CHEMISTRY & BIOCHEMISTRY

Baker Center for Sciences and Mathematics Bldg. (180), Room 206
Phone: 805.756.2693
https://chemistry.calpoly.edu

Department Chair: Seth Bush

Academic Programs

Program name	Program type
Biochemistry	BS
Chemistry	BS
Cross Disciplinary Studies Minor in Bioinformatics	Minor
Polymers and Coatings Science	MS

The Chemistry and Biochemistry Department has two roles in the university: to provide professional education for students who are majors in chemistry and biochemistry and who plan careers in the natural sciences and related fields, and to provide instruction in the fundamentals of chemistry to students with majors in fields related to chemistry, especially in the life sciences, agriculture, and engineering.

The department offers a flexible chemical education degree option for students interested in a career in pre-college science education. Interested students should contact the single subject teaching credential advisor early in their academic career for more information.

Career opportunities for chemists are increasing. There are openings in traditional areas such as environmental analysis, the health professions, industrial research and production, pharmacology, toxicology, product quality control, and teaching at the secondary or university level. Newer opportunities lie in related areas such as library science, market research, patent law, and safety engineering

Undergraduate Programs

BS Biochemistry

The Chemistry and Biochemistry Department provides curricula leading to the Bachelor of Science in Biochemistry and the Bachelor of Science in Biochemistry with a concentration in Polymers and Coatings.

The baccalaureate curriculum in biochemistry includes required courses in general chemistry, analytical chemistry, inorganic chemistry, organic chemistry, biochemistry and physical chemistry. Advanced undergraduates choose electives from courses that cover a broad range of specialized topics, such as environmental chemistry, nutritional biochemistry, advanced organic and physical chemistry, pharmacology, and polymer chemistry. The curriculum emphasizes laboratory work, especially current techniques and the use of instrumentation in all fields of chemistry. The program provides opportunities for independent research under faculty guidance, including a requirement for a senior project. A senior project may consist of pure or applied research in biochemistry, or it may involve interdisciplinary work with another field such as art, biology, agriculture, civil or environmental engineering, psychology, or soil science. Under the department's cooperative education program, bachelor's degree candidates may work full-time in industry or government for one or two quarters, for pay and academic credit.

There are a number of career opportunities in the fields of biotechnology and polymers and coatings. Students completing a degree in biochemistry or a concentration in polymers and coatings are prepared for direct entry into these careers, as well as for postgraduate education in a professional specialty.

Concentration

Polymers and Coatings Concentration

Students may select the Polymers and Coatings concentration instead of advanced approved biochemistry electives in Major Courses.
The concentration includes the required courses in the biochemistry curriculum and electives in the area of polymers, coatings, surface chemistry and materials engineering. The concentration gives students the background and practical experience to move into a rewarding career in a wide range of fields including paints and coatings, resins, plastics, adhesives and sealants.

BS Chemistry

The Chemistry and Biochemistry Department provides curricula leading to the Bachelor of Science in Chemistry and the Bachelor of Science in Chemistry with a certified concentration in Polymers and Coatings. Both the BS in Chemistry and the concentration in Polymers and Coatings are certified by the American Chemical Society. An option in Chemical Education designed for aspiring teachers in secondary schools is also available.

The baccalaureate curriculum in chemistry includes required courses in general chemistry, analytical chemistry, inorganic chemistry, organic chemistry, biochemistry and physical chemistry. Advanced undergraduates choose electives from courses that cover a broad range of specialized topics, such as environmental chemistry, nutritional biochemistry, advanced organic and physical chemistry, pharmacology, and polymer chemistry. The curriculum emphasizes laboratory work, especially current techniques and the use of instrumentation in all fields of chemistry. The program provides opportunities for independent research under faculty guidance, including a requirement for a senior project. A senior project may consist of pure or applied research in chemistry, or it may involve interdisciplinary work with another field such as art, biology, agriculture, civil or environmental engineering, psychology, or soil science. Under the department's cooperative education program, bachelor's degree candidates may work full-time in industry or government for one or two quarters, for pay and academic credit.

Career opportunities for chemists lie in traditional areas such as environmental analysis, the health professions, industrial research and production, pharmacology, toxicology, product quality control, and teaching at the secondary or university level. Newer opportunities lie in related areas such as library science, market research, patent law, and safety engineering.

Concentration

Polymers and Coatings Concentration

Students may select the Polymers and Coatings concentration instead of advanced approved biochemistry electives in Major Courses.
The concentration includes the required courses in the biochemistry curriculum and electives in the area of polymers, coatings, surface chemistry and materials engineering. The concentration gives students the background and practical experience to move into a rewarding career in a wide range of fields including paints and coatings, resins, plastics, adhesives and sealants.

Biotechnology Minor

For information regarding the Biotechnology minor, see the College of Science and Mathematics (https://catalog.calpoly.edu/collegesandprograms/collegeofsciencemathematics/) section of the catalog.

Cross Disciplinary Studies Minor in Bioinformatics

For information regarding the Cross Disciplinary Studies Minor in Bioinformatics, see the Biological Sciences (https://catalog.calpoly.edu/collegesandprograms/collegeofsciencemathematics/biologicalsciences/) section of the catalog.

Graduate Program

Master of Science Degree in Polymers and Coatings Science

General Characteristics

The MS degree in Polymers and Coatings Science offers a unique, focused program closely tied to industry. Students gain academic preparation in polymers and coatings science through lecture and laboratory courses, then undertake a rigorous industrial internship or thesis research. Through the internship or thesis research students specialize and develop advanced skills related to their internship work or research. The program is designed to prepare students for challenging careers in the polymers and coatings industry. The program also provides excellent background for doctoral studies in areas related to polymer and coatings science. This program is unique in California and relies on the close relationship between the department and the polymers and coatings industry for its success.

Prerequisites

Students entering the program must have a bachelor's degree from an accredited institution with a minimum grade point average of 2.5 in the last 90 quarter units attempted. Applicants with majors in chemistry, biochemistry, materials engineering, chemical engineering or related fields generally meet the prerequisites for courses in the program. Applicants with degrees in other areas may need to take supplemental courses in organic and physical chemistry and can be admitted conditionally. For information concerning additional departmental requirements, the student should contact the Graduate Advisor in the Chemistry and Biochemistry Department.

Advancement to candidacy requires completion of 12 units of an approved study plan with a minimum grade point average of 3.0.

Blended BS + MS Polymers and Coatings Science Program

A blended program provides an accelerated route to a graduate professional degree, with simultaneous conferring of both Bachelor's and Master's degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status. Students are required to complete all requirements for both degrees, including senior project for the Bachelor's degree.

A blended program is available for MS Polymers and Coatings Science.

Eligibility

Majors that are eligible for the blended program are:

- BS Chemistry
- BS Materials Engineering

Participation in a blended program is based upon prior academic performance and other measures of professional promise. Refer to Graduate Education (https://catalog.calpoly.edu/graduateeducation/#graduateandpostbaccalaureateadmissionrequirements/) for more information and for the minimum criteria required to be eligible for a blended program at Cal Poly. Contact the Graduate Program Coordinator in the Chemistry and Biochemistry department for any additional eligibility criteria.

Program of Study

Students may begin taking the required graduate courses in either their junior or senior year depending on their preparation. Students may not pursue both the Concentration in Polymers and Coatings and the MS in Polymers and Coatings Science. Students pursuing the concentration take the 400-level polymers and coatings courses while those pursuing the MS degree take the 500-level polymers and coatings courses. Students cannot receive credit for both 400 and 500-level courses in the same topic.

Students in the blended program are eligible to begin the Industrial Internship or Thesis Research upon completion of the required graduate-level chemistry courses.

CHEM Courses

CHEM 101. Introduction to the Chemical Sciences. 1 unit
Term Typically Offered: F
CR/NC
Prerequisite: BCHEM/CHEM majors only.

Introduction to the chemistry and biochemistry disciplines. Orientation, advising, career opportunities and introduction to the faculty. Designed for first-year CHEM and BCHEM majors. Credit/No Credit grading only. 1 lecture.

CHEM 110. World of Chemistry. 4 units
Term Typically Offered: F,W,SP,SU
2020-21 or later catalog: GE Area B1
2020-21 or later catalog: GE Area B3
2019-20 or earlier catalog: GE Area B3
2019-20 or earlier catalog: GE Area B4
Prerequisite: MATH 96, or MATH 115, or appropriate Math Placement Level.

The fundamentals of chemical cause/effect and structure/function relationships. The basic principles of chemistry and their applications to solving human problems in areas such as toxicology, environmental science, agriculture, nutrition, forensics and medicine. Not open for major credit in Biochemistry or Chemistry. Not open to students with credit in CHEM 111, CHEM 124, or CHEM 127. 3 lectures, 1 laboratory. Fulfills GE Areas B1 and B3 (GE Areas B3 and B4 for students on the 2019-20 or earlier catalogs).

CHEM 124. General Chemistry for Physical Science and Engineering I. 4 units
Term Typically Offered: F,W,SP,SU
2020-21 or later catalog: GE Area B1
2020-21 or later catalog: GE Area B3
2019-20 or earlier catalog: GE Area B3
2019-20 or earlier catalog: GE Area B4
Prerequisite: MATH 118 or MATH 330. Recommended: High school chemistry or equivalent.

Introduction to atomic theory, chemical reactions, bonding, stoichiometry, nomenclature, gas laws, thermochemistry, molecular structure, and intermolecular forces. Intended primarily for students in engineering and/or physical sciences. Not open to students with credit in CHEM 127. Credit will be granted in only one of the following courses: CHEM 110, CHEM 124, or CHEM 127. 3 lectures, 1 laboratory. Fulfills GE Areas B1 and B3 (GE Areas B3 and B4 for students on the 2019-20 or earlier catalogs).

CHEM 125. General Chemistry for Physical Science and Engineering II. 4 units
Term Typically Offered: F, W, SP
2020-21 or later catalog: GE Area B1
2020-21 or later catalog: GE Area B3
2019-20 or earlier catalog: GE Area B3
2019-20 or earlier catalog: GE Area B4
Prerequisite: CHEM 124, or AP Chemistry score of 5.

Topics include solution chemistry, thermodynamics, kinetics, equilibrium (including acids and bases), electrochemistry, and nuclear chemistry. Not open to students with credit in CHEM 128. 3 lectures, 1 laboratory. Fulfills GE Areas B1 and B3 (GE Areas B3 and B4 for students on the 2019-20 or earlier catalogs).

CHEM 126. General Chemistry for Physical Science and Engineering III. 4 units
Term Typically Offered: SP
Prerequisite: CHEM 125 with a grade of C- or better or consent of instructor.

Topics in equilibrium, kinetics, acid-base chemistry, and molecular structure, contextualized within major sub-disciplines of chemistry. Not open to students with credit in CHEM 129. 3 lectures, 1 laboratory.

CHEM 127. General Chemistry for Agriculture and Life Science I. 4 units
Term Typically Offered: F, W, SP
2020-21 or later catalog: GE Area B1
2020-21 or later catalog: GE Area B3
2019-20 or earlier catalog: GE Area B3
2019-20 or earlier catalog: GE Area B4
Prerequisite: MATH 118 or MATH 330. Recommended: High school chemistry or equivalent.

Introduction to atomic theory, chemical reactions, bonding, stoichiometry, nomenclature, gas laws, thermochemistry, molecular structure, and intermolecular forces. Intended primarily for students in agriculture and life sciences. Not open to students with credit in CHEM 124. Credit will be granted in only one of the following courses: CHEM 110, CHEM 124, or CHEM 127. 3 lectures, 1 laboratory. Fulfills GE Areas B1 and B3 (GE Areas B3 and B4 for students on the 2019-20 or earlier catalogs).

CHEM 128. General Chemistry for Agriculture and Life Science II. 4 units
Term Typically Offered: W, SP
Prerequisite: CHEM 127 or AP Chemistry score of 5.

Continuation of CHEM 127. Colligative properties, colloids and solutions, oxidation-reduction reactions, electrochemistry, kinetics, equilibria, and thermodynamics. Not open to students with credit in CHEM 125. 3 lectures, 1 laboratory.

CHEM 129. General Chemistry for Agriculture and Life Science III. 4 units
Term Typically Offered: F, SP
Prerequisite: CHEM 128.

Continuation of CHEM 128. Acid and base equilibria, buffers, transition elements, solubility, complex ions, hybrid orbital theory, molecular orbital theory, and nuclear chemistry. Laboratory study of the chemical properties and semi-micro qualitative analysis of the representative group elements of the periodic table. Not open to students with credit in CHEM 126. 3 lectures, 1 laboratory.

CHEM 200. Special Problems for Undergraduates. 1-2 units
Term Typically Offered: TBD
Prerequisite: CHEM 111, CHEM 124, or CHEM 127 and consent of department chair.

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

CHEM 201. Undergraduate Research. 1-2 units
Term Typically Offered: F,W,SP,SU
CR/NC
Prerequisite: Consent of instructor.

Research under faculty supervision. Credit/No Credit grading only. Total credit limited to 10 units.

CHEM 202. Orientation to Biotechnology. 2 units
Term Typically Offered: F, W
Prerequisite: Completion of a course with a BIO, BOT or MCRO prefix and a course with a CHEM prefix.

Introduction to the diversity of fields in biotechnology. Applications in agriculture, nutrition, medicine and environmental problems. 1 lecture, 1 activity. Crosslisted as BIO/CHEM 202.

CHEM 203. Undergraduate Seminar I. 1 unit
Term Typically Offered: W, SP
CR/NC
Prerequisite: CHEM 126.

Introduction to basic scientific literature and scientific presentation skills. Targeted advising and preparation for research and career opportunities. Designed for second-year students majoring in Biochemistry or in Chemistry. Credit/No Credit grading only. 1 seminar.

CHEM 212. Introduction to Organic Chemistry. 5 units
Term Typically Offered: TBD
Prerequisite: CHEM 111, CHEM 124 or CHEM 127.

Structure, isomerism, nomenclature, fundamental reactions of major functional groups and applications of organic chemicals in agriculture, medicine, industry, and the home. CHEM 212 accepted in lieu of CHEM 312, but not for upper division credit. Not open to students with credit in CHEM 312, CHEM 216/316. 4 lectures, 1 laboratory.

CHEM 216. Organic Chemistry I. 5 units
Term Typically Offered: F, W
Prerequisite: CHEM 126 or CHEM 129 with a grade of C- or better or consent of instructor.

Fundamental concepts and laboratory skills of organic chemistry. Structure, bonding, nomenclature, isomerism, stereochemistry and physical properties of organic compounds. Introduction to spectroscopy. Reactions and mechanisms of alkanes, alkenes and alkyl halides. Fundamental laboratory techniques in organic chemistry. Not open to students with credit in CHEM 316. 4 lectures, 1 laboratory.

CHEM 217. Organic Chemistry II. 3 units
Term Typically Offered: W, SP
Prerequisite: CHEM 216 with a grade of C- or better or consent of instructor. Corequisite: CHEM 221 for Chemistry and Biochemistry majors; or CHEM 220 for non-Chemistry and non-Biochemistry majors.

Properties and reactions of carbonyl compounds, alcohols, ethers, amines and carbohydrates with an in-depth treatment of the reaction mechanisms. Introductory concepts and applications of infrared and NMR spectroscopy. Not open to students with credit in CHEM 317. 3 lectures.

CHEM 218. Organic Chemistry III. 3 units
Term Typically Offered: F, SP
Prerequisite: CHEM 217 with a grade of C- or better or consent of instructor. Corequisite: CHEM 324 for Chemistry and Biochemistry majors; or CHEM 223 for non-Chemistry and non-Biochemistry majors.

Properties and reactions of alkynes, heterocyclic and aromatic compounds with an in-depth treatment of the mechanisms of the reactions. Introductory concepts and applications of ultraviolet spectroscopy and mass spectrometry. Not open to students with credit in CHEM 318. 3 lectures.

CHEM 220. Organic Chemistry Laboratory For Life Sciences II. 1 unit
Term Typically Offered: W, SP
Corequisite: CHEM 217.

Laboratory experiments exploring reactions in organic chemistry, applying fundamental laboratory techniques covered in CHEM 216. Not open to Chemistry and Biochemistry majors. 1 laboratory.

CHEM 221. Organic Chemistry Laboratory II. 2 units
Term Typically Offered: W, SP
Prerequisite: major in Chemistry or Biochemistry. Corequisite: CHEM 217.

Laboratory experiments exploring reactions in organic chemistry, applying fundamental laboratory techniques covered in CHEM 216. 2 laboratories.

CHEM 223. Organic Chemistry Laboratory for Life Sciences III. 1 unit
Term Typically Offered: F, SP
Corequisite: CHEM 218.

Practice in multi-step organic synthesis, enzymatic organic chemistry, biomimetic organic chemistry. Not open to Biochemistry or Chemistry majors. 1 laboratory.

CHEM 231. Quantitative Analysis. 5 units
Term Typically Offered: TBD
Prerequisite: CHEM 126 or CHEM 129.

Theory and application of chemical equilibrium to analytical problems. Survey of important analytical methods with stress placed on the theory and application associated with titrimetric and spectrophotometric analysis. 3 lectures, 2 laboratories.

CHEM 270. Selected Topics. 1-4 units
Term Typically Offered: TBD
Prerequisite: Open to undergraduate students and consent of instructor.

Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

CHEM 302. Marine Chemistry. 3 units
Term Typically Offered: SP
Prerequisite: CHEM 216 or CHEM 312.

Introduction to chemical processes in the ocean including chemical oceanography and marine chemical ecology. 3 lectures.

CHEM 303. Undergraduate Seminar II. 1 unit
Term Typically Offered: F, W, SP
CR/NC
Prerequisite: CHEM 203 and CHEM 218.

Advanced exploration of more sophisticated scientific literature and scientific presentation skills. Targeted advising and preparation for research and career opportunities. Designed for third-year CHEM and BCHM majors. Credit/No Credit grading only. 1 seminar.

CHEM 308. Genetic Engineering Technology. 4 units
Term Typically Offered: W
2020-21 or later: Upper-Div GE Area B
2019-20 or earlier catalog: GE Area B5, B6, or B7
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); and one of the following courses: CHEM 110, CHEM 124, or CHEM 127.

Introduction to the biology, methodology, and techniques used in genetic engineering. Potential benefits and problems in application within agriculture, nutrition, medicine and environmental context, including the underlying ethical questions. Not open to students with credit in CHEM 373, or to Biological Sciences, Marine Sciences, or Microbiology majors. 4 lectures. Crosslisted as BIO/CHEM 308. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

CHEM 312. Organic Chemistry: Fundamentals and Applications. 5 units
Term Typically Offered: F,W,SP,SU
Prerequisite: CHEM 125 or CHEM 128.

Structure, isomerism, nomenclature, fundamental reactions of major functional groups and applications of organic chemicals in agriculture, medicine, industry, and the home. Not open to students with credit in CHEM 212 or CHEM 216/316. 4 lectures, 1 laboratory.

CHEM 314. Biochemistry: Fundamentals and Applications. 5 units
Term Typically Offered: F, W, SP
2020-21 or later: Upper-Div GE Area B
2019-20 or earlier catalog: GE Area B5, B6, or B7
Prerequisite: Junior standing; completion of GE Area A with grades C- or better; completion of GE Area B1 (GE Area B3 for students on the 2019-20 or earlier catalogs); completion of GE Area B2; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and one of the following courses: CHEM 212, CHEM 216, CHEM 312, or CHEM 316.

Chemistry of biomolecules including carbohydrates, proteins, lipids, vitamins, enzymes and hormones. Basic molecular biology with applications to biotechnology and genetic engineering. Practical intermediary metabolism of prokaryotic and eukaryotic systems. 4 lectures, 1 laboratory. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

CHEM 324. Organic Chemistry Laboratory III. 2 units
Term Typically Offered: F, SP
Prerequisite: major in Chemistry or Biochemistry. Corequisite: CHEM 218.

Practice in multiple step organic synthesis, column chromatography, vacuum distillation, enzymes as chemical reagents, inert atmosphere techniques, introduction to FT NMR spectroscopy and mass spectrometry, survey of organic chemical literature. 2 laboratories.

CHEM 331. Quantitative Analysis. 5 units
Term Typically Offered: F, SP, SU
Prerequisite: CHEM 126 or CHEM 129.

Theory and application of chemical equilibrium to analytical problems. Survey of important analytical methods with stress placed on the theory and application associated with titrimetric and spectrophotometric analysis. 3 lectures, 2 laboratories.

CHEM 341. Environmental Chemistry: Water Pollution. 3 units
Term Typically Offered: TBD
Prerequisite: CHEM 126 or CHEM 129; and CHEM 212 or CHEM 312; or CHEM 216 or CHEM 316.

Chemical aspects of water and water pollution: alkalinity; acid deposition, particularly relating to lake and stream acidification and forest decline; drinking water treatment and trihalomethanes; wastewater treatment; detergents, builders, and eutrophication; pesticides; other toxic organic compounds such as PCBs and dioxin; hazardous wastes; toxic elements such as Pb, Hg, Sn, Cd, and Se. 3 lectures.

CHEM 349. Chemical and Biological Warfare. 4 units
Term Typically Offered: F, SP
2020-21 or later: Upper-Div GE Area B
2019-20 or earlier catalog: GE Area B5, B6, or B7
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; CHEM course in GE Area B1 (GE Area B3 for students on the 2019-20 or earlier catalogs); BIO or MCRO course in GE Area B2; and completion of GE Area B4 with a grade of C- or better in one course (GE Area B1 for students on the 2019-20 or earlier catalogs).

History, development, and use of chemical and biological warfare (CBW). Chemical and biological disarmament. Production and destruction of CBW agents. CBW terrorism. Ethics of CBW. 2 lectures, 2 seminars. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

CHEM 351. Physical Chemistry I. 3 units
Term Typically Offered: F, W
Prerequisite: CHEM 126 or CHEM 129; MATH 143; PHYS 122 or PHYS 132.

Basic physical chemistry for the study of chemical and biochemical systems. Kinetic-molecular theory, gas laws, principles of thermodynamics. 3 lectures.

CHEM 352. Physical Chemistry II. 3 units
Term Typically Offered: W, SP
Prerequisite: CHEM 351.

Application of physical chemistry to chemical and biochemical systems. Electrochemistry, kinetics, viscosity, surface and transport properties. 3 lectures.

CHEM 353. Physical Chemistry III. 3 units
Term Typically Offered: F, SP
Prerequisite: CHEM 352.

Principles and applications of quantum chemistry. Chemical bonding and molecular structure. Spectroscopy and diffraction. 3 lectures.

CHEM 356. Physical Chemistry Laboratory. 2 units
Term Typically Offered: F, W, SP
GWR
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and CHEM 231/331. Corequisite: CHEM 352.

Experimental studies of gases, solutions, thermochemistry, chemical and phase equilibria, electrochemistry, chemical and enzyme kinetics, computational methods and applications to chemistry and biochemistry. Written communication of scientific results using applicable literature and databases. 2 laboratories. Fulfills GWR.

CHEM 357. Physical Chemistry III Lab. 1 unit
Term Typically Offered: F, SP
Corequisite: CHEM 353.

Experimental and computational investigations of quantum chemistry, spectroscopy, symmetry and statistical chemistry. 1 laboratory.

CHEM 369. Biochemical Principles. 5 units
Term Typically Offered: F, W, SP
2020-21 or later: Upper-Div GE Area B
2019-20 or earlier catalog: GE Area B5, B6, or B7
Prerequisite: Junior standing; completion of GE Area A with grades C- or better; completion of GE Area B1 (GE Area B3 for students on the 2019-20 or earlier catalogs); one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); BIO 161; and CHEM 217 or CHEM 317.

Chemistry and function of major cellular constituents: proteins, lipids, carbohydrates, nucleic acids, and membranes. Mechanisms of protein function and regulation and enzyme catalysis. 4 lectures, 1 laboratory. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

CHEM 372. Metabolism. 4 units
Term Typically Offered: F, SP
Prerequisite: CHEM 371.

Intermediary metabolism of carbohydrates, lipids, amino acids and nucleotides, regulation and integration of metabolic pathways, bioenergetics, photosynthesis, electron transport, nitrogen fixation, biochemical function of vitamins and minerals. 4 lectures.

CHEM 373. Molecular Biology. 3 units
Term Typically Offered: W, SP
Prerequisite: CHEM 371.

Structure of nucleic acids and chromosomes. Mechanisms and regulation of nucleic acid and protein synthesis. Molecular biology techniques. 3 lectures.

CHEM 377. Chemistry of Drugs and Poisons. 3 units
Term Typically Offered: W, SP
Prerequisite: CHEM 313 or CHEM 371.

Introduction to pharmacology and toxicology: history, sources, development and testing, physical and chemical properties, biochemical and physiological effects, mechanisms of action, and the therapeutic uses and toxicology of common drugs and poisons. 3 lectures.

CHEM 400. Special Problems for Advanced Undergraduates. 1-3 units
Term Typically Offered: TBD
Prerequisite: Junior standing and consent of department chair.

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 3 units per quarter. 1-3 laboratories.

CHEM 401. Advanced Undergraduate Research. 1-2 units
Term Typically Offered: F,W,SP,SU
Prerequisite: Consent of instructor.

Research under faculty supervision. Total credit limited to 10 units. 6 units may be applied to approved chemistry electives.

CHEM 403. Undergraduate Seminar III: Senior Project. 1 unit
Term Typically Offered: F, W, SP
Prerequisite: CHEM 303 and CHEM 352.

Culminating experience with high level scientific literature and scientific presentation skills. Targeted advising and preparation for research and career opportunities. Designed for fourth-year CHEM and BCHM majors. 1 seminar.

CHEM 405. Advanced Physical Chemistry. 3 units
Term Typically Offered: TBD
Corequisite: CHEM 353.

Selected advanced topics in physical chemistry, which may include statistical mechanics, computational chemistry, nonequilibrium thermodynamics, lasers in chemistry, solid-state and/or advanced spectroscopy. Total credit limited to 6 units. 3 lectures.

CHEM 414. Advanced Organic Chemistry - Mechanisms. 3 units
Term Typically Offered: W
Prerequisite: CHEM 218 or CHEM 318.

A mechanistic study of organic reactions; correlation of structure with reactivity; reaction intermediates and species involved in reactions; methods of probing reaction mechanisms. 3 lectures.

CHEM 418. Neurochemistry. 3 units
Term Typically Offered: F
Prerequisite: BIO 161 and CHEM 217.

Introduction to the chemistry of neurotransmission. Emphasis on molecular makeup and function of voltage gated ion channels; receptors and enzymes involved in signal transduction; biosynthesis, storage, release, reuptake, and breakdown of major neurotransmitters. Mechanism of action of agonists and antagonists, and their effects on the central and peripheral nervous systems. 3 lectures.

CHEM 420. Advanced Organic Chemistry - Synthesis. 3 units
Term Typically Offered: SP
Prerequisite: CHEM 218/318.

Modern methods of organic synthesis. Carbon-carbon bond forming reactions, functional group transformations, protecting groups, strategies of total synthesis of natural products. 3 seminars.

CHEM 428. Nutritional Biochemistry. 3 units
Term Typically Offered: TBD
Prerequisite: CHEM 371.

Nutritional aspects of biochemistry. Topics include essential and energy providing nutrients, vitamins and minerals, deficiencies, degenerative and genetic diseases of metabolism, hormones and brain chemistry, other current topics. Emphasis on current research and controversy. 3 lectures. Formerly CHEM 528.

CHEM 432. Physical Biochemistry. 3 units
Term Typically Offered: SP
Prerequisite: CHEM 371. Recommended: CHEM 351.

Principles of biochemistry and physical chemistry applied to structure and function of biomacromolecules. Emphasis on the techniques used in the study of protein/ligand binding, macromolecular structure and dynamics, and on understanding current literature. 3 lectures.

CHEM 439. Instrumental Analysis. 5 units
Term Typically Offered: W
Prerequisite: CHEM 231/331, CHEM 354. Recommended: CHEM 353.

Theory, practice and method selection of modern instrumental analytical techniques, including spectroscopic, electrochemical, chromatographic and thermal methods. Current industrial applications. Laboratory work emphasizes optimization of experimental parameters. 3 lectures, 2 laboratories.

CHEM 441. Bioinformatics Applications. 4 units
Term Typically Offered: F, SP
Prerequisite: BIO 302, BIO 303, BIO 351, or CHEM 373.

Introduction to new problems in molecular biology and current computer applications for genetic database analyses. Use of software for: nucleic acid, genome and protein sequence analysis; genetic databases, database tools; industrial applications in bioinformatics; ethical and societal concerns. 3 lectures, 1 laboratory. Crosslisted as BIO/CHEM 441.

CHEM 444. Polymers & Coatings I. 3 units
Term Typically Offered: F
Prerequisite: CHEM 212/312 or CHEM 216/316.

Physical properties of polymers and coatings and their measurement. Molecular weight averages, glass transition, thermodynamics of polymers. Viscoelastic properties, rheology, molecular weight determination. Thermal analysis, spectroscopic analysis, mechanical testing. 3 lectures.

CHEM 445. Polymers & Coatings II. 3 units
Term Typically Offered: W
Prerequisite: CHEM 217/317 and CHEM 444.

Introduction to polymerization methods and mechanisms. Chemistry of initiators, catalysts and inhibitors, kinetics of polymerization. Uses of representative polymer types. Synthesis, film formation, structure and properties of polymers commonly used in coatings and adhesives. 3 lectures.

CHEM 446. Surface Chemistry of Materials. 3 units
Term Typically Offered: SP
Prerequisite: CHEM 125 or CHEM 128; CHEM 351, MATE 380, or ME 302.

Surface energy. Capillarity, solid and liquid interface, adsorption. Surface areas of solids. Contact angles and wetting. Friction, lubrication and adhesion. Relationship of surface to bulk properties of materials. Applications. 3 lectures. Crosslisted as CHEM/MATE 446.

CHEM 447. Polymers and Coatings Laboratory I. 2 units
Term Typically Offered: F
Corequisite: CHEM 444.

Experimental techniques of producing and characterizing coatings. Polymer characterization and analysis. Molecular weight analysis using viscometry, light scattering, and gel permeation chromatography. Thermal analysis using differential scanning calorimetry, thermal mechanical analysis and dynamic mechanical analysis. Polymer rheology. Infrared, Raman and FT-NMR spectroscopy. Atomic force microscopy. 2 laboratories.

CHEM 448. Polymers and Coatings Laboratory II. 2 units
Term Typically Offered: W
Prerequisite: CHEM 447. Corequisite: CHEM 445.

Polymer synthesis using solution, suspension, bulk, emulsion techniques. Synthesis of chain growth polymers using free radical, anionic, cationic, and other catalysts. Synthesis of step-growth polymers. Kinetics of polymer reactions. Synthesis of resins used in modern coatings. 2 laboratories.

CHEM 449. Polymers and Coatings Internship. 2 units
Term Typically Offered: F,W,SP,SU
Prerequisite: CHEM 444.

Selected students will spend up to 12 weeks with an approved polymers and coatings firm engaged in production or related business. Time will be spent applying and developing production and technical skills and abilities in the polymers and coatings industry.

CHEM 450. Polymers and Coatings III. 3 units
Term Typically Offered: SP
Prerequisite: CHEM 444 or CHEM 544.

Formulation of modern coatings. Raw materials including resins, solvents, pigments, and additives. Formulation principles for solvent-borne and coatings, waterborne, powder, radiation cure and architectural coatings. Regulatory issues; VOC's. Coating properties, film formation, film defects, application methods, color and color acceptance. Not open to students with credit in CHEM 550. 3 lectures.

CHEM 451. Polymers and Coatings Laboratory III. 2 units
Term Typically Offered: SP
Prerequisite: CHEM 447 or CHEM 547. Corequisite: CHEM 450. Recommended: CHEM 445 or CHEM 545; CHEM 448 or CHEM 548; CHEM 446.

Preparation and characterization of coatings - solvent based and waterborne. Thermoplastic and thermosetting coatings. Coating film preparation methods. Applications of spectroscopy, scanning probe microscopy, thermal analysis, rheology in characterizing coatings. VOC, long-term exposure testing. Measurement of appearance (color, gloss). Not open to students with credit in CHEM 551. 2 laboratories.

CHEM 454. Functional Polymeric Materials. 4 units
Term Typically Offered: SP
Prerequisite: CHEM 212 or CHEM 216 or CHEM 312 or CHEM 316; CHEM 351 or MATE 380; or graduate standing.

Structure-property-processing correlations of functional polymeric materials. Additive group contribution methodologies for predicting and determining physical properties. Semi-empirical approaches for estimating and evaluating the values of physical properties from chemical structures. 4 lectures.

CHEM 458. Advanced Organic Chemistry: Spectroscopy. 3 units
Term Typically Offered: SP
Prerequisite: CHEM 324.

Separation, purification, and identification of organic molecules using chemical and instrumental methods, including nuclear magnetic resonance, infrared and ultraviolet spectroscopy and mass spectrometry, and techniques in high-resolution FT-NMR. 1 lecture, 2 laboratories.

CHEM 459. Undergraduate Seminar. 2 units
Term Typically Offered: F,W,SP,SU
Corequisite: CHEM 218 or CHEM 318 and junior standing.

Oral presentation of current developments in chemistry based on current literature. Searching for, organizing and presenting developments from current literature in chemistry and biochemistry. Preparation for employment and for independent work, including senior project, in chemistry and biochemistry. 2 seminars.

CHEM 461. Senior Project Report. 1 unit
Term Typically Offered: F,W,SP,SU
Prerequisite: Consent of instructor.

Completion of a senior project report under faculty supervision. Minimum 30 hours time commitment.

CHEM 463. Honors Research. 1 unit
Term Typically Offered: F,W,SP,SU
Prerequisite: Junior standing and consent of instructor.

Advanced laboratory research. Results are presented in a poster session or other public forum. Total credit limited to 2 units with a maximum of 1 unit per quarter. 1 laboratory.

CHEM 465. College Teaching Practicum. 1-2 units
Term Typically Offered: F, W, SP
CR/NC
Prerequisite: Junior standing, CHEM 231/331 (or permission of instructor), evidence of satisfactory preparation in chemistry; department chair approval required.

Teaching assignment in an undergraduate college classroom. Includes teaching and related activities under the direction of a permanent faculty member in the Department of Chemistry and Biochemistry. Total credit limited to 4 units.

CHEM 466. Learning Assistant Seminar. 2 units
Term Typically Offered: F, W, SP
CR/NC
Prerequisite: Junior standing and consent of instructor.

Pedagogical instruction and introduction to education research for Chemistry Learning Assistants. Effective questioning, the effect of explanatory knowledge on student learning, student misconceptions in chemistry, collaborative problem solving techniques in chemistry, studio curriculum development, content in the general chemistry curriculum. Total credit limited to 4 units. Credit/No Credit grading only. 2 seminars.

CHEM 470. Selected Advanced Topics. 1-4 units
Term Typically Offered: F
Prerequisite: CHEM 351, CHEM 217 or CHEM 317.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

CHEM 471. Selected Advanced Laboratory. 1-4 units
Term Typically Offered: TBD
Prerequisite: Consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

CHEM 474. Protein Techniques Laboratory. 3 units
Term Typically Offered: F, W, SP
Prerequisite: CHEM 371.

Experiments in protein purification and analysis from recombinant sources. Ion-exchange and affinity chromatography, electrophoresis and blotting. UV, chemical, immune, and fluorescent detection. Enzyme kinetic analysis. 1 lecture, 2 laboratories.

CHEM 475. Molecular Biology Laboratory. 3 units
Term Typically Offered: F, W, SP
Prerequisite: BIO 161, and grade of C- or better in BIO 351 or CHEM 373 or consent of instructor.

Introduction to techniques used in molecular biology and biotechnology; DNA extraction, characterization, cloning, Southern blotting, reverse transcription, polymerase chain reaction, and sequencing analysis. 1 lecture, 2 laboratories. Crosslisted as BIO/CHEM 475.

CHEM 476. Gene Expression Laboratory. 3 units
Term Typically Offered: SP
Prerequisite: BIO/CHEM 475 with a grade of C- or better or consent of instructor; CHEM 313 or CHEM 371, or graduate standing in Biological Sciences.

Heterologous gene expression of a recombinant protein in a microbial system: gene cloning, construction of expression plasmid, DNA sequence analysis, transformation of microbial host, selection and analysis of transformed host cells, expression and purification of recombinant protein. 1 lecture, 2 laboratories. Crosslisted as BIO/CHEM 476.

CHEM 477. Biochemical Pharmacology. 3 units
Term Typically Offered: TBD
Prerequisite: CHEM 218 or CHEM 318.

Consideration of current selected topics in pharmacology and drug targeting. 3 lectures.

CHEM 481. Inorganic Chemistry. 3 units
Term Typically Offered: F
Prerequisite: CHEM 352 and CHEM 231/331.

A systematic study of chemical and physical properties of inorganic compounds based on periodic groupings with emphasis on chemical bonding and structure. Topics will include coordination chemistry and kinetics, organometallic chemistry, advanced acid-base relationships and bonding theories plus other selected topics. 3 lectures.

CHEM 484. Inorganic Chemistry Laboratory. 2 units
Term Typically Offered: F
Corequisite: CHEM 481.

Laboratory techniques in inorganic chemistry. Synthetic and analytic techniques as applied to inorganic and organometallic chemistry. 2 laboratories.

CHEM 485. Cooperative Education Experience. 6 units
Term Typically Offered: F,W,SP,SU
CR/NC
Prerequisite: Sophomore standing and consent of instructor.

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. 2 units only applicable to approved chemistry electives. Major credit limited to 4 units; total credit limited to 12 units. Credit/No Credit grading only.

CHEM 495. Cooperative Education Experience. 12 units
Term Typically Offered: F,W,SP,SU
CR/NC
Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. 2 units only applicable to approved chemistry electives. Major credit limited to 4 units; total credit limited to 24 units. Credit/No Credit grading only.

CHEM 500. Special Problems for Graduate Students. 1-3 units
Term Typically Offered: F,W,SP,SU
Prerequisite: Graduate standing and consent of department chair.

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 6 units, with a maximum of 3 units per quarter.

CHEM 544. Polymer Physical Chemistry and Analysis. 3 units
Term Typically Offered: F
Prerequisite: CHEM 212/312 or CHEM 216/316 or equivalent; CHEM 351 or equivalent.

Physical properties of polymers and coatings and their measurement; molecular weight averages, glass transition, thermodynamics of polymers, viscoelastic properties, rheology; molecular weight determination, thermal analysis, spectroscopic analysis, mechanical testing, atomic force microscopy. Special individual project. Not open to students with credit in CHEM 444. 3 lectures.

CHEM 545. Polymer Synthesis and Mechanisms. 3 units
Term Typically Offered: W
Prerequisite: CHEM 544.

Polymerization methods and mechanisms; chemistry of initiators, catalysts and inhibitors; use of representative types; synthesis, structure and properties of polymers commonly used in coatings and adhesives. Special individual project. Not open to students with credit in CHEM 445. 3 lectures.

CHEM 547. Polymer Characterization and Analysis Laboratory. 2 units
Term Typically Offered: F
Corequisite: CHEM 544.

Polymer characterization and analysis. Molecular weight analysis using viscometry, light scattering, and gel permeation chromatography. Thermal analysis using differential scanning calorimetry, thermal mechanical analysis and dynamic mechanical analysis. Polymer rheology. Infrared, Raman and FT-NMR spectroscopy. Atomic force microscopy. Special individual project. Not open to students with credit in CHEM 447. 2 laboratories.

CHEM 548. Polymer Synthesis Laboratory. 2 units
Term Typically Offered: W
Prerequisite: CHEM 547. Corequisite: CHEM 545.

Polymer synthesis using solution, suspension, bulk, emulsion techniques. Synthesis of chain growth polymers using free radical, anionic, cationic, and other catalysts. Synthesis of step-growth polymers. Kinetics of polymer reactions. Synthesis of resins used in modern coatings. Special individual project. Not open to students with credit in CHEM 448. 2 laboratories.

CHEM 550. Coatings Formulation Principles. 3 units
Term Typically Offered: SP
Prerequisite: CHEM 444 or CHEM 544.

Formulation of modern coatings. Raw materials including resins, solvents, pigments, and additives. Formulation principles for solvent-borne and high solids coatings, water-borne coatings, powder coatings, radiation cure coatings and architectural coatings. Regulatory issues; VOC's. Coating properties, film formation, film defects, application methods, color and color acceptance. Special individual project. 3 lectures.

CHEM 551. Coatings Formulation Laboratory. 2 units
Term Typically Offered: SP
Corequisite: CHEM 550.

Laboratory formulation of modern coatings. Formation of pigment dispersions. Formulation of solvent-borne and high solids coatings, water-borne coatings, powder coatings, radiation cure coatings and architectural coatings. VOC measurements. Measurement of coating properties, film formation, film defects, application methods, color and color acceptance, hiding, gloss. Accelerated weathering. Special individual project. 2 laboratories.

CHEM 570. Selected Advanced Topics. 1-4 units
Term Typically Offered: TBD
Prerequisite: Graduate standing or consent of instructor.

Directed group study of selected topics for graduate students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1-4 lectures.

CHEM 571. Selected Advanced Laboratory. 1-4 units
Term Typically Offered: TBD
Prerequisite: Graduate standing or consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

CHEM 590. Graduate Seminar in Polymers and Coatings. 1 unit
Term Typically Offered: F, W, SP
Prerequisite: Graduate standing in the Polymers and Coatings program or consent of instructor.

Problems and topics in polymers and coatings selected according to the interest and needs of the students enrolled. Total credit limited to 3 units. 1 seminar.

CHEM 598. Graduate Project. 3 units
Term Typically Offered: F,W,SP,SU
Prerequisite: CHEM 545, CHEM 547, CHEM 548, CHEM 550, CHEM 551.

Supervised industrial graduate internship in polymers and coatings science. Provides students with industrial research experience. Requires approval of graduate advisor. Students engage in industrial research and development at an approved industry, make regular reports back to graduate advisor, and present formal report and seminar on work each quarter. Total credit limited to 9 units.

CHEM 599. Graduate Thesis. 3 units
Term Typically Offered: F,W,SP,SU
Prerequisite: CHEM 545, CHEM 547, CHEM 548, CHEM 550, CHEM 551.

Directed graduate research in specialized advanced topics related to polymers and coatings science, leading to a graduate thesis of suitable quality. Requires approval of graduate advisor. Students are expected to work independently and report weekly to faculty advisor. Total credit limited to 9 units.