CHEMISTRY

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

Chemistry is central to many scientific disciplines. It enables developments in biotechnology, nanotechnology, catalysis, human health, materials, and earth and environmental sciences. 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 are all research areas that are pursued actively in the Chemistry Department. 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 for scientific and societal benefit.

Undergraduate Program

Mission

The mission of the undergraduate program in Chemistry is to provide students with the fundamental concepts of the molecular sciences through a program of coursework and laboratory experiences. Students acquire in-depth knowledge of the principles of chemistry, the methodologies necessary to solve complex problems, and the ability to articulate their ideas effectively to the scientific community. The Chemistry program has a long-standing tradition of encouraging undergraduate majors to become involved in research during the academic year and through a ten-week summer research program. The major is designed to provide students with excellent preparation for further study in graduate or professional schools as well as careers in chemistry.

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. understand the knowledge and master the skills to solve problems in the synthesis, measurement and modeling of chemical systems.
2. critically assess and integrate the reasoning process used in chemical science and communicate it effectively in written and spoken form.
3. apply the knowledge and skills gained by study of specific chemical systems to understand and predict the chemistry of a broad range of complex systems of scientific and societal interest.
4. apply the understanding of synthesis, measurement and modeling to extract new chemical information from experimental data and to propose new chemical investigations.

Chemistry Premedical Recommendations

The department recommends that students interested in a health profession take the following courses for a letter grade:

		Units
Select one of the following:		5-10
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	
CHEM 31X	Chemical Principles Accelerated	
CHEM 33	Structure and Reactivity	5
CHEM 35	Synthetic and Physical Organic Chemistry	5
CHEM 130	Organic and Bio-organic Chemistry Laboratory	3
CHEM 131	Organic Polyfunctional Compounds	3
CHEM 135	Physical Biochemistry	3
or CHEM 171	Physical Chemistry I	
CHEM 181	Biochemistry I	3

Historically, these courses have fulfilled the chemistry requirements at most medical schools. For information on medical school advising and resources, download the Undergraduate Advising and Research publication (http://www.stanford.edu/dept/undergrad/cgi-bin/drupal_ual/AP_planning_school_GraduateSchool.html#5).

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, including suggested course schedules, can be found on the Department of Chemistry web site beginning with the section on Requirements for

the B.S. Degree (http://chemistry.stanford.edu/undergradprograms/requirements-bs-degree). 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.

Chemistry Option

Requirements for students choosing the Chemistry Option:

		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	5
CHEM 35	Synthetic and Physical Organic Chemistry	5
CHEM 130	Organic and Bio-organic Chemistry Laboratory	3
CHEM 131	Organic Polyfunctional Compounds	3
CHEM 132	Synthesis Laboratory	3
CHEM 134	Analytical Chemistry Laboratory	5
CHEM 151	Inorganic Chemistry I	3
CHEM 153	Inorganic Chemistry II	3
CHEM 171	Physical Chemistry I	3
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 41	Calculus	
MATH 42	Calculus	
Select one of the following series:		
Series A		11-15
MATH 51	Linear Algebra and Differential Calculus of Several Variables	
MATH 51M	Introduction to MATLAB for Multivariable Mathematics	
or CME 192	Introduction to MATLAB	
or CS 106A	Programming Methodology	
MATH 53	Ordinary Differential Equations with Linear Algebra	
Series B		15
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		86-95

Biological Chemistry Option

Requirements for students choosing the Biological Chemistry Option.

		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	5
CHEM 35	Synthetic and Physical Organic Chemistry	5
CHEM 130	Organic and Bio-organic Chemistry Laboratory	3
CHEM 131	Organic Polyfunctional Compounds	3
CHEM 132	Synthesis Laboratory	3
CHEM 134	Analytical Chemistry Laboratory	5
CHEM 151	Inorganic Chemistry I	3
CHEM 171	Physical Chemistry I	3
CHEM 173	Physical Chemistry II	3
CHEM 176	Spectroscopy Laboratory	3
CHEM 181	Biochemistry I	3
CHEM 183	Biochemistry II	3
CHEM 184	Biological Chemistry Laboratory	4
CHEM 185	Biophysical Chemistry	3
BIO 42	Cell Biology and Animal Physiology	5
Mathematics or CME		
MATH 41	Calculus	
MATH 42	Calculus	
Select one of the following Series:		
Series A		11-15
MATH 51	Linear Algebra and Differential Calculus of Several Variables	
MATH 51M	Introduction to MATLAB for Multivariable Mathematics	
or CME 192	Introduction to MATLAB	
or CS 106A	Programming Methodology	
MATH 53	Ordinary Differential Equations with Linear Algebra	
Series B		15
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	
CHEM 223	Advanced Organic Chemistry	
CHEM 225	Advanced Organic Chemistry	
CHEM 227	Therapeutic Science at the Chemistry - Biology Interface strongly recommended	
CHEM 235	Applications of NMR Spectroscopy	
CHEM 255	Advanced Inorganic Chemistry	
CHEM 271	Advanced Physical Chemistry	
CHEM 277	Materials Chemistry and Physics not offered 2014-15	
CHEM 297	Bio-Inorganic Chemistry	
BIOC 241	Biological Macromolecules	
BIOPHYS 232	Advanced Imaging Lab in Biophysics	

BIOE 214	Representations and Algorithms for Computational Molecular Biology
BIOE 300A	Molecular and Cellular Bioengineering
BIOE 224	Probes and Applications for Multi-modality Molecular Imaging of Living Subjects
BIOE 331	Protein Engineering
BIOE 335	Molecular Motors I
BIO 214	Advanced Cell Biology
BIO 230	Molecular and Cellular Immunology
BIO 232	Advanced Imaging Lab in Biophysics
CSB 220	Chemistry of Biological Processes
CSB 260	Concepts and Applications in Chemical Biology
Total Units	98-108

For further information on the undergraduate program, see the Department of Chemistry (http://chemistry.stanford.edu/undergraduate-programs) web site.

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 Concentration

First Year	Units		
	Autumn	Winter	Spring
Chemical Principles I (CHEM 31A)		5	
Calculus (MATH 41)		5	
Chemical Principles II (CHEM 31B)			5
Calculus (MATH 42)			5
Structure and Reactivity (CHEM 33)			5
Linear Algebra and Differential Calculus of Several Variables (MATH 51)			5
Year Total:		10	10	10

Second Year	Units		
	Autumn	Winter	Spring
Synthetic and Physical Organic Chemistry (CHEM 35)		5	
Introduction to MATLAB for Multivariable Mathematics (MATH 51M)		1	
Ordinary Differential Equations with Linear Algebra (MATH 53)		5	
Organic and Bio-organic Chemistry Laboratory (CHEM 130)			3
Organic Polyfunctional Compounds (CHEM 131)			3
Mechanics (PHYSICS 41)			4
Classical Mechanics Laboratory (PHYSICS 42)			1
Analytical Chemistry Laboratory (CHEM 134)			5
Electricity and Magnetism (PHYSICS 43)			4
Electricity and Magnetism Lab (PHYSICS 44)			1
Year Total:		11	11	10

Third Year	Units		
	Autumn	Winter	Spring
Synthesis Laboratory (CHEM 132)			3
Inorganic Chemistry I (CHEM 151)			3
Physical Chemistry I (CHEM 171)			3
Year Total:			6	3

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:				86

Accelerated Schedule for the Traditional Concentration

First Year	Units		
	Autumn	Winter	Spring
Chemical Principles Accelerated (CHEM 31X)		5	
Linear Algebra and Differential Calculus of Several Variables (MATH 51)		5	
Introduction to MATLAB for Multivariable Mathematics (MATH 51M)		1	
Structure and Reactivity (CHEM 33)			5
Mechanics (PHYSICS 41)			4
Classical Mechanics Laboratory (PHYSICS 42)			1
Synthetic and Physical Organic Chemistry (CHEM 35)			5
Electricity and Magnetism (PHYSICS 43)			4
Electricity and Magnetism Lab (PHYSICS 44)			1
Year Total:		11	10	10

Second Year	Units		
	Autumn	Winter	Spring
Organic and Bio-organic Chemistry Laboratory (CHEM 130)		3	
Organic Polyfunctional Compounds (CHEM 131)		3	
Synthesis Laboratory (CHEM 132)			3
Inorganic Chemistry I (CHEM 151)			3
Ordinary Differential Equations with Linear Algebra (MATH 53)			5
Analytical Chemistry Laboratory (CHEM 134)			5
Physical Chemistry I (CHEM 171)			3
Year Total:		6	11	8

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:				71

Schedule for Biological Chemistry Concentration

First Year	Units		
	Autumn	Winter	Spring
Chemical Principles I (CHEM 31A)		5	
Calculus (MATH 41)		5	
Chemical Principles II (CHEM 31B)			5
Calculus (MATH 42)			5
Structure and Reactivity (CHEM 33)			5
Linear Algebra and Differential Calculus of Several Variables (MATH 51)			5
Year Total:		10	10	10

Second Year	Units		
	Autumn	Winter	Spring
Synthetic and Physical Organic Chemistry (CHEM 35)		5	
Introduction to MATLAB for Multivariable Mathematics (MATH 51M)		1	
Ordinary Differential Equations with Linear Algebra (MATH 53)		5	
Organic and Bio-organic Chemistry Laboratory (CHEM 130)			3
Organic Polyfunctional Compounds (CHEM 131)			3
Mechanics (PHYSICS 41)			4
Classical Mechanics Laboratory (PHYSICS 42)			1
Analytical Chemistry Laboratory (CHEM 134)			5
Physical Chemistry I (CHEM 171)			3

Year Total:		11	11	8

Third Year	Units			
	Autumn	Winter	Spring	
Biochemistry I (CHEM 181)		3		
Inorganic Chemistry I (CHEM 151)			3	
Biochemistry II (CHEM 183)			3	
Cell Biology and Animal Physiology (BIO 42)			5	
Electricity and Magnetism (PHYSICS 43)				4
Electricity and Magnetism Lab (PHYSICS 44)				1
Year Total:		3	11	5

Fourth Year	Units			
	Autumn	Winter	Spring	
Physical Chemistry II (CHEM 173)		3		
Synthesis Laboratory (CHEM 132)			3	
Spectroscopy Laboratory (CHEM 176)			3	
Biological Chemistry Laboratory (CHEM 184)				4
Biophysical Chemistry (CHEM 185)				3
Therapeutic Science at the Chemistry - Biology Interface (CHEM 227)				3
Year Total:		3	6	10

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 and Differential Calculus of Several Variables (MATH 51)		5		
Introduction to MATLAB for Multivariable Mathematics (MATH 51M)		1		
Structure and Reactivity (CHEM 33)			5	
Mechanics (PHYSICS 41)			4	
Classical Mechanics Laboratory (PHYSICS 42)			1	
Synthetic and Physical Organic Chemistry (CHEM 35)				5
Electricity and Magnetism (PHYSICS 43)				4
Electricity and Magnetism Lab (PHYSICS 44)				1
Year Total:		11	10	10

Second Year	Units			
	Autumn	Winter	Spring	
Organic and Bio-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)			3	
Cell Biology and Animal Physiology (BIO 42)			5	
Analytical Chemistry Laboratory (CHEM 134)				5
Physical Chemistry I (CHEM 171)				3
Year Total:		11	11	8

Third Year	Units			
	Autumn	Winter	Spring	
Physical Chemistry II (CHEM 173)		3		
Biochemistry I (CHEM 181)		3		
Spectroscopy Laboratory (CHEM 176)			3	
Biochemistry II (CHEM 183)			3	
Biological Chemistry Laboratory (CHEM 184)				4
Biophysical Chemistry (CHEM 185)				3
Therapeutic Science at the Chemistry - Biology Interface (CHEM 227)				3
Year Total:		6	6	10

Total Units in Sequence:	83

Related Courses

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

		Units
BIO 41	Genetics, Biochemistry, and Molecular Biology	5
BIO 42	Cell Biology and Animal Physiology	5
BIO 43	Plant Biology, Evolution, and Ecology	5
CHEMENG 20	Introduction to Chemical Engineering	3
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 I	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	3
CHEM 183	Biochemistry II	3
PHYSICS 45	Light and Heat	4
PHYSICS 46	Light and Heat Laboratory	1
CHEM 190	Advanced Undergraduate Research (6 units)	1-5

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 honors 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 Affairs 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 Affairs 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	3
CHEM 183	Biochemistry II	3
CHEM 185	Biophysical Chemistry	3
CHEM 221	Advanced Organic Chemistry	3
CHEM 223	Advanced Organic Chemistry	3
CHEM 225	Advanced Organic Chemistry	3
CHEM 235	Applications of NMR Spectroscopy	3
CHEM 251	Advanced Inorganic Chemistry	3
CHEM 255	Advanced Inorganic Chemistry	3
CHEM 271	Advanced Physical Chemistry	3
CHEM 273	Advanced Physical Chemistry	3
CHEM 275	Advanced Physical Chemistry	3
CHEM 291	Introduction to Nuclear Magnetic Resonance	3
CHEM 297	Bio-Inorganic Chemistry	3

Minor in Chemistry

Courses required for a minor are:

		Units
CHEM 33	Structure and Reactivity	5
CHEM 35	Synthetic and Physical Organic Chemistry	5
CHEM 130	Organic and Bio-organic Chemistry Laboratory	3
CHEM 131	Organic Polyfunctional Compounds	3
CHEM 134	Analytical Chemistry Laboratory	5
CHEM 151	Inorganic Chemistry I	3
CHEM 171	Physical Chemistry I Prerequisite MATH 51 and (Math 51M or CME 192 or CS 106A)	3
Total Units		27

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.

Courses offered in previous years that may count toward the M.S. include CHEM 285.

		Units
Of the 12 units, at least 6 units must be from:		
CHEM 221	Advanced Organic Chemistry	3
CHEM 223	Advanced Organic Chemistry	3
CHEM 225	Advanced Organic Chemistry	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 271	Advanced Physical Chemistry	3
CHEM 273	Advanced Physical Chemistry	3
CHEM 275	Advanced Physical Chemistry	3
CHEM 277	Materials Chemistry and Physics	3
CHEM 280	Single-Molecule Spectroscopy and Imaging	3
CHEM 291	Introduction to Nuclear Magnetic Resonance	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. There is no foreign language requirement for the Ph.D. degree. Admission to candidacy for the Ph.D. degree must be done before June 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 should be taken within the Chemistry Department. A minimum of four courses should be completed by the end of the first year.

Course Requirements

		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 (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.

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

Chair: Keith O. Hodgson

Vice Chair: T. Daniel P. Stack

Professors: Carolyn R. Bertozzi, Steven G. Boxer, Hongjie Dai, Michael D. Fayer, Keith O. Hodgson, Chaitan Khosla, Eric T. Kool, Todd J. Martínez, W. E. Moerner, Vijay S. Pande, Edward I. Solomon, Barry M. Trost, Robert M. Waymouth, Paul A. Wender, Richard N. Zare

Associate Professors: Christopher E. D. Chidsey, Bianxiao Cui, Justin Du Bois, T. Daniel P. Stack

Assistant Professors: Noah Z. Burns, Lynette Cegelski, Matthew Kanan, Hemamala Karunadasa, Thomas E. Markland, Yan Xia

Courtesy Professors: Zhenan Bao, Stacey F. Bent, Karlene A. Cimprich, Curtis W. Frank, Daniel Herschlag

Courtesy Associate Professors: James K. Chen, Yi Cui, Jianghong Rao, Thomas J. Wandless

Lecturers: Charles Cox, Megan McClory, Jennifer Schwartz Poehlmann, Heidi Vollmer-Snarr