfill their senior requirement before the end of the prior term. For general information

on the Year or Term Abroad, see Academic Regulations, section K, Special Academic Programs, "Year or Term Abroad."

UNIQUE TO THE MAJOR

Special restrictions on lecture courses For the general, organic, or physical chemistry sequences, CHEM 1610 and 1650; CHEM 1740 or 2200 and CHEM 1750, 2210, or CHEM 2300; and CHEM 3320 or CHEM 3280 and 3330, completion of the first term with a passing grade is a prerequisite for registration in the subsequent term. Completion of CHEM 1700 with a passing grade is a prerequisite for registration in CHEM 2200.

Students receive credit for only one chemistry sequence of any given type. For example, a student who has completed CHEM 1700 may not subsequently enroll in CHEM 1610 or CHEM 1650; a student who has completed CHEM 1740 and 1750 may not subsequently enroll in CHEM 2200, 2210, or CHEM 2300. Similarly, students may not enroll in a course (typically of lower number) that is a prerequisite to a course they already have taken. For example, a student who has completed an organic chemistry laboratory cannot subsequently enroll in a general chemistry laboratory.

Special restrictions on laboratory courses Although the department does not recommend it, chemistry courses may be taken without the accompanying laboratory. However, the appropriate lecture course is a prerequisite or corequisite for each laboratory course. Students dropping the lecture course corequisite with a laboratory must also drop the laboratory course.

SUMMARY OF MAJOR REQUIREMENTS

Prerequisites CHEM 1610 and 1650 or CHEM 1700 (CHEM 1630 and 1670 are not offered AY 2025-2026); CHEM 1340L, 1360L, or CHEM 1710L; MATH 1150 or 1160; (MATH 1200, MATH 1210, or ENAS 1510 suggested); PHYS 1700, 1800, 2000, or 2600; or equivalents in adv placement

Number of courses *B.A.*— 10 course credits, beyond prereqs (incl senior req); *B.S.*— 13 course credits, beyond prereqs (incl senior requirement); *B.S., intensive major*— 15 course credits, beyond prereqs (incl senior req)

Specific courses required *All degrees*—5 course credits as listed under common degree requirements; *B.S.*—CHEM 3300L, 3330; *B.S., intensive major*—CHEM 3300L, 3330; second term of intro physics, PHYS 1710 or higher

Distribution of courses *B.A. and B.S.*—4 additional course credits in advanced lectures or labs, incl at least 1 lecture credit and 1 lab; *B.S., intensive major*—5 additional course credits in advanced lectures or labs, incl at least 2 credits of lectures and 1 lab

Substitution permitted Up to 2 relevant advanced science courses in other departments for adv chemistry courses with DUS permission

Senior requirement *B.A.*—CHEM 4000; *B.S.*—2 terms of CHEM 4900, or CHEM 4000 and 1 additional course credit in advanced lecture or lab; *B.S., intensive major*—2 terms of CHEM 4900; all degree programs require submission of senior capstone essay

FACULTY OF THE DEPARTMENT OF CHEMISTRY

Professors Victor Batista, Gary Brudvig, Robert Crabtree (*Emeritus*), Jason Crawford, †Craig Crews, R. James Cross, Jr. (*Emeritus*), Jonathan Ellman, John Faller (*Emeritus*), Nilay Hazari, Seth Herzon, Patrick Holland, Mark Johnson, William Jorgensen, J. Patrick Loria, James Mayer, J. Michael McBride (*Emeritus*), Scott Miller, Peter Moore (*Emeritus*), Timothy Newhouse, †Anna Pyle, †James Rothman, Martin Saunders (*Emeritus*), †Dieter Söll, David Spiegel, †Scott Strobel, John Tully (*Emeritus*), Patrick Vaccaro, Hailiang Wang, Kenneth Wiberg (*Emeritus*), Elsa Yan, Frederick Ziegler (*Emeritus*), Kurt Zilm

Associate Professor Sarah Slavoff

Assistant Professors Amymarie Bartholomew, Caitlin Davis, †Stavroula Hatzios, Stacy Malaker, †Mingjiang Zhong

Lecturers Paul Anastas, Paul Cooper, Christine DiMeglio, Laura Herder, Jonathan Parr

Preceptors TBD

†A joint appointment with primary affiliation in another department.