CHEMISTRY

Courses offered by the Department are listed under the subject code CHEM on the Stanford Bulletin's ExploreCourses web site.

For further information about the Department of Chemistry, see the department's web site (https://chemistry.stanford.edu).

Chemistry is about the nature of matter, how to make it, how to measure it, how to model it. In that sense chemistry really matters; it is essential to explaining all the real world. It holds the key to making new drugs, creating new materials, and understanding and controlling material properties of all sorts. It is no wonder then that chemistry is called the "Central Science." Traditionally, it is divided into subdisciplines, such as organic, inorganic, physical, biological, theoretical, and analytical, but these distinctions blur as it is increasingly appreciated how all of science, let alone chemistry, is interconnected.

A deeper understanding of chemistry enables students to participate in research and studies involving biotechnology, nanotechnology, catalysis, human health, materials, earth and environmental sciences, and more. Together, faculty, postdoctoral scholars, graduate and undergraduate students actively work side by side developing new probes of biological molecules, modeling protein folding and reactivity, manipulating carbon nanotubes, developing new oxidation and polymerization catalysts, and synthesizing organic molecules to probe ion-channels. The overarching theme of these pursuits is a focus at the atomic and molecular levels, whether this concerns probing the electronic structure and reactivity of molecules as small as dihydrogen or synthesizing large polymer assemblies. The ability to synthesize new molecules and materials and to modify existing biological structures allows the properties of complex systems to be analyzed and harnessed with huge benefit to both the scientific community and society at large.

Undergraduate Program

Mission

The mission of the undergraduate program in Chemistry is to provide students with foundational knowledge in the subdisciplines of chemistry as well as depth in one or more advanced areas, including cutting-edge research. Introductory course work allows students to gain hands-on experience with chemical phenomena, gather data, and propose models and explanations for their observations, thus participating in the scientific process from the start. In advanced labs and lectures, students build an in-depth knowledge of the molecular principles of chemistry empowering them to become molecular engineers comfortable with the methodologies necessary to solve complex problems and effectively articulate their ideas to the scientific community. Ultimately the analytical thinking and problem solving skills developed within the chemistry major make students successful candidates for a wide range of careers in chemistry and beyond, including engineering, teaching, consulting, medicine, law, science writing, and science policy.

Learning Outcomes (Undergraduate)

The department expects undergraduate majors in the program to be able to demonstrate the following learning outcomes. These learning outcomes are used in evaluating students and the department's undergraduate program. Students are expected to:

1. demonstrate the knowledge and skills required to solve problems in the synthesis, measurement, and modeling of chemical systems.
2. apply this set of chemical knowledge and skills to analyze scientific data, evaluate and interpret its significance, and articulate conclusions supportable by the data.
3. be able to construct a scientific hypothesis and devise appropriate experiments to test and evaluate this hypothesis.
4. communicate scientific research effectively in written and spoken form.

Graduate Program

The University's basic requirements for the M.S. and Ph.D. degrees are discussed in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" section of this bulletin.

Learning Outcomes (Graduate)

The purpose of the master's program is to further develop knowledge and skills in Chemistry and to prepare students for a professional career or doctoral studies. This is achieved through completion of courses, in the primary field as well as related areas, and experience with independent work and specialization.

The Ph.D. is conferred upon candidates who have demonstrated substantial scholarship and the ability to conduct independent research and analysis in the field of chemistry. Through completion of advanced course work and rigorous skills training, the doctoral program prepares students to make original contributions to the knowledge of chemistry and to interpret and present the results of such research.

Fellowships and Scholarships

In addition to University and school fellowships and scholarships open to properly qualified students, there are several department fellowships in chemistry awarded based on merit. Teaching assistantships and research assistantships are provided to eligible graduate students. Teaching assistantships beyond the required quarters are available for those interested. Graduate fellowships, scholarships, and teaching assistantships are administered through the Department of Chemistry student services office.

Teaching Credentials

The requirements for certification to teach chemistry in the secondary schools of California may be ascertained by consulting the section on credentials under the "School of Education (http://exploredegrees.stanford.edu/schoolofeducation)" section of this bulletin and the credential administrator of the School of Education.

Chemical Physics

Students with an exceptionally strong background in physics and mathematics may, with special arrangement, pursue a program of studies in chemical physics.

Bachelor of Science in Chemistry

Entrance Preparation

Entrance credit in the preparatory subjects of chemistry, physics, and especially mathematics provides flexibility in creating a four-year schedule for students intending to major in Chemistry.

Degree Requirements

Additional information on the undergraduate program can be found on the Department of Chemistry web site under Academics beginning with the section on The Major for the B.S. Degree (https://chemistry.stanford.edu/academics/undergraduate-program/major). All degree courses must be taken for a letter grade.

Lab Courses

Lab courses have a mandatory, non-refundable fee. Students who have not yet taken a lab course must purchase a department-approved lab coat and safety glasses. The department makes these available for purchase at the lowest possible price during the first few days of each quarter.

Traditional Chemistry Concentration

Requirements:

		Units
Select one of the following:		5-10
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	
CHEM 31X	Chemical Principles Accelerated	
Required Chemistry Courses		
CHEM 33	Structure and Reactivity of Organic Molecules	5
CHEM 35	Organic Chemistry of Bioactive Molecules	5
CHEM 130	Organic Chemistry Laboratory	3
CHEM 131	Organic Polyfunctional Compounds	3
CHEM 132	Synthesis Laboratory	3
CHEM 134	Instrumental Analysis Principles and Practice	5
CHEM 151	Inorganic Chemistry I	4
CHEM 153	Inorganic Chemistry II	3
CHEM 171	Physical Chemistry I	4
CHEM 173	Physical Chemistry II	3
CHEM 174	Electrochemical Measurements Lab	3
CHEM 175	Physical Chemistry III	3
CHEM 176	Spectroscopy Laboratory	3
Mathematics or CME		
MATH 19	Calculus	3
MATH 20	Calculus	3
MATH 21	Calculus	4
Select one of the following series:		10-15
Series A		
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
MATH 53	Ordinary Differential Equations with Linear Algebra	
Series B		
CME 100	Vector Calculus for Engineers	
CME 102	Ordinary Differential Equations for Engineers	
CME 104	Linear Algebra and Partial Differential Equations for Engineers	
Physics Required Courses		
PHYSICS 41	Mechanics	4
PHYSICS 42	Classical Mechanics Laboratory	1
PHYSICS 43	Electricity and Magnetism	4
PHYSICS 44	Electricity and Magnetism Lab	1
Total Units		82-92

Biological Chemistry Concentration

Requirements:

		Units
Select one of the following:		5-10
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	
CHEM 31X	Chemical Principles Accelerated	
Required Chemistry and Biology courses		
CHEM 33	Structure and Reactivity of Organic Molecules	5
CHEM 35	Organic Chemistry of Bioactive Molecules	5
CHEM 130	Organic Chemistry Laboratory	3
CHEM 131	Organic Polyfunctional Compounds	3
CHEM 132	Synthesis Laboratory	3
CHEM 134	Instrumental Analysis Principles and Practice	5
CHEM 151	Inorganic Chemistry I	4
CHEM 171	Physical Chemistry I	4
CHEM 173	Physical Chemistry II	3
CHEM 176	Spectroscopy Laboratory	3
CHEM 181	Biochemistry I	4
CHEM 183	Biochemistry II	3
CHEM 184	Biological Chemistry Laboratory	3
CHEM 185	Biophysical Chemistry	3
Select one of the following BIO courses:		4
BIO 82	Genetics	
BIO 84	Physiology	
BIO 86	Cell Biology	
Mathematics or CME		
MATH 19	Calculus	3
MATH 20	Calculus	3
MATH 21	Calculus	4
Select one of the following Series:		10-15
Series A		
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
MATH 53	Ordinary Differential Equations with Linear Algebra	
Series B		
CME 100	Vector Calculus for Engineers	
CME 102	Ordinary Differential Equations for Engineers	
CME 104	Linear Algebra and Partial Differential Equations for Engineers	
Required Physics Courses		
PHYSICS 41	Mechanics	4
PHYSICS 42	Classical Mechanics Laboratory	1
PHYSICS 43	Electricity and Magnetism	4
PHYSICS 44	Electricity and Magnetism Lab	1
Elective		3-4
Select one graduate-level elective course related to your biochemical interests.		
CHEM 221	Advanced Organic Chemistry I	
CHEM 223	Advanced Organic Chemistry II	
CHEM 225	Advanced Organic Chemistry III	
CHEM 226	Synthesis and Analysis at the Chemistry-Biology Interface	
CHEM 227	Therapeutic Science at the Chemistry - Biology Interface	
CHEM 235	Applications of NMR Spectroscopy	
CHEM 255	Advanced Inorganic Chemistry	
CHEM 271	Advanced Physical Chemistry	
CHEM 277	Materials Chemistry and Physics	
CHEM 297	Bio-Inorganic Chemistry	
BIO 214	Advanced Cell Biology	
BIO 230	Molecular and Cellular Immunology	
BIO 232	Advanced Imaging Lab in Biophysics	
BIOC 241	Biological Macromolecules	

BIOE 214	Representations and Algorithms for Computational Molecular Biology
BIOE 224	Probes and Applications for Multi-modality Molecular Imaging of Living Subjects
BIOE 300A	Molecular and Cellular Bioengineering
BIOE 335	Molecular Motors I
BIOPHYS 232	Advanced Imaging Lab in Biophysics
BIOPHYS 279	Computational Biology: Structure and Organization of Biomolecules and Cells
CSB 220	Chemistry of Biological Processes
CSB 260	Concepts and Applications in Chemical Biology
Total Units	93-104

Chemistry Major Schedule

Below are possible schedules for the traditional concentration and the biological chemistry concentration, each followed by an accelerated schedule.

Schedule for Traditional Chemistry Concentration

First Year	Units		
	Autumn	Winter	Spring
Chemical Principles I (CHEM 31A)		5	
Calculus (MATH 19)		3	
Chemical Principles II (CHEM 31B)			5
Calculus (MATH 20)			3
Structure and Reactivity of Organic Molecules (CHEM 33)			5
Calculus (MATH 21)			4
Year Total:		8	8 9

Second Year	Units		
	Autumn	Winter	Spring
Organic Chemistry of Bioactive Molecules (CHEM 35)		5	
Linear Algebra, Multivariable Calculus, and Modern Applications (MATH 51)		5	
Inorganic Chemistry I (CHEM 151)			4
Mechanics (PHYSICS 41)			4
Classical Mechanics Laboratory (PHYSICS 42)			1
Instrumental Analysis Principles and Practice (CHEM 134)			5
Physical Chemistry I (CHEM 171)			4
Year Total:		10	9 9

Third Year	Units		
	Autumn	Winter	Spring
Organic Chemistry Laboratory (CHEM 130)		3	
Organic Polyfunctional Compounds (CHEM 131)		3	
Synthesis Laboratory (CHEM 132)			3
Ordinary Differential Equations with Linear Algebra (MATH 53)			5
Electricity and Magnetism (PHYSICS 43)			4
Electricity and Magnetism Lab (PHYSICS 44)			1
Year Total:		6	8 5

Fourth Year	Units		
	Autumn	Winter	Spring
Physical Chemistry II (CHEM 173)		3	
Electrochemical Measurements Lab (CHEM 174)		3	
Physical Chemistry III (CHEM 175)			3
Spectroscopy Laboratory (CHEM 176)			3
Inorganic Chemistry II (CHEM 153)			3
Year Total:		6	6 3

Total Units in Sequence: 87

Accelerated Schedule for the Traditional Chemistry Concentration

First Year	Units		
	Autumn	Winter	Spring
Chemical Principles Accelerated (CHEM 31X)		5	
Linear Algebra, Multivariable Calculus, and Modern Applications (MATH 51)		5	
Structure and Reactivity of Organic Molecules (CHEM 33)			5
Mechanics (PHYSICS 41)			4
Classical Mechanics Laboratory (PHYSICS 42)			1
Organic Chemistry of Bioactive Molecules (CHEM 35)			5
Electricity and Magnetism (PHYSICS 43)			4
Electricity and Magnetism Lab (PHYSICS 44)			1
Year Total:		10	10 10

Second Year	Units		
	Autumn	Winter	Spring
Organic Chemistry Laboratory (CHEM 130)		3	
Organic Polyfunctional Compounds (CHEM 131)		3	
Ordinary Differential Equations with Linear Algebra (MATH 53)		5	
Synthesis Laboratory (CHEM 132)			3
Inorganic Chemistry I (CHEM 151)			4
Instrumental Analysis Principles and Practice (CHEM 134)			5
Physical Chemistry I (CHEM 171)			4
Year Total:		11	7 9

Third Year	Units		
	Autumn	Winter	Spring
Physical Chemistry II (CHEM 173)		3	
Electrochemical Measurements Lab (CHEM 174)		3	
Physical Chemistry III (CHEM 175)			3
Spectroscopy Laboratory (CHEM 176)			3
Inorganic Chemistry II (CHEM 153)			3
Year Total:		6	6 3

Total Units in Sequence: 72

Schedule for Biological Chemistry Concentration

First Year	Units		
	Autumn	Winter	Spring
Chemical Principles I (CHEM 31A)		5	
Calculus (MATH 19)		3	
Chemical Principles II (CHEM 31B)			5
Calculus (MATH 20)			3
Structure and Reactivity of Organic Molecules (CHEM 33)			5
Calculus (MATH 21)			4
Year Total:		8	8 9

Second Year	Units		
	Autumn	Winter	Spring
Organic Chemistry of Bioactive Molecules (CHEM 35)		5	
Linear Algebra, Multivariable Calculus, and Modern Applications (MATH 51)		5	
Inorganic Chemistry I (CHEM 151)			4
Mechanics (PHYSICS 41)			4
Classical Mechanics Laboratory (PHYSICS 42)			1
Instrumental Analysis Principles and Practice (CHEM 134)			5
Physical Chemistry I (CHEM 171)			4
Cell Biology (BIO 86)			4
Year Total:		10	9 13

Third Year	Units		
	Autumn	Winter	Spring
Organic Chemistry Laboratory (CHEM 130)		3	
Organic Polyfunctional Compounds (CHEM 131)		3	

Biochemistry I (CHEM 181)	4		
Synthesis Laboratory (CHEM 132)		3	
Biochemistry II (CHEM 183)		3	
Ordinary Differential Equations with Linear Algebra (MATH 53)		5	
Biological Chemistry Laboratory (CHEM 184)			3
Electricity and Magnetism (PHYSICS 43)			4
Electricity and Magnetism Lab (PHYSICS 44)			1
Year Total:	10	11	8

Fourth Year	Units		
	Autumn	Winter	Spring
Physical Chemistry II (CHEM 173)	3		
Spectroscopy Laboratory (CHEM 176)		3	
Biophysical Chemistry (CHEM 185)			3
Therapeutic Science at the Chemistry - Biology Interface (CHEM 227)			3
Year Total:	3	3	6

Total Units in Sequence:	98

Accelerated Schedule for the Biological Chemistry Concentration

First Year	Units		
	Autumn	Winter	Spring
Chemical Principles Accelerated (CHEM 31X)	5		
Linear Algebra, Multivariable Calculus, and Modern Applications (MATH 51)	5		
Structure and Reactivity of Organic Molecules (CHEM 33)		5	
Mechanics (PHYSICS 41)		4	
Classical Mechanics Laboratory (PHYSICS 42)		1	
Organic Chemistry of Bioactive Molecules (CHEM 35)			5
Electricity and Magnetism (PHYSICS 43)			4
Electricity and Magnetism Lab (PHYSICS 44)			1
Year Total:	10	10	10

Second Year	Units		
	Autumn	Winter	Spring
Organic Chemistry Laboratory (CHEM 130)	3		
Organic Polyfunctional Compounds (CHEM 131)	3		
Ordinary Differential Equations with Linear Algebra (MATH 53)	5		
Synthesis Laboratory (CHEM 132)		3	
Inorganic Chemistry I (CHEM 151)		4	
Physiology (BIO 84) (BIO 82 Autumn; BIO 86 Spring) or Genetics (BIO 82) or Cell Biology (BIO 86)		4	
Instrumental Analysis Principles and Practice (CHEM 134)			5
Physical Chemistry I (CHEM 171)			4
Year Total:	11	11	9

Third Year	Units		
	Autumn	Winter	Spring
Physical Chemistry II (CHEM 173)	3		
Biochemistry I (CHEM 181)	4		
Spectroscopy Laboratory (CHEM 176)		3	
Biochemistry II (CHEM 183)		3	
Biological Chemistry Laboratory (CHEM 184)			3
Biophysical Chemistry (CHEM 185)			3
Therapeutic Science at the Chemistry - Biology Interface (CHEM 227)			3
Year Total:	7	6	9

Total Units in Sequence:	83

Related Courses

Courses offered by other departments that may be of interest to Chemistry majors include:

		Units
BIO 82	Genetics	4
BIO 84	Physiology	4
BIO 86	Cell Biology	4
CHEMENG 20	Introduction to Chemical Engineering	4
CHEMENG 120A	Fluid Mechanics	4
CHEMENG 120B	Energy and Mass Transport	4
CHEMENG 130	Separation Processes	3
CS 106A	Programming Methodology (recommended for students planning graduate study)	3-5
CS 106B	Programming Abstractions (recommended for students planning graduate study)	3-5
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis	4
MATH 106	Functions of a Complex Variable	3
MATH 109	Applied Group Theory	3
MATH 113	Linear Algebra and Matrix Theory	3
MATH 131P	Partial Differential Equations	3
MATSCI 151	Microstructure and Mechanical Properties	4
PHYSICS 110	Advanced Mechanics	4
STATS 110	Statistical Methods in Engineering and the Physical Sciences	4-5
STATS 116	Theory of Probability	3-5

American Chemical Society (ACS) Certification

Students who wish to be certified as having met the minimum requirements of the American Chemical Society for professional training must complete, in addition to the above requirements:

		Units
CHEM 181	Biochemistry I	4
CHEM 190	Advanced Undergraduate Research	1-5

Effective for Chemistry students graduating 2018-19 and beyond, an A.C.S. certified bachelor's degree is no longer offered.

Honors Program

A bachelor's degree in Chemistry with honors is available to those students interested in chemical research. Admission to the honors program requires a grade point average (GPA) of 3.3 in science courses and an overall GPA of 3.0 in all University courses. Beyond the standard B.S. course requirements for each track, 9 units of research credit and 9 units of course work need to be completed during the junior and senior academic years. A thesis, approved by the honors adviser, must be completed during the senior year. The theses must be submitted to the research adviser, at least one week before the end of regular classes in Spring Quarter, and must be completed by May 15 to be considered for the Firestone or Golden award. The use of a single course for multiple requirements for honors, major, minor, or coterminal requirements is not allowed. Students who wish to be admitted to the honors program should register with the student services manager in the Mudd Chemistry Building in Spring Quarter of their junior year.

CHEM 190 Advanced Undergraduate Research research units towards honors may be completed, after being accepted into the program, in any laboratory within Chemistry or with courtesy faculty in Chemistry. Other chemical research can be approved through a formal petitioning of the Undergraduate Studies Committee. At least 3 units must be completed during the senior year. Participation in a summer research program in an academic setting between junior and senior years may be used in lieu of 3 units of CHEM 190 Advanced Undergraduate Research. For each

quarter, a progress report reflecting the units undertaken is required. This report must be signed by the honors adviser, and filed in the department student services office before the last day of finals in the quarter during which the research is performed.

The 9 units of course work for honors must be completed from courses approved by the Undergraduate Studies Committee and taken for a letter grade. At least six of these units need to be taken from the following CHEM courses:

		Units
CHEM 153	Inorganic Chemistry II	3
CHEM 174	Electrochemical Measurements Lab	3
CHEM 175	Physical Chemistry III	3
CHEM 181	Biochemistry I	4
CHEM 183	Biochemistry II	3
CHEM 184	Biological Chemistry Laboratory	3
CHEM 185	Biophysical Chemistry	3
CHEM 221	Advanced Organic Chemistry I	3
CHEM 223	Advanced Organic Chemistry II	3
CHEM 225	Advanced Organic Chemistry III	3
CHEM 226	Synthesis and Analysis at the Chemistry-Biology Interface	3
CHEM 227	Therapeutic Science at the Chemistry - Biology Interface	3
CHEM 235	Applications of NMR Spectroscopy	3
CHEM 251	Advanced Inorganic Chemistry	3
CHEM 255	Advanced Inorganic Chemistry	3
CHEM 261	Computational Chemistry	3
CHEM 271	Advanced Physical Chemistry	3
CHEM 273	Advanced Physical Chemistry	3
CHEM 275	Advanced Physical Chemistry - Single Molecules and Light	3
CHEM 277	Materials Chemistry and Physics	3
CHEM 297	Bio-Inorganic Chemistry	3

Minor in Chemistry

Courses required for a minor must be taken for a letter grade and all courses below are required:

		Units
CHEM 33	Structure and Reactivity of Organic Molecules	5
CHEM 35	Organic Chemistry of Bioactive Molecules	5
CHEM 130	Organic Chemistry Laboratory	3
CHEM 131	Organic Polyfunctional Compounds	3
CHEM 134	Instrumental Analysis Principles and Practice	5
CHEM 151	Inorganic Chemistry I	4
CHEM 171	Physical Chemistry I	4
Total Units		29

Master of Science in Chemistry

The Master of Science is available only to current Ph.D. students or as part of a coterminal program. Applicants for the M.S. degree in Chemistry are required to complete, in addition to the requirements for the bachelor's degree, a minimum of 45 graduate-level units and a M.S. thesis. Of the 45 units, approximately two-thirds must be in the department and must include at least 12 units of graduate level lecture courses exclusive of the thesis.

University Coterminal Requirements

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master's Program (http://exploredegrees.stanford.edu/cotermdegrees)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken three quarters prior to the first graduate quarter, or later, are eligible for consideration for transfer to the graduate career. No courses taken prior to the first quarter of the sophomore year may be used to meet master's degree requirements.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate adviser be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

		Units
Of the 12 units, at least 6 units must be from:		
CHEM 221	Advanced Organic Chemistry I	3
CHEM 223	Advanced Organic Chemistry II	3
CHEM 225	Advanced Organic Chemistry III	3
CHEM 226	Synthesis and Analysis at the Chemistry-Biology Interface	3
CHEM 227	Therapeutic Science at the Chemistry - Biology Interface	3
CHEM 235	Applications of NMR Spectroscopy	3
CHEM 251	Advanced Inorganic Chemistry	3
CHEM 253	Advanced Inorganic Chemistry	3
CHEM 255	Advanced Inorganic Chemistry	3
CHEM 261	Computational Chemistry	3
CHEM 271	Advanced Physical Chemistry	3
CHEM 273	Advanced Physical Chemistry	3
CHEM 275	Advanced Physical Chemistry - Single Molecules and Light	3
CHEM 277	Materials Chemistry and Physics	3
CHEM 285	Biophysical Chemistry	3
CHEM 297	Bio-Inorganic Chemistry	3

Doctor of Philosophy in Chemistry

Process to Candidacy

Graduate students are eligible to become formal candidates for the Ph.D. degree after taking the department placement examinations, satisfactory completion of most of the formal lecture course requirements, and satisfactory progress on a dissertation research project determined by passing a progress report with one's thesis committee. There is no foreign language requirement for the Ph.D. degree. Admission to candidacy for the Ph.D. degree must be done before July of the second year of graduate registration.

Placement Examinations

Each new graduate student must take placement examinations upon entrance. These consist of three written examinations of two hours each in the fields of inorganic, organic, and physical chemistry, and cover such material as ordinarily is given in a rigorous one-year undergraduate course in each of these subjects. Students concentrating in biophysical chemistry or chemical physics must take examinations in biophysical or chemical physics, physical chemistry, and organic or inorganic chemistry. Students concentrating in chemical biology must take examinations in biophysical, organic chemistry, and physical chemistry or inorganic chemistry. All placement examinations are given the week before instruction begins in Autumn Quarter, and must be taken at that time. Each new graduate student meets with a member of the graduate study committee to define a program of courses based on results of the placement examinations.

General Requirements

After taking the departmental placement examinations, students select a research adviser by interviewing members of the Chemistry faculty. An Application to Start Research form is submitted to the Department as research begins under the supervision of the adviser. All students in good standing are required to start research by the end of February, during Winter Quarter of the first year of graduate registration.

Candidates for the Ph.D. degree are required to participate continually in the department colloquium (CHEM 300 Department Colloquium) and in the division seminar of the major subject (CHEM 229 Organic Chemistry Seminar, CHEM 259 Inorganic Chemistry Seminar, or CHEM 279 Physical Chemistry Seminar).

Candidates for advanced degrees must have a minimum grade point average (GPA) of 3.0 for all Chemistry lecture courses as well as for all courses taken during graduate study. Required courses must be taken for a letter grade. Most course work ends in the second year of studies, and students will then focus on full-time dissertation research.

Students may major in organic, chemical biology, physical, biophysical, chemical physics, or inorganic chemistry. All graduate students are required to take six graduate-level lecture courses (course numbers greater than 199) of at least 3 units each in chemistry or related disciplines (e.g., biochemistry, electrical engineering, mathematics, chemical engineering, chemical and systems biology, physics, materials science), to be selected in consultation with their research adviser and the Graduate Study Committee. All six courses must be taken for a letter grade. At least three of the six courses must be taken within the Chemistry Department. A minimum of four courses should be completed by the end of the first year.

Course Requirements for entering classes beginning with 2018-19

		Units
All students must complete:		
CHEM 211A	Research Progress in Chemistry (in the second year)	1
CHEM 211B	Chemistry Research Seminar Presentation (in the third year)	1
CHEM 211C	Chemistry Research Proposal (in the fourth year)	1
Students majoring in physical or biophysical chemistry or chemical physics must also complete:		
CHEM 271	Advanced Physical Chemistry (in the first year)	3
CHEM 273	Advanced Physical Chemistry (in the first year)	3

Course Requirements for entering classes prior to 2018-19

		Units
Students majoring in organic chemistry or chemical biology must complete:		
CHEM 231	Organic Chemistry Seminar Presentation (Autumn, Winter, and Spring of the second year)	1
CHEM 233A	Creativity in Organic Chemistry (Research Progress)	1
CHEM 233B	Creativity in Organic Chemistry (Research Progress)	1
CHEM 233C	Creativity in Organic Chemistry (Research Progress)	1
Students majoring in physical or biophysical chemistry or chemical physics must complete:		
CHEM 271	Advanced Physical Chemistry (in the first year)	3
CHEM 273	Advanced Physical Chemistry (in the first year)	3
CHEM 275	Advanced Physical Chemistry - Single Molecules and Light (in the first year)	3
CHEM 278A	Research Progress in Physical Chemistry	1
CHEM 278B	Research Progress in Physical Chemistry	1
Students majoring in inorganic chemistry must complete:		
CHEM 258A	Research Progress in Inorganic Chemistry	1
CHEM 258B	Research Progress in Inorganic Chemistry (Seminar Presentation)	1
CHEM 258C	Research Progress in Inorganic Chemistry (Research Proposal)	1

Continuous enrollment in CHEM 301 Research in Chemistry is expected after the student has chosen a research supervisor.

Post-Candidacy

Before candidates may request scheduling of the University oral examination, clearance must be obtained from the dissertation adviser and an academic review meeting made with the Student Services Manager for the Department of Chemistry.

During the period in which a dissertation is being read by members of the faculty, candidates must be available for personal consultation until the dissertation has received final department approval.

Ph.D. Minor in Chemistry

Candidates for the Ph.D. degree in other departments who wish to obtain a minor in chemistry must complete, with a GPA of 3.0 or higher, 20 graduate-level units in Chemistry including four lecture courses of at least three units each.

Graduate Advising Expectations

The Department of Chemistry is committed to providing academic advising in support of graduate student scholarly and professional development. This advising relationship entails collaborative and sustained engagement with mutual respect by both the adviser and advisee.

1. The adviser is expected to meet at least monthly with the graduate student to discuss on-going research.
2. There should be a yearly independent development plan (IDP) meeting between the graduate student and adviser. Topics include

research progress, expectations for completion of Ph.D., areas for both the student and adviser to improve in their joint research effort.

3. A research adviser should provide timely feedback on manuscripts and thesis chapters.
4. Graduate students are active contributors to the advising relationship, proactively seeking academic and professional guidance and taking responsibility for informing themselves of policies and degree requirements for their graduate program.
5. If there is a significant issue concerning the graduate student's progress in research, the adviser must communicate this to the student and to the Graduate Studies Committee in writing. This feedback should include the issues, what needs to be done to overcome these issues, and by when.

For a statement of University policy on graduate advising, see the "Graduate Advising (http://exploredegrees.stanford.edu/graduatedegrees/#advisingandcredentialstext)" section of this bulletin. Academic advising by Stanford faculty is a critical component of all graduate students' education and additional resources can be found in the Policies and Best Practices for Advising Relationships at Stanford (http://stanford.box.com/shared/static/73oj7zqvy9h0fezqf310onbuunv91nyl.pdf) and the Guidelines for Faculty-Student Advising at Stanford (https://stanford.box.com/shared/static/mespm59bcanq03o4pppu7r4n9p4sb6t6.pdf).

Emeriti: (Professors) Hans C. Andersen, John I. Brauman, James P. Collman, Wray H. Huestis, Robert Pecora

Chair: Keith O. Hodgson

Vice Chair: T. Daniel P. Stack

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