

# CHEMISTRY (CHM)

## CHM 100 Chemistry for the Consumer (3 credits)

This course is designed to help students understand the chemistry that affects them throughout their lives. Topics include: nuclear chemistry, home products, food and drugs, acid rain, energy, climate control, and sustainability. May be taken for science or elective credit without previous chemistry courses. Successful completion of this course will fulfill a lecture-only natural science course requirement for the GEP natural science area.

*Restrictions:* Students cannot enroll who have a major in Biology, Chemistry, Chemical Biology, Food Marketing or Physics.

*Attributes:* GEP Natural Science, Undergraduate

## CHM 112 Food Chemistry (4 credits)

The study of chemistry as it specifically relates to food. Underlying basic chemical principles will allow the study of particular molecules found in food (carbohydrates, proteins, lipids) and the changes these molecules undergo as they are cooked and absorbed. Topics will also include preservation, food safety, and food additives. This laboratory course will introduce students to the use of laboratory techniques to study food, including the measurement of food properties including pH, flavor, color, and texture. Students will learn how chemical and physical changes can alter food quality. The content material of CHM 112 overlaps with the content of IHS 253 Nutrition: Health and Disease. Students may take either CHM 112 or IHS 253 not both. Successful completion of CHM 112/112L fulfills the GEP science requirement for Food Marketing majors only. It will serve as a free-elective for all other majors.

*Restrictions:* Enrollment is limited to students with a major in Food Marketing Co-Op or Food Marketing.

*Attributes:* GEP Natural Science, Science Course w/Lab (Sci Maj), Undergraduate

## CHM 112L Food Chemistry: Lab (0 credits)

Students who register for this Chemistry lab must also register for the corresponding lecture. For example, if you register for CHM 112L you must, at the same time, register for CHM 112.

*Restrictions:* Enrollment is limited to students with a major, minor, or concentration in Food Marketing Co-Op or Food Marketing.

*Attributes:* GEP Natural Science, Undergraduate

## CHM 115 Chemistry in Daily Life (4 credits)

This course explains the basic theories and need-to-know facts of scientific events one encounters in daily life from a chemistry perspective. In addition to explaining the fundamental concepts of chemistry, the course will cover topics such as acids and bases, oxidation and reduction, household chemicals, nuclear energy, nuclear medicine, biochemistry, and drugs. This laboratory course will cover a wide range of experiments that require mastering a variety of laboratory skills, which utilize many different types of equipment. The proper use of beakers, flasks, pipets, burets, simple calorimeters, balances, and thermometers, to name a few, is critical to a student's success in the course. Accurate observations and recording of data is stressed and evaluated. Students will submit data and results forms at the conclusion of each experiment. Both qualitative (observations and descriptions) and quantitative (calculations and graphs) methods will be stressed.

*Attributes:* GEP Natural Science, Science Course w/Lab (Sci Maj), Undergraduate

## CHM 115L Chemistry in Daily Life (0 credits)

Students who register for this Chemistry lab must also register for the corresponding lecture. For example, if you register for CHM 115L you must, at the same time, register for CHM 115.

*Attributes:* Undergraduate

## CHM 118 Chemical Sciences Orientation (1 credit)

Introduction to all aspects of the chemical sciences, including biochemistry. Students are presented with an overview of the department, the University, the curricula, active research areas, career opportunities, and scientific ethics, as well as information on how they can maximize their educational experience.

*Attributes:* Undergraduate

## CHM 120 General Chemistry I (3 credits)

Topics included are chemical formulas, stoichiometry, balancing reactions, ideal gases, thermodynamics, atomic structure, chemical bonding and molecular structure, kinetics, equilibrium, the chemistry of acids and bases, entropy, free energy, and electrochemistry.

*Attributes:* GEP Natural Science, Science Course w/Lab (Sci Maj), Undergraduate

## CHM 120L General Chemistry Lab I (1 credit)

A lecture-laboratory course to accompany CHM 120-125 with emphasis upon concepts in chemistry, quantitative and qualitative analysis, and introduction to instrumental methods. One four-hour period. Successful completion of CHM 120 and CHM 120L fulfills the GEP natural science requirement.

*Attributes:* GEP Natural Science, Undergraduate

## CHM 121 General Chemistry Honors I (3 credits)

The material covered in this honors course is the same as CHM 120-125 but more extensive in depth. Additional topics may be added as time permits. The course assumes that the student has had chemistry in high school. The format of the course may differ from the standard lecture model. Fulfills the GEP natural science requirement.

*Attributes:* GEP Natural Science, Honors Course, Science Course w/Lab (Sci Maj), Undergraduate

## CHM 125 General Chemistry II (3 credits)

Topics included are chemical formulas, stoichiometry, balancing reactions, ideal gases, thermodynamics, atomic structure, chemical bonding and molecular structure, kinetics, equilibrium, the chemistry of acids and bases, entropy, free energy, and electrochemistry.

*Prerequisites:* CHM 120 or CHM 121 or CH 101 or CH 111

*Attributes:* Science Course w/Lab (Sci Maj), Undergraduate

## CHM 125L General Chemistry Lab II (1 credit)

A lecture-laboratory course to accompany CHM 120-125 with emphasis upon concepts in chemistry, quantitative and qualitative analysis, and introduction to instrumental methods. One four-hour period.

*Prerequisites:* CHM 120L or CH 103 or CH 113

*Attributes:* Undergraduate

## CHM 126 General Chemistry Honors II (3 credits)

The material covered in this honors course is the same as CHM 120-125 but more extensive in depth. Additional topics may be added as time permits. The course assumes that the student has had chemistry in high school. The format of the course may differ from the standard lecture model.

*Prerequisites:* CHM 120 or CHM 121

*Attributes:* Honors Course, Science Course w/Lab (Sci Maj), Undergraduate

**CHM 150 First Year Seminar (3 credits)**

The First-Year Seminar (FYS) is designed to introduce students to the adventures of learning in a college context. The challenge and excitement of intellectual exploration of a topic of shared interest is its prime purpose. First-Year Seminars focus in depth on a question or topic of disciplinary or interdisciplinary interest. By means of its specific focus, the seminar will explore the thinking, research, and writing practices in a particular field. Discussions based on careful reading of texts, writing assignments, both reflection and research types, and in-class student presentations will be supplemented, as appropriate, with activities including guest lecturers, museum trips, attendance at local cultural events and/or field excursions. Topics vary according to individual instructors. First year seminar.

*Attributes:* First-Year Seminar, Undergraduate

**CHM 170 Special Topics in Chemistry (3 credits)**

Advanced study on a topic that is arranged with a Chemistry faculty member.

*Attributes:* Undergraduate

**CHM 204 Literature of Chemistry (1 credit)**

The study of the nature and uses of the primary, secondary, and tertiary literature of chemistry and biochemistry and of modern information-retrieval techniques.

*Attributes:* Undergraduate

**CHM 210 Organic Chemistry I (3 credits)**

Modern organic chemistry in which the treatment of aliphatic and aromatic compounds is integrated as much as possible. Reactions of the functional groups are explained in terms of electronic mechanisms.

*Prerequisites:* CHM 125 or CHM 126 or CH 102 or CH 112

*Attributes:* Undergraduate

**CHM 210L Organic Chemistry Lab I (1 credit)**

This semester concentrates on experiments designed to introduce students to the various techniques used in the organic laboratory.

*Prerequisites:* CHM 125L or CH 114 or CH 104

*Attributes:* Undergraduate

**CHM 215 Organic Chemistry II (3 credits)**

Modern organic chemistry in which the treatment of aliphatic and aromatic compounds is integrated as much as possible. Reactions of the functional groups are explained in terms of electronic mechanisms.

*Prerequisites:* CHM 210 or CH 201 or CH 211

*Attributes:* Undergraduate

**CHM 215L Organic Chemistry Lab II (1 credit)**

A continuation of CHM 210L utilizing micro scale laboratory techniques in organic chemistry for the preparation, purification and analysis of organic compounds.

*Prerequisites:* CHM 210L or CH 203 or CH 213

*Attributes:* Undergraduate

**CHM 230 Basic Inorganic Chemistry (3 credits)**

Introduction to basic inorganic chemistry, including elementary bonding theories, the chemistry of elements other than carbon, coordination chemistry, acid-base chemistry, organometallic chemistry, and solid-state chemistry.

*Prerequisites:* (CH 102 or CH 112 or CHM 125) and (CH 104 or CH 114 or CHM 125L)

*Attributes:* Undergraduate

**CHM 270 Special Topics in Chemistry (3 credits)**

Advanced study on a topic that is arranged with a Chemistry faculty member.

*Attributes:* Undergraduate

**CHM 293 Sophomore Research Studies I (3,6 credits)**

Integrated literature and laboratory investigation of an assigned problem under the supervision of a departmental faculty member. Each credit of CHM 293-294 requires four hours each week in the research laboratory. Students need to complete the application form for independent study and have the approval of the Chemistry Department Chair and Associate Dean in order to register.

*Attributes:* Undergraduate

**CHM 294 Sophomore Research Studies II (3,6 credits)**

Integrated literature and laboratory investigation of an assigned problem under the supervision of a departmental faculty member. Each credit of CHM 293-294 requires four hours each week in the research laboratory. Students need to complete the application form for independent study and have the approval of the Chemistry Department Chair and Associate Dean in order to register.

*Attributes:* Undergraduate

**CHM 300 Discussions in Chemistry (1 credit)**

Discussion of ethical issues and research opportunities in the chemical sciences as well as career planning.

*Attributes:* Undergraduate

**CHM 310 Physical Chemistry I (3 credits)**

Covers thermodynamic principles and applications to gases, liquids, and ideal and non-ideal solutions; thermodynamics of chemical reactions and equilibria, electrochemistry and reaction kinetics.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 310L Physical Chemistry Lab I (2 credits)**

Experiments are performed to reinforce the concepts learned in CHM 310

*Attributes:* Undergraduate

**CHM 315 Physical Chemistry II (3 credits)**

Quantum Chemistry. The fundamental postulates of quantum mechanics are introduced in the form of historical narrative to illustrate the logical progression to quantization in natural theory. Eigenvalue problems, operator mathematics, uncertainties and orthonormality are discussed as essential portions of quantum mechanical calculations. The Schrodinger equations for the harmonic oscillator and rigid rotor are solved and related specifically to molecular spectroscopy techniques. The course ends with the description of the hydrogen atom in terms of quantum mechanics, with emphasis on the origin of the familiar atomic orbitals.

*Prerequisites:* CHM 310

*Attributes:* Undergraduate

**CHM 315L Physical Chemistry Lab II (2 credits)****CHM 318 Essentials of Physical Chem (4 credits)**

Fundamental concepts of physical chemistry: aspects of thermodynamics including the first and second laws, chemical and phase equilibria, solutions, surface chemistry, reaction kinetics, introduction to quantum chemistry including QM postulates/Schrodinger equation/particle in a box, rigid rotor and harmonic oscillator/hydrogen atom/many electron atom, chemical bond, molecular structure, introduction to statistical mechanics including Boltzmann distribution/partition functions.

*Prerequisites:* PY 212 or PHY 212

*Attributes:* Undergraduate

**CHM 320 Physical Chem for Chem Bio (3 credits)**

Study of atomic and molecular structure; chemical thermodynamics; states of matter; kinetics and mechanisms of reactions; phase and chemical equilibria; emphasis on applications in biological systems.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 321 Physical Chemistry I (4 credits)****CHM 322 Physical Chemistry II (4 credits)**

Continuation of Physical Chemistry I, including quantum chemistry, reaction kinetics, spectroscopy, photochemistry, statistical mechanics, and theories of reaction rates.

*Prerequisites:* CH 321 or CHM 310

*Attributes:* Undergraduate

**CHM 330 Instrumental Analysis (3 credits)**

This course covers the theory, methodology, and instrumentation for the study of atomic and molecular species and/or processes.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 330L Instrumental Analysis Lab (2 credits)**

CHM 330 is a co-requisite to CHM 330L.

*Prerequisites:* CHM 215L

*Attributes:* Undergraduate

**CHM 335 Survey of Biochemistry (3 credits)**

This survey of biochemistry uses a descriptive approach to biological molecules, including both structure and function. Cellular components, biochemical reactions, metabolism, and the workings of the genetic code will all be discussed. Overall, a general understanding of biochemistry and its relationship to the world around us will be provided.

*Prerequisites:* (BS 119 or BIO 119) or (BS 133 or BIO 133) and (CH 202 or CHM 215)

*Attributes:* Undergraduate

**CHM 340 Biochemistry (3 credits)**

A basic introduction to the chemistry of living systems emphasizing their major metabolic activities. Structure and function of proteins, lipids, and carbohydrates. Basic principles of intermediary metabolism and photosynthesis.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 340L Biochemistry Lab (2 credits)**

Laboratory applications of the topics covered in CHM 340. CHM 340 is a co-requisite to CHM 340L.

*Prerequisites:* CHM 215L and CHM 340 (may be taken concurrently)

*Attributes:* Undergraduate

**CHM 341 Molecular Structure Biochemist (3 credits)**

This introduction to biochemistry covers protein structure and function, enzyme kinetics and mechanisms, membrane structure and function, and principles of biological regulation.

*Prerequisites:* CH 212 or CH 202 or CHM 215

*Attributes:* Undergraduate

**CHM 342 Nucleic Acid Biochemistry (3 credits)**

Focused on molecular genetics. Topics include structure, replication, transcription, translation, repair, recombination, and processing of nucleic acids; control of gene expression; and modern recombinant methods of DNA splicing, cloning, and sequencing.

*Prerequisites:* CH 341 and BS 462 and BS 462L

*Attributes:* Undergraduate

**CHM 343 Intermediary Metabolic Biochem (3 credits)**

Catabolic and anabolic pathways with emphasis on chemical logic, mechanisms, and regulatory control. Also includes carbohydrate, lipid, amino acid, and nucleotide metabolism, and oxidative and photosynthetic phosphorylation.

*Prerequisites:* CH 341

*Attributes:* Undergraduate

**CHM 346 Biochemistry (4 credits)**

An introduction to biochemistry that includes structure of proteins, nucleic acids, and membranes; enzyme kinetics and mechanisms; membrane transport; central metabolic pathways and their regulation; and basic methods of biochemistry.

*Prerequisites:* CH 202 or CHM 215

*Attributes:* Undergraduate

**CHM 350 Inorganic Chemistry (3 credits)**

This course includes the study of atomic structure, bonding, molecular orbital theory, symmetry and group theory, the chemistry of the main group elements, and the structure and reactivity of transition metal complexes.

*Prerequisites:* CHM 215 or CH 212 or CH 331

*Attributes:* Undergraduate

**CHM 350L Inorganic Chemistry Lab (2 credits)**

This course focuses on synthetic inorganic chemistry and emphasizes the use of modern analytical techniques for the characterization of inorganic and organometallic compounds. CHM 350 is a co-requisite for CHM 350L.

*Prerequisites:* CHM 215L

*Attributes:* Undergraduate

**CHM 356 Molecular Biology and Genetics (3 credits)**

Introduction to molecular biology and genetics. The biochemistry of the synthesis of DNA, RNA, and proteins and their regulation will be studied. We will also investigate the importance of genetic information to biochemistry and medicine.

*Prerequisites:* CH 346

*Attributes:* Undergraduate

**CHM 360 Nanochemistry (3 credits)**

This course covers the synthesis, characterization and physical properties of materials chemistry systems on the length scale of individual molecules. Emphasis is placed on the distinction between macro- and nanoscale properties of matter. Course topics to include (but not limited to): quantum confinement in semiconductor nanocrystals; localized surface plasmon resonance (LSPR), superhydrophobicity in self-assembled monolayers; electronic and mechanical properties of 2D materials

*Prerequisites:* CHM 215 and (MAT 161 or MAT 155) and (PHY 102 (may be taken concurrently) or PHY 106 (may be taken concurrently))

*Attributes:* Undergraduate

**CHM 361 Analytical Chemistry (3 credits)**

Introductory analytical chemistry with emphasis on relevant chemical principles, combining both classical and modern instrumental techniques.

*Prerequisites:* (CH 102 or CH 112 or CHM 125) and (CH 104 or CH 114 or CHM 125L)

*Attributes:* Undergraduate

**CHM 361L Analytical Chemistry Laborator (1 credit)****CHM 370 Special Topics in Chemistry (3 credits)**

Advanced study on a topic that is arranged with a Chemistry faculty member.

*Attributes:* Undergraduate

**CHM 390 Chemistry Seminar (0 credits)**

Lectures by outside and local speakers and discussions of special topics in chemistry. Enrollment is required each semester for junior and senior chemistry majors.

*Attributes:* Undergraduate

**CHM 393 Junior Research I (3,6 credits)**

Integrated literature and laboratory investigation of an assigned problem under the supervision of a departmental faculty member. Each credit of CHM 393-394 requires four hours each week in the research laboratory. Students need to complete the application form for independent study (available in the Dean's Office) and have the approval of the Chemistry Department chair and Associate Dean in order to register.

*Attributes:* Undergraduate

**CHM 394 Junior Research II (3,6 credits)**

Integrated literature and laboratory investigation of an assigned problem under the supervision of a departmental faculty member. Each credit of CHM 393-394 requires four hours each week in the research laboratory. Students need to complete the application form for independent study (available in the Dean's Office) and have the approval of the Chemistry Department chair and Associate Dean in order to register.

*Prerequisites:* CHM 393 or CHM 293

*Attributes:* Undergraduate

**CHM 400 Chemistry of the Earth (3 credits)**

This course examines the chemical processes that control the distribution, speciation, and transfer of essential elements and energy in natural systems. Topics include: the concept of the Earth as a biogeochemical system; the use of quantitative methods to model the chemical fluxes of elements on a global scale; dominant chemical reactions in natural environments, evolution of metabolic pathways; the biogeochemical cycling of water, carbon, nitrogen, phosphorus, sulfur, and select heavy metals under natural and anthropogenically-influenced conditions. CHM 340 can be taken concurrently with CHM 400.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 401 Seminar in Chemistry I (1 credit)**

Chemical and biochemical topics of current interest presented orally by students and invited guest speakers. Writing, speech, delivery, and use of visual aids are critiqued. All biochemistry, chemistry, and pharmaceutical chemistry majors, and other interested persons are invited to attend.

*Attributes:* Undergraduate

**CHM 402 Seminar in Chemistry II (1 credit)**

Lectures by outside and local speakers and discussions of special topics in Chemistry

*Prerequisites:* CH 401

*Attributes:* Undergraduate

**CHM 410 Biophysical Chemistry (3 credits)**

This course utilizes the concepts of physical chemistry to understand the properties of biological systems.

*Prerequisites:* CHM 310 or CHM 320

*Attributes:* Undergraduate

**CHM 410L Biophysical Chemistry Lab (1 credit)****CHM 411 Medicinal Chemistry (3 credits)**

A study of the biochemical mechanisms of drug action in order to develop a rational approach to the analysis of drugs and their metabolites and to design new drugs.

*Prerequisites:* CH 341 or CHM 341

*Attributes:* Undergraduate

**CHM 414 Structure-Activity Relationships (3 credits)**

Selected classes of medicinal agents are examined, stressing general structures, synthesis, and, in particular, the relationships between structure and pharmacological activity.

*Prerequisites:* CH 212 or CHM 215

*Attributes:* Undergraduate

**CHM 416L Chemical Synthesis Laboratory (3 credits)**

Techniques of organic and inorganic synthesis, including reaction control, vacuum and fractional distillation, uniform reagent addition, controlled stirring, operation in inert atmosphere, safe handling of toxic or unstable reagents, and chromatographic purification.

*Prerequisites:* (CH 212 and CH 214 and CH 368) or CHM 330L

*Attributes:* Undergraduate

**CHM 420 Atmospheric Environmental Chem (3 credits)**

This course examines the behavior of chemical species in the atmosphere. Topics include: stratospheric chemistry and the role of ozone, tropospheric chemistry and photochemical smog formation, precipitation, aerosol chemistry, indoor and urban air quality and regulatory efforts, energy, the chemistry of global climate and potential mitigation strategies, biogeochemical cycling of elements, and green chemistry.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 430 Mechanisms in Organic Chem (3 credits)**

Application of the electron pushing formalism for manipulating Lewis structure representations of organic structures. Emphasis is placed on mechanistic rationalization of complex organic transformations. Classes of mechanisms include elimination, substitution, rearrangement, oxidation-reduction, enolate alkylation, and others.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 435 Tech Applications of Chemistry (3 credits)**

Course will focus on current and future technologies that utilize fundamental and advanced theories of chemistry. Topics will include, but are not limited to, microwave ovens, liquid crystal displays (LCD), light emitting diode displays (LED), plasma screens, charge coupled devices (CCD), field effect transistors (FET), positron emission tomography (PET), magnetic resonance imaging (MRI), battery systems, data storage devices, and solar panels.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 440 Organometallic Chemistry (3 credits)**

This course will focus on the structure and reactivity of organometallic transition metal complexes. Topics include catalysis, reaction mechanisms, applications to organic chemistry, and characterization by spectroscopic methods.

*Prerequisites:* CHM 350

*Attributes:* Undergraduate

**CHM 444L Biochemistry Laboratory I (1 credit)**

Techniques of isolation, purification, and assay of representative biomolecules, particularly proteins.

*Prerequisites:* (CH 341 or CHM 341)

*Attributes:* Undergraduate

**CHM 445 Thermodynamics & Stat Mechanic (3 credits)****CHM 445L Biochemistry Laboratory II (1 credit)****CHM 448 Computer-Aided Drug Design (3 credits)**

Introduction to the theory and practice of molecular modeling, especially as applied to the problem of identifying and designing bioactive and therapeutic agents, using specialized software and advanced computer hardware such as workstations and supercomputer clusters.

*Prerequisites:* CH 341

*Attributes:* Undergraduate



**CHM 450 Polymer Chemistry (3 credits)****CHM 460 Aqueous Environmental Chem (3 credits)**

This course examines the behavior of chemical species in natural and engineered water systems and their interactions with the terrestrial environment. Topics include: the chemical composition of surface and subsurface water; geochemical controls on water composition; equilibrium and kinetic processes in aquatic systems; fate and reactions of inorganic and organic constituents in water; acid-base chemistry, complexation chemistry, and redox chemistry in water; the applications of isotopic and other tracers in the study of aquatic systems; water pollution and treatment.

*Prerequisites:* CHM 215

*Attributes:* Undergraduate

**CHM 464 Pharmaceutical Analytical Chem (3 credits)**

The application of analytical chemical techniques to pharmaceutical materials and dosage forms. The development and evaluation of methods appropriate for pharmaceutical materials.

*Prerequisites:* CH 376 or CHM 330

*Attributes:* Undergraduate

**CHM 464L Pharm Analytical Chemistry Lab (1 credit)**

The application of analytical chemical techniques to pharmaceutical materials and dosage forms. The development and evaluation of methods appropriate for pharmaceutical materials.

*Prerequisites:* CH 368 or CHM 330L

*Attributes:* Undergraduate

**CHM 470 Special Topics (3 credits)**

Advanced study on a topic that is arranged with a chemistry faculty member. Permission of the Department of Chemistry chair is required.

*Attributes:* Undergraduate

**CHM 480 Inorganic Biochemistry (3 credits)**

The chemical and biological properties of various metal ions in biological systems will be examined at the molecular level. Permission of the Department of Chemistry chair is required.

*Prerequisites:* CHM 215 and CHM 340

*Attributes:* Undergraduate

**CHM 490 Spectroscopy (3 credits)**

This course provides an exposure to aspects of spectroscopic theory, methods, and instrumentation that are not covered in Instrumental Analysis.

*Prerequisites:* CHM 330

*Attributes:* Undergraduate

**CHM 491 Chemistry Internship I (3 credits)****CHM 492 Chemistry Internship II (3 credits)****CHM 493 Senior Research I (3,6 credits)**

Integrated literature and laboratory investigation of an assigned problem under the supervision of a departmental faculty member. Includes a seminar, a poster presentation, and written reports. Each credit of CHM 493 and CHM 494 requires four hours each week in the research laboratory. Students need to complete the application form for independent study (available in the Dean's Office) and have the approval of the Chemistry Department chair and Associate Dean in order to register.

*Attributes:* Undergraduate

**CHM 494 Senior Research II (3,6 credits)**

Integrated literature and laboratory investigation of an assigned problem under the supervision of a departmental faculty member. Includes a seminar, a poster presentation, and written reports. Each credit of CHM 493 and CHM 494 requires four hours each week in the research laboratory. Students need to complete the application form for independent study (available in the Dean's Office) and have the approval of the Chemistry Department chair and Associate Dean in order to register.

*Prerequisites:* CHM 493

*Attributes:* Undergraduate

**CHM 495 Undergraduate Research (1-3 credits)**

Qualified students may elect to carry out research in analytical, inorganic, organic, or physical chemistry or biochemistry under the direction of a member of the department.

**CHM 522 Physical Chemistry II (4 credits)**

Continuation of Physical Chemistry I, including quantum chemistry, reaction kinetics, spectroscopy, photochemistry, statistical mechanics, and theories of reaction rates.

**CHM 530 Instrumental Analysis (3 credits)**

This course covers the theory, methodology, and instrumentation for the study of atomic and molecular species and/or processes.

*Restrictions:* Enrollment is limited to Doctoral or Graduate level students.

**CHM 560 Nanochemistry (3 credits)**

This course covers the synthesis, characterization and physical properties of materials chemistry systems on the length scale of individual molecules. Emphasis is placed on the distinction between macro- and nanoscale properties of matter. Course topics to include (but not limited to): quantum confinement in semiconductor nanocrystals; localized surface plasmon resonance (LSPR), superhydrophobicity in self-assembled monolayers; electronic and mechanical properties of 2D materials

*Restrictions:* Students with the University Sciences Legacy attribute may **not** enroll.

*Attributes:* Doctoral

**CHM 570 Special Topics (4 credits)****CHM 620 Atmospheric Environmental Chem (3 credits)**

This course examines the behavior of chemical species in the atmosphere. Topics include: stratospheric chemistry and the role of ozone, tropospheric chemistry and photochemical smog formation, precipitation, aerosol chemistry, indoor and urban air quality and regulatory efforts, energy, the chemistry of global climate and potential mitigation strategies, biogeochemical cycling of elements, and green chemistry.

*Restrictions:* Students with the University Sciences Legacy attribute may **not** enroll.

*Attributes:* Doctoral

**CHM 640 Organometallics (3 credits)**

This course will focus on the structure and reactivity of organometallic transition metal complexes. Topics include catalysis, reaction mechanisms, applications to organic chemistry, and characterization by spectroscopic methods.

*Restrictions:* Students with the University Sciences Legacy attribute may **not** enroll.

*Attributes:* Doctoral

**CHM 660 Aqueous Environmental Chem (3 credits)**

This course examines the behavior of chemical species in natural and engineered water systems and their interactions with the terrestrial environment. Topics include: the chemical composition of surface and subsurface water; geochemical controls on water composition; equilibrium and kinetic processes in aquatic systems; fate and reactions of inorganic and organic constituents in water; acid-base chemistry, complexation chemistry, and redox chemistry in water; the applications of isotopic and other tracers in the study of aquatic systems; water pollution and treatment.

*Restrictions:* Students with the University Sciences Legacy attribute may **not** enroll.

*Attributes:* Doctoral

**CHM 680 Inorganic Biochemistry (3 credits)**

The chemical and biological properties of various metal ions in biological systems will be examined at the molecular level. Permission of the Department of Chemistry chair is required.

*Restrictions:* Students with the University Sciences Legacy attribute may **not** enroll.

*Attributes:* Doctoral

**CHM 700 Intro to Graduate Studies (1-3 credits)**

Individualized coursework designed to strengthen a student's background prior to taking advanced graduate courses.

*Restrictions:* Enrollment is limited to Graduate level students.

**CHM 711 Medicinal Chemistry (3 credits)**

A study of the biochemical mechanisms of drug action in order to develop a rational approach to the analysis of drugs and their metabolites and to design new drugs.

**CHM 714 Structure-Activity Relation (3 credits)**

Selected classes of medicinal agents are examined, stressing general structures, synthesis, and, in particular, the relationships between structure and pharmacological activity.

*Restrictions:* Enrollment is limited to Graduate level students.

**CHM 716 Chemical Synthesis Laboratory (3 credits)**

Techniques of organic and inorganic synthesis, including reaction control, vacuum and fractional distillation, uniform reagent addition, controlled stirring, operation in inert atmosphere, safe handling of toxic or unstable reagents, and chromatographic purification.

**CHM 718 Heterocyclic Chemistry (3 credits)**

A study of the major types of aromatic and nonaromatic heterocyclic compounds with a special interest in those having biochemical activity: their synthesis, physical properties, reactivity, and influence on living systems, etc.

**CHM 720 Applications of Computational (3 credits)**

Introduction to the theory and applications of computational chemistry methods, including quantum mechanics, density functional theory, and classical molecular dynamics simulation methods. Project-based exercises on applying the above methods to chemical/biochemical processes while utilizing state-of-the-art computational software packages.

**CHM 721 Chemical Kinetics (3 credits)**

The Study of theoretical aspects of reaction kinetics and the experimental methods used to measure the rates of reactions.

**CHM 728 Advanced Biochemistry (3 credits)**

Selected topics in protein structure and function, especially enzymology.

*Restrictions:* Enrollment is limited to Graduate level students.

**CHM 733 Computational Chemistry (3 credits)**

This course will give hands on training in current computational chemistry methods. Particularly on how to manipulate large data sets through computational algorithms and programs. The course will explore and have hands on training with practical computational methods currently used in modern computational research.

*Restrictions:* Enrollment is limited to Graduate level students.

**CHM 748 Computer Aided Drug Design (3 credits)**

Introduction to the theory and practice of molecular modeling, especially as applied to the problem of identifying and designing bioactive and therapeutic agents, using specialized software and advanced computer hardware such as workstations and supercomputer clusters.

*Restrictions:* Enrollment limited to students with the University Sciences Legacy attribute.

*Attributes:* Doctoral

**CHM 764 Pharmaceutical Analytical Chem (3 credits)**

In-depth treatment of the principles and practice of analytical chemistry and instrumental methods as applied to drug analysis, pharmaceutical product quality, concentration of drug and metabolites in biological fluids, drug formulation, etc., with an emphasis on HPLC methods.

*Restrictions:* Enrollment is limited to Graduate level students.

**CHM 786 Research Ethics (1 credit)**

This course will provide an examination of ethical behavior and practice in scientific research. The course will follow a case study format in which students will be expected to present and participate in group discussions.

*Restrictions:* Enrollment limited to students with the University Sciences Legacy attribute.

*Attributes:* Doctoral

**CHM 802 Research Seminar (2 credits)**

Students present a formal seminar based on their research endeavors.

*Restrictions:* Enrollment is limited to Doctoral or Graduate level students.

*Attributes:* Doctoral

**CHM 813 Chem of Surfaces & Interfaces (3 credits)**

This hybrid lecture/lab course will cover the thermodynamics, phenomenology, and chemistry of surfaces and interfaces. Lectures will be capped by three weeks of a lab practicum covering the methods of surface analysis and characterization.

*Restrictions:* Enrollment limited to students with the University Sciences Legacy attribute.

*Attributes:* Doctoral

**CHM 815 Intro to Polymer Chemistry (3 credits)**

This course will cover basic concepts and the most important topics in modern polymer science including synthesis, physical properties, and current applications.

*Attributes:* Doctoral

**CHM 828 Biophysical & Biochemical Meth (3 credits)**

This course will provide a survey of important biophysical and biochemical methods with special emphasis on applications to drug discovery and design. Topics include single-molecule techniques, calorimetry, binding and high throughput screening, kinetic modeling, spectroscopy, computer simulation and others. Results from the current literature that rely on these techniques will be reviewed.

**CHM 878 Introduction to Research (1 credit)**

A laboratory rotation through two seven-week chemical, biochemical, or pharmacognosy research projects for graduate students matriculated in a graduate program in the Department of Chemistry & Biochemistry.

*Restrictions:* Enrollment is limited to Doctoral level students.

*Attributes:* Doctoral

**CHM 887 Graduate Colloquium (1 credit)**

This course will highlight and help students develop the skills needed to be successful graduate school. We will discuss many components of the graduate school, such as (but not limited to) reading and critiquing papers, writing papers and grants, getting along with lab mates, and being an effective instructor. We will go over some strategies for life balance which will include having fun and learning during this process. This course will help you prepare you for the next step(s) in your career.

*Restrictions:* Enrollment limited to students with the University Sciences Legacy attribute.

*Attributes:* Doctoral

**CHM 892 Non-trivial Problems in Chem (3 credits)**

This course will discuss the practical aspects of solving everyday problems encountered in research in the physical and natural sciences. Students will apply knowledge from different fields of chemistry and various other scientific disciplines to solve chemical problems. Students will also learn the application of mathematical modeling and numerical fitting to quantitatively determine solutions to these problems.

*Restrictions:* Enrollment is limited to Doctoral or Graduate level students. Enrollment limited to students with the University Sciences Legacy attribute.

*Attributes:* Doctoral

**CHM 897 Scientific Proposals (3 credits)**

This course is designed to guide students in the development of an F31 - Kirschstein NRSA grant application. The course is heavily weighted in writing and peer assessment of grant proposals. By the end of the course, students will be expected to have completed the Specific Aims page and Research Plan sections of the F31 application. For thesis students, the application must be focused on the student's approved research prospectus and build upon current research in the student's thesis laboratory. Student's without an approved research prospectus, part-time extramural thesis students and non-thesis graduate students will develop a grant application focused on a research project of interest.

*Attributes:* Doctoral

**CHM 899 Graduate Research (1-9 credits)**

Candidates for the Doctor of Philosophy degree, specializing in chemistry, biochemistry, or pharmacognosy, are required to fulfill their research requirement under the direction of a faculty member in the department graduate program.

*Restrictions:* Enrollment is limited to Doctoral level students.

*Attributes:* Doctoral