

# CHEMISTRY

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<http://www.pacific.edu/Academics/Schools-and-Colleges/College-of-the-Pacific/Academics/Departments-and-Programs/Chemistry.html>  
Phone: (209) 946-2271

Location: Classroom Building, South Campus  
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## Degrees Offered

Bachelor of Arts  
Bachelor of Science

## Majors Offered

Chemistry (BA, BS)  
Chemistry with Departmental Honors (BS)  
Biochemistry (BS)  
Biochemistry with Departmental Honors (BS)  
Pharmaceutical/Chemical Science (MS, PhD)

## Minors Offered

Chemistry

## Objective

An appreciation of the principles of chemistry is fundamental to understanding our daily lives and the future of our planet. Chemistry also serves as a foundation not only to industrial careers, but also to careers in the health sciences. The emphasis in all chemistry classes is to provide a thorough understanding of basic chemical concepts and to develop the competence in how to apply these concepts in a logical fashion to solve real world problems. Students can choose among a variety of degree programs designed to meet a range of career goals. The Chemistry Department has a long history of success in placing students into excellent medical, dental, pharmacy and graduate school programs. Students are also well prepared for rewarding careers in industry, government service and private business.

The Bachelor of Arts degree is designed to give students a broad understanding of chemistry for careers in health services and teaching.

The more rigorous Bachelor of Science degree prepares students for a variety of options including advanced degree studies in chemistry and biochemistry, professional schools of pharmacy, dentistry, and medicine as well as careers in the chemical industry. The Bachelor of Science Degrees in Chemistry are certified by the American Chemical Society (ACS). The BS Biochemistry program follows national guidelines and is aligned with pre-requisites for professional schools.

Virtually all Bachelor of Science and many Bachelor of Arts candidates choose undergraduate research as one of their chemistry electives. In this course, the student has the opportunity to use the modern instrumentation available in the department and to work closely with faculty and graduate students on an original research project.

The Master of Science and Doctor of Philosophy degrees are run jointly with the Pharmacy School as part of the Pharmaceutical and Chemical Sciences Program. Given an assistantship of tuition and a stipend, masters and doctoral graduate students teach lab courses as teaching assistants and conduct independent research projects directly with chemistry faculty.

## I. Critical Thinking/Analytical Skills

- Identify and apply relevant fundamental concepts to solve a variety of problems of different complexity.
- Analyze theories and methods for both strengths and weaknesses.
- Respond to analysis of one's own work, theories and/or methods.

## II. Laboratory and Research Skills

- Basic analytical and technical skills necessary to work effectively in fields of chemistry.
- Perform accurate quantitative measurements using modern chemical instrumentation. Interpret experimental results, perform calculations with these results, and draw reasonable scientific conclusions.
- Synthesize, separate, and characterize compounds using modern methodologies and techniques.
- Knowledge and understanding of safety: chemical regulations, laboratory safety, best/safe practices and chemical disposal.

## III. Quantitative Reasoning Skills

- Accurately collect and interpret numerical data.
- Solve problems competently using mathematical methods such as extrapolation, approximation, and limiting behavior, as well as understanding of concepts such as precision, accuracy, estimation, and statistical validity.
- Proficiency in the scientific method.

## IV. Knowledge of Chemical Facts and Information

- A working knowledge of the chemical principles appropriate for a degree in chemistry: thermodynamics, equilibrium, kinetics, quantum mechanics, structure of materials, reactivities, and synthesis.
- A broad set of chemical factual knowledge with respect to the properties of substances, molecules, atoms, and elements.

## V. Computer, Library and Information Skills

- Make effective use of the library and other information resources in chemistry. Understand the primary literature, tabulated data, and secondary sources (such as the Internet).
- Make effective use of chemical software applications including symbolic mathematics, chemical word processing, and data presentation/ interpretation software.
- Describe, perform, and interpret basic molecular modeling and quantum chemical calculations using common software packages.

## VI. Oral and Written Communication Skills

- Skill in technical writing and oral presentations, including electronic slideshows.
- Communicate chemical research and results in both oral and written formats to both technical and non-technical audiences.
  - Bachelor of Arts Major in Chemistry (p. 2)
  - Bachelor of Science Major in Chemistry (p. 2)
  - Bachelor of Science Major in Chemistry with Departmental Honors (p. 3)
  - Bachelor of Science Major in Biochemistry (p. 4)

- Bachelor of Science Major in Biochemistry with Departmental Honors (p. 5)

discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.)

## Bachelor of Arts Major in Chemistry

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 2.0 in order to earn the bachelor of arts degree with a major in chemistry.

### I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

#### A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

**Note: 1)** CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

#### B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

**Note: 1)** No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

#### C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

**Note: 1)** Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

#### D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

**Note: 1)** Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

## II. College of the Pacific BA Requirement

Students must complete one year of college instruction or equivalent training in a language other than English.

**Note: 1)** Transfer students with sophomore standing are exempt from this requirement.

## III. Breadth Requirement

Students must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that

## IV. Major Requirements

Minimum 54 units and 12 courses that include:

CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5
CHEM 141	Analytical Chemistry	4
One of the following courses:		4
CHEM 159	Biophysical Chemistry	
CHEM 161	Physical Chemistry -Thermodynamics and Kinetics	
CHEM 163	Theoretical Physical Chemistry	
CHEM 165	Physical Chemistry III-Kinetics	
CHEM Electives (2 additional courses that exclude CHEM 132 and CHEM 134)		8
One of the following groups:		10
Group A		
PHYS 023	General Physics I	
PHYS 025	General Physics II	
Group B		
PHYS 053	Principles of Physics I	
PHYS 055	Principles of Physics II	
MATH 051	Calculus I	4
MATH 053	Calculus II	4

**Note: 1)** At least 4 of your major required courses must be taken at Pacific.

## Bachelor of Science Major in Chemistry

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 2.0 in order to earn the bachelor of science degree with a major in chemistry.

### I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

#### A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

**Note: 1)** CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

#### B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry

Social Inquiry

World Perspectives & Ethics

**Note: 1)** No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

### C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

**Note: 1)** Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

### D. Fundamental Skills

Students must demonstrate competence in:

Writing

Quantitative Analysis (Math)

**Note: 1)** Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

## II. Breadth Requirement

Students must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.).

## III. Major Requirements

Minimum 74 units and 17 courses that include:

CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5
CHEM 141	Analytical Chemistry	4
CHEM 143	Instrumental Analysis Lab	4
CHEM 151	Biochemistry I	4
CHEM 161	Physical Chemistry -Thermodynamics and Kinetics	4
CHEM 171	Advanced Inorganic Chemistry	4
Two of the following courses:*		8
CHEM 153	Biochemistry II	
CHEM 158	Nucleic Acid Chemistry	
CHEM 163	Theoretical Physical Chemistry	
CHEM 167	Experimental Physical Chemistry	
Select one of the following:		4
CHEM 157	Biochemistry Laboratory	
CHEM 197	Independent Research	
PHYS 053	Principles of Physics I	5
PHYS 055	Principles of Physics II	5
MATH 051	Calculus I	4
MATH 053	Calculus II	4
Select one of the following: **		4
MATH 055	Calculus III	
MATH 057	Applied Differential Equations I: ODEs	
MATH 075	Introduction to Linear Algebra	

Note: 1) At least 4 of your major required courses must be taken at Pacific. 2) Students are strongly recommended to engage in undergraduate research as an elective.

\* One of the courses selected must be CHEM 163 or CHEM 167.

\*\* Any additional chemistry courses above CHEM 123, excluding CHEM 132, CHEM 134, and CHEM 195.

## Bachelor of Science Major in Chemistry with Departmental Honors

Students must complete a minimum of 120 units with a Pacific cumulative and major/program grade point average of 3.30 in order to earn the bachelor of science degree with a major in chemistry with departmental honors.

### I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

#### A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

**Note: 1)** CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

#### B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

**Note: 1)** No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

### C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

**Note: 1)** Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

### D. Fundamental Skills

Students must demonstrate competence in:

Writing

Quantitative Analysis (Math)

**Note: 1)** Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

## II. Breadth Requirement

Students must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that

discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.).

### III. Major Requirements

Minimum 74 units and 19 courses that include:

CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5
CHEM 141	Analytical Chemistry	4
CHEM 143	Instrumental Analysis Lab	4
CHEM 151	Biochemistry I	4
CHEM 161	Physical Chemistry -Thermodynamics and Kinetics	4
CHEM 171	Advanced Inorganic Chemistry	4
Two of the following courses:*		7
CHEM 153	Biochemistry II	
CHEM 158	Nucleic Acid Chemistry	
CHEM 163	Theoretical Physical Chemistry	
CHEM 167	Experimental Physical Chemistry	
PHYS 053	Principles of Physics I	5
PHYS 055	Principles of Physics II	5
MATH 051	Calculus I	4
MATH 053	Calculus II	4
Select one of the following or any additional chemistry course above CHEM 123: **		4
MATH 055	Calculus III	
MATH 057	Applied Differential Equations I: ODEs	
MATH 145	Applied Linear Algebra	
CHEM 195	Chemistry Department Seminars	1
CHEM 197	Independent Research	1-4

Note: 1) At least 4 of your major required courses must be taken at Pacific. 2) Students are strongly recommended to engage in undergraduate research as an elective.

\* One of the courses selected must be CHEM 163 or CHEM 167.

\*\* Any additional chemistry course above CHEM 123, excluding CHEM 132, CHEM 134, and CHEM 195.

\*\*\* Students must complete at least two semesters of CHEM 197. A written research thesis must be submitted, which will be read by the academic advisor and one other Chemistry faculty member. The thesis must be presented to the Department and defended.

## Bachelor of Science Major in Biochemistry

Students must complete a minimum of 120 credits with a Pacific cumulative and major/program grade point average of 2.0 in order to earn the bachelor of science degree with a major in biochemistry.

### I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

### A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

**Note: 1)** CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

### B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

**Note: 1)** No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

### C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

**Note: 1)** Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

### D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

**Note: 1)** Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

## II. Breadth Requirement

The student must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.)

## III. Major Requirements

Minimum 80 units and 18 courses that includes:

CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5
CHEM 151	Biochemistry I	4
CHEM 153	Biochemistry II	3
CHEM 157	Biochemistry Laboratory	4
BIOL 051	Principles of Biology	5
BIOL 061	Principles of Biology	5
Select one of the following groups:		10
Group A		
PHYS 023	General Physics I	
PHYS 025	General Physics II	
Group B		

PHYS 053	Principles of Physics I	
PHYS 055	Principles of Physics II	

Select one of the following tracks:

#### Conventional Track

CHEM Electives (3 course above CHEM 123 excluding CHEM 132, CHEM 134, CHEM 151, CHEM 153, CHEM 157, and CHEM 195) 12

BIOL Electives: Select two of the following: 8

BIOL 170	Human Anatomy	
BIOL 180	Human Physiology	
BIOL 101	Genetics	
BIOL 122	Principles of Immunology	
BIOL 124	Cancer Biology	
BIOL 126	Neurobiology	
BIOL 145	Microbiology	
BIOL 153	Cell Biology	

Math Courses: Select two of the following: 8

MATH 037	Introduction to Statistics and Probability	
MATH 041	Pre-calculus	
MATH 051	Calculus I	
MATH 053	Calculus II	

#### ACS Accredited Track

CHEM 141	Analytical Chemistry	4
CHEM 161	Physical Chemistry -Thermodynamics and Kinetics	4
CHEM 171	Advanced Inorganic Chemistry	4
MATH 051	Calculus I	4
MATH 053	Calculus II	4

Select one of the following: 4

CHEM 167	Experimental Physical Chemistry	
CHEM 197	Independent Research	

Select one of the following: 5

BIOL 101	Genetics	
BIOL 145	Microbiology	
BIOL 153	Cell Biology	

Note: 1) At least 4 of your major required courses must be taken at Pacific. 2) In addition, students are encouraged to complete at least one other course in biology and at least one semester of research.

**Note: 1)** At least 4 of your major required courses must be taken at Pacific. **2)** In addition, students are encouraged to complete at least one other course in biology and at least one semester of research.

## Bachelor of Science Major in Biochemistry with Departmental Honors

Students must complete a minimum of 120 credits with a Pacific cumulative and major/program grade point average of 3.30 in order to earn the bachelor of science degree with a major in biochemistry with departmental honors.

### I. General Education Requirements

For more details, see General Education (<https://catalog.pacific.edu/uop/generalinformation/generaleducation/>)

Minimum 28 units and 9 courses that include:

### A. CORE Seminars (2 courses)

CORE 001	Problem Solving & Oral Comm	3
CORE 002	Writing and Critical Thinking	4

**Note: 1)** CORE Seminars cannot be taken for Pass/No Credit. **2)** Transfer students with 28 or more transfer credits taken after high school are exempt from both CORE seminars.

### B. Breadth Requirement (7 courses, at least 3 units each)

At least one course from each of the following areas:

Artistic Process & Creation
Civic & Global Responsibility
Language & Narratives
Quantitative Reasoning
Scientific Inquiry
Social Inquiry
World Perspectives & Ethics

**Note: 1)** No more than 2 courses from a single discipline can be used to meet the Breadth Requirement.

### C. Diversity and Inclusion Requirement

All students must complete Diversity and Inclusion coursework (at least 3 units)

**Note: 1)** Diversity and Inclusion courses can also be used to meet the breadth category requirements, or major or minor requirements.

### D. Fundamental Skills

Students must demonstrate competence in:

Writing
Quantitative Analysis (Math)

**Note: 1)** Failure to satisfy the fundamental skills requirements by the end of four semesters of full-time study at the University is grounds for academic disqualification.

## II. Breadth Requirement

The student must complete 60 units outside the primary discipline of the first major, regardless of the department who offers the course(s) in that discipline. (This includes general education courses, transfer courses, CPCE/EXTN units, internships, etc.)

## III. Major Requirements

Minimum 80 units and 20 courses that includes:

CHEM 025	General Chemistry	5
CHEM 027	General Chemistry	5
CHEM 121	Organic Chemistry	5
CHEM 123	Organic Chemistry	5
CHEM 151	Biochemistry I	4
CHEM 153	Biochemistry II	3
CHEM 157	Biochemistry Laboratory	4
BIOL 051	Principles of Biology	5
BIOL 061	Principles of Biology	5
Select one of the following groups:		10
Group A		
PHYS 023	General Physics I	
PHYS 025	General Physics II	
Group B		

PHYS 053	Principles of Physics I	
PHYS 055	Principles of Physics II	
CHEM 195	Chemistry Department Seminars	1
CHEM 197	Independent Research	1-4

**Select one of the following tracks:**

**Conventional Track**

CHEM Electives (3 course above CHEM 123 excluding CHEM 132, CHEM 134, CHEM 151, CHEM 153, CHEM 157, and CHEM 195) 12

BIOL Electives: Select two of the following: 8

BIOL 170	Human Anatomy	
BIOL 180	Human Physiology	
BIOL 101	Genetics	
BIOL 122	Principles of Immunology	
BIOL 124	Cancer Biology	
BIOL 126	Neurobiology	
BIOL 145	Microbiology	
BIOL 153	Cell Biology	

Math Courses: Select two of the following: 8

MATH 037	Introduction to Statistics and Probability	
MATH 041	Pre-calculus	
MATH 051	Calculus I	
MATH 053	Calculus II	

**ACS Accredited Track**

CHEM 141	Analytical Chemistry	4
CHEM 161	Physical Chemistry -Thermodynamics and Kinetics	4
CHEM 171	Advanced Inorganic Chemistry	4
MATH 051	Calculus I	4
MATH 053	Calculus II	4

Select one of the following: 4

CHEM 167	Experimental Physical Chemistry	
CHEM 197	Independent Research	

Select one of the following: 5

BIOL 101	Genetics	
BIOL 145	Microbiology	
BIOL 153	Cell Biology	

\* Students must complete at least two semesters of CHEM 197. A written research thesis must be submitted, which will be read by the academic advisor and one other Chemistry faculty member. The thesis must be presented to the Department and defended.

**Note: 1)** At least 4 of your major required courses must be taken at Pacific. **2)** In addition, students are encouraged to complete at least one other course in biology and at least one semester of research.

## Programs Offered

**Master of Science in Pharmaceutical and Chemical Sciences**  
**Doctor of Philosophy in Pharmaceutical and Chemical Sciences**

Specialized Areas in Chemistry (2): 1) Bioanalytical/Physical Chemistry and Biochemistry and 2) Chemical Synthesis and Drug Design/Discovery

For detailed program information for these degrees please consult the Thomas J. Long School of Pharmacy (<https://catalog.pacific.edu/uop/thethomasjlongschoolofpharmacy/>)

pharmaceuticalandchemicalsciences/#programtext) section in this catalog.

## Chemistry Courses

**CHEM 015. Chemistry in Society. 3 Units.**

A survey of the fundamentals of Chemistry in the context of everyday situations or problems. The course is designed for non-science majors to learn the fundamentals of chemistry as they relate to our everyday lives, to build scientific literacy, and to improve quantitative reasoning and technical writing skills. The course surveys basic chemical concepts and models, in the context of Chemistry's role in Society. Topics related to energy, environment, health, and food are discussed. The course is intended for students with no college-level background in Chemistry. Prerequisites: Unavailable for students who already took CHEM23 or higher. **(GE3A, GESI)**

**CHEM 023. Elements of Chemistry. 4 Units.**

This course is designed for general interest in physical science and for preparation for further study in chemistry. Three class periods, one three-hour laboratory period a week, and enrollment in the Chemistry Workshop are required. Prerequisite: MATH 005 or demonstration of equivalent proficiency on Math Placement Test. May be taken concurrently. **(GE3A, GESI)**

**CHEM 024. Fundamentals of Chem. 4 Units.**

This course covers general chemistry especially tailored for engineers and earth scientists. Important principles, theories and concepts include: stoichiometry, atomic and molecular structure, equilibrium, gases, thermodynamics, kinetic, electrochemistry and nuclear chemistry. Three lecture periods and one three-hour lab are required. Prerequisites: High school algebra or the equivalent, one year of high school chemistry with a "B" or better, or appropriate score on the Pacific Diagnostic Chemistry test or CHEM 023. **(GE3A, GESI)**

**CHEM 025. General Chemistry. 5 Units.**

The important general principles, theories and concepts of chemistry are studied, including fundamentals of chemistry and equilibrium. Three class periods, two three-hour laboratory periods a week, and enrollment in the Chemistry Workshop are required. Prerequisites: CHEM 023 with a "C-" or better, Chemistry Subject Test, or appropriate score on Pacific Diagnostic Chemistry test. High school chemistry is highly recommended. High school algebra or the equivalent. MATH 005 with a "C-" or better or appropriate score on Pacific Diagnostic Math test. **(GESI)**

**CHEM 026. Applied General Chemistry I. 4 Units.**

In this first semester of the General Chemistry sequence, stoichiometry, chemical reactions, gas properties, equilibrium, and thermodynamics are covered, along with a synthesis of these concepts in the topic of electrochemistry. Lecture meets for three hours per week, and there is one three-hour laboratory period per week. Enrollment is limited to undergraduates in the Pre-Pharmacy Advantage Program. High school chemistry is highly recommended. Prerequisites: CHEM 023 with a "C" or better, Chemistry Subject Test, or appropriate score on Pacific Diagnostic Chemistry test.

**CHEM 027. General Chemistry. 5 Units.**

More important general principles, theories, and concepts of chemistry are studied including modern applications of quantum mechanics, bonding, chemical kinetics, liquids, solids, and properties of solutions. Additional special topics include coordination compounds, nuclear chemistry, organic chemistry and biochemistry. Three class periods, two three-hour laboratory periods a week, and enrollment in the Chemistry Workshop are required. At least one year of high school chemistry is highly recommended. Prerequisite: CHEM 025 with a "C-" or better, Chemistry Subject Test, or appropriate score on Pacific Diagnostic Chemistry test.

**CHEM 028. Applied General Chemistry II. 4 Units.**

In this second semester of the General Chemistry sequence, molecular quantum mechanics, bonding, chemical kinetics, and the natures of liquids, solids, and solutions are covered, along with the special topics of coordination compounds, nuclear chemistry, organic chemistry, and biochemistry. Lecture meets for three hours per week, and there is one three-hour laboratory period per week. Prerequisites: CHEM 026 with a "C" or better, or CHEM 025 with a "C" or better. Enrollment is limited to undergraduates in the Pre-Pharmacy Advantage Program.

**CHEM 033. Elements of Organic Chemistry. 3 Units.**

This is an introductory course for students who do not major in the chemistry or biological sciences, but whose main interest - dental hygiene, medical technology, nursing, nutrition, pharmacy technician, and more - requires some knowledge of organic chemistry. The course provides familiarity with nomenclature and functional groups with special emphasis on practical applications of organic chemistry to everyday life and to biological processes. Does not count towards a major in Chemistry or Biological Sciences. Course is required for Dental Hygiene Program. Prerequisites: CHEM 025 and CHEM 027 with a "C-" or better.

**CHEM 035. Organic Chemistry Primer. 3 Units.**

This course is designed to prepare students for a regular one year course in Organic Chemistry. It links and applies the concepts learned in General Chemistry to organic systems, provides familiarity with Organic Chemistry nomenclature and functional groups, emphasizes pattern recognition and introduces basic elements of reaction mechanisms. The course fulfills the Organic Chemistry requirements of the Dental Hygiene program. ONLINE. Prerequisite: CHEM 027 with a "C-" or better.

**CHEM 093. Special Topics. 3 or 4 Units.****CHEM 121. Organic Chemistry. 5 Units.**

An Introduction to the fundamental principles of organic chemistry including molecular structure, chemical bonding, functional groups, nomenclature, stereochemistry, basic organic reactions, and modern spectroscopy for structural characterization. Three lecture periods and two three-hour laboratory periods per week are required. Prerequisites: CHEM 025 and CHEM 027 with a "C-" or better.

**CHEM 122. Applied Organic Chemistry I. 4 Units.**

Applied Organic Chemistry I is an introduction to the fundamental principles of organic chemistry, including molecular structure, chemical bonding, functional groups, nomenclature, stereochemistry, basic organic reactions, and modern spectroscopy for structural characterization. It is a foundation of pharmaceutical science, biochemistry, nanotechnology, and material science, etc. It is intended for pre-health students. The lecture will highlight the key information of organic chemistry and will provide materials that complement and exceed the textbook. Three lecture periods and one three-hour laboratory period per week are required. Prerequisites: Both CHEM 026 and CHEM 028 with a "C" or better, or both CHEM 025 and CHEM 027 with a "C-" or better. Enrollment is limited to undergraduates in the Pre-Pharmacy Advantage Program.

**CHEM 123. Organic Chemistry. 5 Units.**

This course is a continuation of CHEM 121 with an emphasis on organic synthesis and mechanisms. The reactions of the aromatics, aldehydes, ketones, amines, carboxylic acids and their derivatives, and carbohydrates are covered. The course also touches on polymers and biological molecules including amino acids, proteins, and nucleic acids. Three lecture periods and two three-hour laboratory periods per week and are required. Prerequisite: CHEM 121 with a "C-" or better.

**CHEM 124. Applied Organic Chemistry II. 4 Units.**

Applied Organic Chemistry II is a continuation of Applied Organic Chemistry I with an emphasis on organic synthesis and mechanisms. The reactions of aromatics, aldehydes, ketones, amines, carboxylic acids and their derivatives, and carbohydrates are covered. The course also touches on polymers and biological molecules including amino acids, proteins, and nucleic acids. Three lecture periods and one three-hour laboratory periods per week are required. Prerequisites: CHEM 122 with "C" or better, or CHEM 121 with "C" or better. Enrollment is limited to undergraduates in the Pre-Pharmacy Advantage Program.

**CHEM 132. Teaching and Learning Chemistry. 2 Units.**

Students are prepared for participation in peer-led team-learning (PLTL) models of instruction in this course and it provides the opportunity for the students to become student leaders. In the PLTL, or General Chemistry Workshops, a small group of students get together under the guidance of the trained student leaders and work through a set of challenging problems prepared by the instructor of the course. The main idea is for all the students in the group to work together and gain experience and confidence solving challenging problems as a group. The Workshop provides an active teaching and learning experience. This course can be taken multiple times. Prerequisites: CHEM 025 and CHEM 027 with a "B" or better and permission of the instructor.

**CHEM 134. Teaching and Learning Organic Chemistry. 2 Units.**

Students are introduced to the learning and leadership model, Peer-Led Team Learning (PLTL). The student will gain hands-on experience in leading small discussion groups in organic chemistry. Instructor-covered topics in organic chemistry include specific instructions regarding the workshop lessons, strategies in guided problem solving for the groups, and review of organic chemistry materials. Instructor-covered topics in the didactic portion of the course include, but are not limited to, practical information (understanding motivation, managing time, dealing with dominating students, learning styles, group dynamics, study skills, helping students improve critical thinking, develop logical reasoning, and prepare for tests), and a foundation in learning theory. Prerequisites: CHEM 025 and CHEM 027 with "C-" or better, CHEM 121 and CHEM 123 with "B" or better and permission of instructor.

**CHEM 141. Analytical Chemistry. 4 Units.**

The roots of analytical chemistry and the principles used in modern instruments come from traditional techniques. These techniques include gravimetry, acid-base, complexometric, and redox titrations form the backbone of the course, which covers most major areas of modern quantitative analysis. The theory behind the techniques is covered through many numerical examples and their applications in environmental and biochemical analyses are emphasized. Standard procedures used in analytical laboratories are introduced, including error reporting, statistics, and quality assurance. Prerequisites: CHEM 025 and CHEM 027 or GEOS 142 with a "C-" or better.

**CHEM 143. Instrumental Analysis Lab. 4 Units.**

Advanced analytical methodology involving electronic instrumentation is offered with emphasis on practical application and "hands-on" experience. The theory of instrumental operation is covered. Examples from modern spectroscopy, mass spectrometry, NMR, chromatography and other methods of analysis are included. Prerequisite: CHEM 141 with a "C-" or better or permission of the instructor.

**CHEM 151. Biochemistry I. 4 Units.**

This is the first semester of a 2 semester survey of biochemistry. The fundamental building blocks of biochemical systems are introduced covering amino acids and proteins (enzymatic & structural), nucleic acids, lipids and membranes, and carbohydrates. Particular topics of oxygen transport, enzyme kinetics, DNA replication, RNA expression, and protein expression are gone over in detail. Prerequisites: CHEM 121 and CHEM 123; CHEM 159 or CHEM 161 all with a "C-" or better; or permission of instructor.

**CHEM 153. Biochemistry II. 3 Units.**

As the second semester in this biochemistry series, the detailed biochemical mechanisms of the major metabolic pathways are covered. These pathways include glycolysis, gluconeogenesis, citric acid cycle, electron transport/oxidative phosphorylation, photosynthesis/Calvin cycle, lipid metabolism/fatty acid catabolism, and the synthesis/degradation of amino and nucleic acids. Discussion centers on the enzymatic mechanisms, energy, reduction/oxidation, control/regulation, and integration of these pathways. Prerequisite: CHEM 151 with a "C-" or better or permission of instructor.

**CHEM 157. Biochemistry Laboratory. 4 Units.**

Standard techniques used in Biochemistry. Exercises focus on the expression, mutation, and purification of a protein target and involves the following techniques: site-directed mutagenesis, column chromatography, electrophoresis, nucleic acid isolation and manipulation/use of relevant databases. Prerequisite: CHEM 151 or BIOL 169 with a "C-" or better; or permission of instructor.

**CHEM 158. Nucleic Acid Chemistry. 4 Units.**

This course surveys fundamental and advanced knowledge and current biotechnological applications in nucleic acid chemistry. Students completing this course will be able to improve critical thinking skills, oral communication, and technical writing skills. Topics related to structures of DNA and RNA, synthesis of DNA using an automated method, small molecule and nucleic acid interactions, DNA damage and repair, representative anticancer drugs, and nucleic acids used in real-life applications are discussed. Prerequisites: CHEM 121 and CHEM 123 with a grade of C- or better or instructor approval.

**CHEM 159. Biophysical Chemistry. 4 Units.**

This course applies the approaches and concepts of physical chemistry to describe the reactions and phenomena in biological systems. The principles of thermodynamics, kinetics, spectroscopy and transport phenomena are covered. While this is not a mathematic intensive course, the concepts require a basic knowledge of calculus. Prerequisites: MATH 051, CHEM 025, CHEM 027, PHYS 055 all with a "C-" or better or permission of instructor.

**CHEM 161. Physical Chemistry -Thermodynamics and Kinetics. 4 Units.**

A classical course on equilibrium thermodynamics and kinetics, including the laws of thermodynamics, the Gibbs equations, the phase rule, solutions, chemical reactions, non-ideal systems, multi-component phase equilibrium, equilibrium electrochemistry, kinetics, molecular dynamics and transport properties. Three class periods a week are required. Prerequisites: CHEM 027, MATH 053, PHYS 053 all with a "C-" or better, or permission of instructor. Students may not receive credit for both CHEM 159 and CHEM 161.

**CHEM 163. Theoretical Physical Chemistry. 4 Units.**

This course covers the principles of quantum theory, atomic structure and spectra, bonding, molecular spectroscopy, the foundations of statistical mechanics, the use of partition functions, the connection between statistical ensembles and thermodynamic potentials, and statistical models of gases, solids and liquids. This 4-unit course requires three 1-hour class periods and one 3-hour laboratory each week, accompanied by substantial out-of-class exercises. Prerequisites: CHEM 161 or CHEM 159, MATH 055, and PHYS 053, all with a C- or better, or permission of the instructor.

**CHEM 165. Physical Chemistry III-Kinetics. 4 Units.**

The fundamental principles of Chemical Kinetics are introduced in this course which covers: kinetic molecular theory of gases, rates of chemical reactions, rate laws, collision theory and chemical dynamics. Selected applications include photochemistry, catalysis, enzyme kinetics, pharmacodynamics, electrochemical systems, transport properties, viscosity, diffusion, and sedimentation. Prerequisites: CHEM 025, CHEM 027, MATH 053 or MATH 055, PHYS 053 or PHYS 055 or permission of instructor.

**CHEM 167. Experimental Physical Chemistry. 4 Units.**

This course introduces the principles and practice of physical chemical measurements. Techniques used in the design and construction of apparatus are discussed in lectures, and practice is provided through lab exercises and experiments. Subjects covered include kinetic theory of gases, reaction kinetics, thermodynamics, thermochemistry, and various flavors of spectroscopy. Research orientation is provided through the preparation of article manuscripts and oral presentations of results. Error analysis and statistical treatment of experimental data are emphasized. Prerequisite: CHEM 159 or CHEM 161 with a "C-" or better.

**CHEM 171. Advanced Inorganic Chemistry. 4 Units.**

This course includes: atomic structure, periodicity, covalent bonding theory, molecular geometry and symmetry, molecular orbital theory and its applications. Also covers coordination and organometallic chemistry, ligand field theory, spectroscopy, structure, reaction mechanisms, introduction to bioinorganic chemistry and metals in medicine. Two class periods and four hours of laboratory per week are required. Prerequisite: CHEM 163 with a "C-" or better or permission of the instructor.

**CHEM 173. Enzymology. 4 Units.**

The goal of this course in enzymology is to provide students with an introduction to the mechanisms used by enzymes to achieve catalysis and the methods used to study these enzyme mechanisms. This will be accomplished by reading the primary literature, creating presentations, and discussions of these papers. A secondary goal is to also understand the implementation and limitations of these methods characterizing enzyme mechanisms. Prerequisites: CHEM 123.

**CHEM 181. Intro to Molecular Simulation. 4 Units.**

This course enables chemistry and other science students to utilize computational tools for molecular simulation. Students who complete this class are able to understand the theory behind molecular dynamics and force-fields. In addition, students construct and execute molecular simulations using standard tools such as CHARMM, NAMD, VMD and GAUSSIAN. Students then demonstrate an ability to analyze and present the data obtained from such simulations. Prerequisites: CHEM 025 and CHEM 027 with a grade of "C-" or better and permission of instructor.

**CHEM 191. Independent Study. 2-4 Units.**

**CHEM 193. Special Topics. 4 Units.**

**CHEM 195. Chemistry Department Seminars. 1 Unit.**

The Department hosts a series of research seminars in which internationally recognized scientists present their latest research to an audience of Chemistry Faculty, graduate students, and Chemistry/Biochemistry undergraduate students. The selection of the speakers and the talks is designed to display a cross-section of current research trends, with talks representing each significant sub-discipline within Chemistry. Restriction on registration: Honors Students Only. Prerequisite: Permission of instructor.

**CHEM 197. Independent Research. 1-4 Units.**

Prerequisite: CHEM 025 with a "C-" or better.

**CHEM 197D. Independent Research. 1-4 Units.**

**CHEM 197E. Independent Research. 1-4 Units.**

**CHEM 197F. Independent Research. 1-4 Units.**

**CHEM 197G. Independent Research. 1-4 Units.**

**CHEM 197H. Independent Research. 2-4 Units.**

**CHEM 234. Selected Topics: Organic Chemistry. 4 Units.**

Topics presented at various times under this course description include physical organic, natural products and structure elucidation, stereochemistry, heterocycles and carbohydrate chemistry.

**CHEM 243. Advanced Instrumental Analysis Lab. 4 Units.**

Comprehensive investigation of absorption, emission, partition and electrical methods of chemical analysis. Theoretical basis and practical experience are combined in a total course. Some background in elementary optics and electronics useful but not required.

**CHEM 245. Advanced Instrumental Methods. 4 Units.**

Team-taught course. Students select from a number of instrumental projects, including: FTNMR, GC-mass spectrometry, advanced electrochemical techniques, high pressure liquid chromatography, photochemistry, fluorescence and phosphorescence and radioimmunoassay.

**CHEM 264. Selected Topics - Physical Chemistry. 4 Units.**

Topics presented at various times under this course description include: advanced thermodynamics, statistical mechanics, physical chemistry of solutions, physical methods in chemistry, photoluminescence and molecular photochemistry, and advanced kinetics. Permission of the instructor required.

**CHEM 271. Advanced Inorganic/Bioinorganic Chemistry. 4 Units.**

Review of basic concepts; descriptive transition metal chemistry; studies in main group and coordination chemistry; inorganic chemistry in biological systems; organometallic systems. Permission of the instructor required.

**CHEM 274. Selected Topics - Inorganic Chemistry. 4 Units.**

Topics presented at various times under this course description include: mechanisms of inorganic reactions, bonding theory, physical methods, nuclear chemistry and geochemistry.

**CHEM 291. Independent Study. 2-4 Units.**

**CHEM 293. Special Topics. 3 or 4 Units.**

**CHEM 295. Graduate Seminar. 2 Units.**

**CHEM 297. Graduate Research. 1-4 Units.**

**CHEM 299. Thesis. 1-4 Units.**

**CHEM 381. Apprentice Teaching. 1-4 Units.**

**CHEM 391. Independent Study. 2-4 Units.**

**CHEM 395. Tchg. Sem. in the Clg. Chem.. 2 Units.**

**CHEM 397. Graduate Research. 1-6 Units.**

**CHEM 397A. Graduate Research. 1-4 Units.**

**CHEM 399. Dissertation. 1-6 Units.**

**CHEM XXX. Chemistry-General Education. 0 Units.**

General Education Chemistry course for new freshmen. Selection of this course on the Registration Choices Worksheet indicates your interest in taking a general education Chemistry course during your first term. The appropriate Chemistry course will be scheduled based on your Chemistry placement test results.