

## Chemistry

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Chemistry involves the study of matter at the atomic and molecular level. Concepts and tools of chemistry are used to study the composition, structure, reactivity and energy changes of materials in the world around us. At PLU, students will find a chemistry program that supports their interests, whether in the chemistry of natural products, the environment, biological systems, polymers, or inorganic compounds, and that supports their educational goals, whether toward graduate study, the medical and health professions, biotechnology, education, business, or as a complement to other studies in the natural sciences, humanities, or social sciences. For good reason, chemistry is often called “the central science.”

The chemistry department's courses, curriculum, faculty, and facilities are approved by the American Chemical Society.

Students have hands-on use of sophisticated instrumentation in coursework and research with faculty, including 500 MHz Fourier transform nuclear magnetic resonance (FTNMR) spectroscopy, atomic force microscopy (AFM), inductively coupled plasma atomic emission spectroscopy (ICP AES), spectrofluorometry, differential scanning calorimetry (DSC), Fourier transform infrared (FTIR) and Raman spectroscopy, laser light scattering instrumentation, gas chromatography with mass selective detection (GCMS), high performance liquid chromatography (HPLC), and Linux workstations for molecular modeling and computational chemistry.

Faculty research projects involve undergraduate participation.

**Faculty:** Fryhle, *Chair*; Lytle, Naasz, Rink, Swank, Tonn, Waldow, Yakelis.

### CHEMISTRY MAJOR DECLARATION PROCESS

- Consultation with chemistry faculty member required
- Declare major early and preferably by completion of CHEM 331
- Transfer students must consult with a department advisor no later than the start of the junior year
- A minimum grade of C- in all courses required by the major; overall chemistry GPA of 2.00 or higher.
- A minimum grade of C in courses required by the minor
- Department Honors requires a 3.50 overall GPA in the major; overall GPA of 2.00 or higher.

### FOUNDATION COURSES REQUIRED FOR ALL CHEMISTRY MAJORS

47 semester hours

- **Chemistry Courses** - 29 semester hours  
CHEM 115, 116, 320, 331, 332, 333, 334 (or 336), 341, 343, 499
- **Additional Courses** - 18 semester hours  
MATH 151, 152  
PHYS 153, 154, 163, 164

### BACHELOR OF ARTS MAJOR

Four semester hours beyond the Foundation

Required Foundation Courses listed above

47 semester hours, plus CHEM 342

### BACHELOR OF SCIENCE MAJOR

Three Emphasis Areas

- **General Emphasis**  
**14 semester hours beyond the Foundation.** The General emphasis leads to American Chemical Society Certification which requires CHEM 450 and either CHEM 405, 440 or 456.

#### Required Foundation Courses

47 semester hours, plus:

CHEM 342, 344

CHEM 405 or 450 or 456; CHEM 410, 420

- **Biochemistry Emphasis**

**29 semester hours beyond the Foundation.** The B.S. in Biology with Biochemistry is often done as a double-major with Chemistry.

#### Required Foundation Courses

47 semester hours, plus:

CHEM 403, 405, 410, 420

BIOL 125, 126

Four semester hours from CHEM 342 or BIOL 328, 332, 364, 407, 441 or 448

American Chemical Certification for Biochemistry requires CHEM 342 and 450.

- **Chemistry-Physics Emphasis**

**26 semester hours beyond the Foundation**

#### Required Foundation Courses

47 semester hours, plus:

CHEM 342, 344

MATH 253

PHYS 331, 332, 336, 356

### B.S. DEGREE: GENERALIZED CHEMISTRY CURRICULUM

#### FIRST YEAR

<i>Fall Semester</i>	<i>Spring Semester</i>
CHEM 115	CHEM 116
Freshman Inquiry or Writing Seminar (and/or BIOL 125 for students interested in B.S. in Chemistry, Biochemistry Emphasis)	Freshman Inquiry or Writing Seminar and/or BIOL 126
MATH 151	MATH 152
PHED 100 or other activity course	PHED 100 or other activity course
GUR	

#### SECOND YEAR

<i>Fall Semester</i>	<i>Spring Semester</i>
CHEM 331, 333	CHEM 332, 334 (or 336), 320, 410

BIOL 323 (if B.S. in Chemistry, with Biochemistry Emphasis)	PHYS 153, 163
Two additional courses	GUR elective(s)

**THIRD YEAR**

<i>Fall Term</i>	<i>Spring Term</i>
CHEM 341, 343	CHEM 342, 344
PHYS 154, 164	CHEM 320, if not taken in second year
GUR elective(s)	GUR elective(s)
Elective	Elective

**FOURTH YEAR**

<i>Fall Semester</i>	<i>Spring Semester</i>
CHEM 403, 499	CHEM 405 (for Biochemistry Emphasis), 420, 499
Electives	Electives

**Alternate Year Advanced Courses**

In the third or fourth year, B.S. students enroll in CHEM 450 (required for all ACS Certification options) and either 440, 456 (or 405 in Spring Term after 403).

Refer to the Division of Natural Sciences section of this catalog for other beginning curriculum options. See page 85.

Students interested in the Bachelor of Science with Biochemistry Emphasis should start biology in the fall of the first or second year. Physics should be started in either the first or the second year, so as to prepare students for upper-division chemistry courses.

**Departmental Honors**

In recognition of outstanding work the designation of Departmental Honors may be granted to Bachelor of Science graduates by vote of the faculty of the chemistry department, based on the student's performance in the following areas:

- **Course Work:** A minimum 3.50 grade point average in all chemistry courses.
- **Written Work:** At time of declaration of the chemistry major, all copies of outstanding work (e.g., laboratory, seminar and research projects) need to be maintained by the student for later faculty evaluation for departmental honors.
- **Oral Communication:** Students must evidence ability to communicate effectively as indicated by the sum of their participation in class discussion, seminars, help session leadership, and teaching assistantship work.
- **Independent chemistry-related activities:** Positive considerations include the extent and quality of extracurricular work done in background reading, independent study, and research; assisting in laboratory preparation, teaching, or advising; any other chemistry-related employment, on campus or elsewhere; and participation in campus and professional chemistry-related organizations.

The departmental honors designation will appear on the transcript of a student graduating with a chemistry major.

**BACHELOR OF ARTS IN EDUCATION**

Students interested in a high school chemistry teaching endorsement should plan to complete a B.A. or B.S. in Chemistry. The degree program is developed through the chemistry department in conjunction with the Department of Instructional Development and Leadership. See page 69 for details.

**CHEMICAL ENGINEERING**

Students interested in pursuing studies in chemical engineering should see the course outline in the Engineering Dual-Degree section of this catalog. The department chair should be consulted for assignment of a program advisor.

**MINOR****22 semester hours**

- CHEM 115, 116
- CHEM 320, 331, 332, 333, 334 (or 336) completed with grades of C or higher.

Prerequisite and co-requisite requirements are strictly enforced.

To view Chemistry (CHEM) courses, see the PLU Directory of Approved Courses beginning on page 161.

**Chinese**

To view curriculum requirements, please go to Department of Languages & Literature, page 75.

To view Chinese Language (CHIN) courses, go to the PLU Directory of Approved Courses, page 163.

**Chinese Studies Program**

253.535.7216  
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The Chinese Studies program is an interdisciplinary program which is designed to provide students interested in China a broad foundation in Chinese language, culture, and history, and an opportunity to focus on the cultural-philosophical world view and the economic and business structure of China. The program requires that major and minor students complete coursework in at least three different disciplines: Chinese language, history, and anthropology, with optional work in political science, the arts, religion, business, and other disciplines.

Students are strongly encouraged to participate in the university's China exchange programs (currently at Sichuan University) and may request that credits earned through these programs be counted toward the major or minor. With the approval of the program director, selected January-term, summer, and experimental courses may be included in the major or minor.

**Faculty:** A committee of faculty administers this program: Manfredi, Chair; Barnowe, Byrnes, Cathcart, Dwyer-Shick, Guldin, Li, Youtz. Mr. Sidney Rittenberg serves as honorary advisor.

### ***BUSA 595: Internship***

Application of business knowledge in field setting. Credit granted determined by hours spent in working environment and depth of project associated with course of study. Pass/fail. (1-4)

## **Chemistry (CHEM)**

Term	Courses
Fall	CHEM 104, 115, 331, 333, 341 343, 403, 499
Spring	CHEM 105, 116, 320, 332, 334 (or 336), 343, 344, 405, 410, 420, 499
Alternate Years	CHEM 440 (J Term), 450 (Spring Term), 456 (J Term)

### ***CHEM 104: Environmental Chemistry – NS, SM***

Basic principles of chemistry and reactions, with applications to human activities and the natural environment. No prerequisite; students without high school chemistry are encouraged to take CHEM 104 before taking CHEM 105 or CHEM 115. Also suitable for environmental studies, general science teachers, B.A. in geosciences, and general university core requirements. (4)

### ***CHEM 105: Chemistry of Life – NS, SM***

Basic organic and biochemistry applied to chemical processes in human systems; suitable for liberal arts students, nursing students, physical education majors, and prospective teachers. Students who have not completed high school chemistry recently should take CHEM 104 before taking CHEM 105. (4)

### ***CHEM 115: General Chemistry I – NS, SM***

Topics explored include the structure of matter, nomenclature, atomic and molecular theory, periodic relationships, states of matter, quantitative relationships, and thermochemistry. The course includes laboratory experiences that take place in the Open laboratory and a weekly discussion section. **Prerequisite:** One year of high school chemistry. **Co-requisite:** MATH 140 or Math Placement in MATH 151 or higher. (4)

### ***CHEM 116: General Chemistry II – NS, SM***

Introduces students to chemical kinetics, chemical equilibrium, acid-base chemistry thermodynamics, electrochemistry, chemistry of the elements, and coordination compounds. The course includes laboratory experiences that take place in the Open laboratory and a weekly discussion section.

**Prerequisites:** MATH 140 or higher and CHEM 115. (4)

### ***CHEM 320: Analytical Chemistry***

Chemical methods of quantitative analysis, including volumetric, gravimetric, and selected instrumental methods. Includes laboratory. **Prerequisites:** CHEM 116; MATH 140. (4)

### ***CHEM 331: Organic Chemistry I***

An introduction to structure, reactivity, and general properties of organic molecules. **Prerequisite:** CHEM 116.

**Co-requisite:** CHEM 333. (4)

### ***CHEM 332: Organic Chemistry II***

Chemistry of aromatic compounds, carbonyl-containing functional groups, amines, phenols, and an introduction to biologically important molecules. **Prerequisites:** CHEM 331, 333. **Co-requisite:** CHEM 334 or 336. (4)

### ***CHEM 333: Organic Chemistry I Laboratory***

Reactions and methods of synthesis, separation, and analysis of organic compounds. Microscale techniques. Practical investigation of reactions and classes of compounds discussed in CHEM 331. **Co-requisite:** CHEM 331. (1)

### ***CHEM 334: Organic Chemistry II Laboratory***

Synthesis of organic compounds, including instrumental and spectroscopic analysis. Practical investigation of reactions and classes of compounds discussed in CHEM 332. **Prerequisite:** CHEM 333. **Co-requisite:** CHEM 332. (1)

### ***CHEM 336: Organic Special Projects Laboratory***

Individual projects emphasizing current professional-level methods of synthesis and property determination of organic compounds. This course is an alternative to CHEM 334 and typically requires somewhat more time commitment. Students who wish to prepare for careers in chemistry or related areas should apply for departmental approval of their admission to this course. **Co-requisite:** CHEM 332. (1)



***CHEM 341: Physical Chemistry***

A study of the relationship between the energy content of systems, work, and the physical and chemical properties of matter. Classical and statistical thermodynamics, thermochemistry, solution properties, phase equilibria, and chemical kinetics.

**Prerequisites:** CHEM 116, MATH 152, PHYS 154. (4)

***CHEM 342: Physical Chemistry***

A study of the physical properties of atoms, molecules and ions, and their correlation with structure. Classical and modern quantum mechanics, bonding theory, atomic and molecular structure, spectroscopy.

**Prerequisites:** CHEM 116, MATH 152, PHYS 154. (4)

***CHEM 343: Physical Chemistry Laboratory***

Experiments in kinetics and thermodynamics. Attention given to data handling, error analysis, instrumentation, computational analysis, and correlation with theory.

**Prerequisite or co-requisite:** CHEM 341. (1)

***CHEM 344: Physical Chemistry Laboratory***

Experiments in molecular structure and spectroscopy. Attention given to data handling, error analysis, instrumentation, computational analysis, and correlation with theory.

**Prerequisite or co-requisite:** CHEM 342. (1)

***CHEM 403: Biochemistry I***

An overview of the structures, function, and regulation of proteins, carbohydrates, lipids, and nucleic acids, and an introduction to metabolic and regulatory cellular processes. Majors are encouraged to take both CHEM 403 and 405 for a comprehensive exposure to biochemical theory and techniques.

**Prerequisites:** CHEM 332, 334. (4)

***CHEM 405: Biochemistry II***

A continuation of 403 that provides further insight into cellular metabolism and regulation, enzyme kinetics and mechanisms of catalysis, protein synthesis, nucleic acid chemistry, and biotechnology. Concepts introduced in Physical Chemistry and Biochemistry I will be applied to this course. Laboratory designed to stimulate creativity and problem-solving abilities through the use of modern biochemical techniques.

**Prerequisite:** CHEM 403. (3)

***CHEM 410: Introduction to Research***

An introduction to laboratory research techniques, use of the chemical literature, including computerized literature searching, research proposal and report writing. Students develop an independent chemical research problem chosen in consultation with a member of the chemistry faculty. Students attend seminars as part of the course requirement. (2)

***CHEM 420: Instrumental Analysis***

Theory and practice of instrumental methods along with basic electronics. Special emphasis placed on electronics, spectrophotometric, radiochemical, and mass spectrometric methods. **Prerequisites:** CHEM 320; 341 and/or CHEM 342; 343. (4)

***CHEM 440: Advanced Organic Chemistry***

Students will develop a repertoire of synthetic methodology and a general understanding of a variety of organic reaction mechanisms. Synthetic organic strategies and design, the analysis of classic and recent total syntheses from the literature, and advanced applications of instrumentation in organic chemistry. **Prerequisite:** CHEM 332. (2)

***CHEM 450: Inorganic Chemistry***

Techniques of structural determination (IR, UV, VIS, NMR, X-ray, EPR), bonding principles, nonmetal compounds, coordination chemistry, organometallics, donor/acceptor concepts, reaction pathways and biochemical applications are covered. Laboratory: Synthesis and characterization of non-metal, coordination and organometallic compounds.

**Prerequisites:** CHEM 332, 341

**Prerequisite or co-requisite:** CHEM 342. (3)

***CHEM 456: Polymers and Biopolymers – NS, SM***

A course presenting the fundamentals of polymer synthesis, solution thermodynamic properties, molecular characterization, molecular weight distribution, and solution kinetics. Free radical, condensation, ionic, and biopolymer systems, with emphasis on applications. The 1-credit laboratory examining polymer synthesis through experiments is optional.

**Prerequisite:** CHEM 341

**Prerequisite or co-requisite:** CHEM 342. (3)

***CHEM 491: Independent Studies***

Library and/or laboratory study of topics not included in regularly offered courses. Proposed project must be approved by department chair and supervisory responsibility accepted by an instructor. May be taken more than once. A specific title for the project may be appended to the general title of Independent Studies for CHEM 491. (1 to 4)

***CHEM 497: Research***

Experimental or theoretical investigation open to upper-division students with consent of department chair. May be taken more than once. Generally consists of a research project developed in consultation with a chemistry faculty member. A specific title for the project may be appended to the general title of Research for CHEM 497. (1 to 4)

***CHEM 499: Capstone: Seminar – SR***

Senior capstone course. Presentation by students of knowledge gained by personal library or laboratory research, supplemented with seminars by practicing scientists. Participation of all senior chemistry majors is required and all other chemistry-oriented students are encouraged to participate. Seminar program will be held during the entire year but credit will be awarded in the spring semester. (2)

