

# CHEMISTRY AND BIOCHEMISTRY

Nicholas Burgis, Chair of Chemistry, Biochemistry department web page (<https://www.ewu.edu/cstem/chemistry-biochemistry/>)

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## Faculty

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## Degrees

BA–Chemistry/Biochemistry–Chemistry (<http://catalog.ewu.edu/stem/chem-phys/chemistry/chemistry-biochemistry-general-option-ba/>)

BAE–Chemistry/Biochemistry/Secondary Major (<http://catalog.ewu.edu/stem/chem-phys/chemistry/chemistry-biochemistry-secondary-bae/>)

BS–Chemistry/Biochemistry–Chemistry (<http://catalog.ewu.edu/stem/chem-phys/chemistry/chemistry-biochemistry-standard-option-bs/>)

BS–Chemistry/Biochemistry Major with Biochemistry Option (<http://catalog.ewu.edu/stem/chem-phys/chemistry/chemistry-biochemistry-option-bs/>)

BS–Chemistry/Biochemistry Major with Forensic Science Option (<http://catalog.ewu.edu/stem/chem-phys/chemistry/chemistry-biochemistry-forensic-science-option-bs/>)

Minor–Chemistry/Biochemistry (<http://catalog.ewu.edu/stem/chem-phys/chemistry/chemistry-biochemistry-minor/>)

Minor–Chemistry/Biochemistry Secondary (<http://catalog.ewu.edu/stem/chem-phys/chemistry/chemistry-biochemistry-secondary-minor/>)

Minor–Environmental Chemistry (<http://catalog.ewu.edu/stem/chem-phys/chemistry/environmental-chemistry-minor/>)

Add-on Endorsement–General Science (<http://catalog.ewu.edu/stem/chem-phys/chemistry/general-science-add-on-endorsement/>)

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Required courses in these programs of study may have prerequisites. Reference the course description section for clarification.

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**Pre Admissions Requirements for Chemistry and Biochemistry:** students considering a major in Chemistry and Biochemistry should complete a high school chemistry course and mathematics courses through precalculus.

**General Admissions Requirements for Transfer Students:** students transferring from other institutions are urged to consult with the department chair to plan their Eastern program of study.

**Admissions Requirements for Chemistry Majors:** Chemistry courses must be taken in proper sequence and with certain prerequisites satisfied. To graduate within four years, chemistry majors must take CHEM 171, or HONS 171, and CHEM 171L, CHEM 172 and CHEM 172L, CHEM 173 and

CHEM 173L during their first year. The physics and mathematics supporting courses must also be started without delay. Students should complete the required calculus and physics courses prior to their junior year in order to have prerequisites for upper division chemistry courses. Completion of a computer programming course is recommended before taking CHEM 431.

**Grade Requirements:** due to the cumulative nature of chemistry courses, the department strongly recommends that students receive a grade  $\geq C$  in all prerequisite chemistry courses.

**Pre-Professional Programs:** students interested in the pre-professional programs should contact a departmental advisor regarding the curriculum, application procedures and professional aptitude examinations.

## Undergraduate Programs

Chemistry occupies a unique position within the modern sciences. Ultimately, most of the phenomena in the biological, geological, physical, environmental and medical sciences can be expressed in terms of the chemical and physical behavior of atoms and molecules. Because of chemistry's key role, majors in chemistry and biochemistry are well prepared to pursue careers in a wide variety of disciplines.

The department offers programs leading to the Bachelor of Science and the Bachelor of Arts. These programs prepare students for careers in chemistry, biochemistry, biotechnology, medicine and related fields, forensic science, environmental science and education. Each of the department's BS options in chemistry can be tailored so that the degree is certified by the American Chemical Society. BS degrees are recommended for students planning professional careers in chemistry or related areas, while BA degrees are recommended for students with other career goals.

Students majoring in chemistry have the opportunity to engage in research projects with department faculty and to gain experience with modern instrumental techniques including gas and liquid chromatography; ultra-violet, visible, infra-red, Raman, fluorescence, and atomic absorption spectrophotometry; nuclear magnetic resonance; and x-ray diffraction. Upon graduation, our students are knowledgeable, experienced and independent laboratory workers.

## Graduate Program

The Department of Chemistry does not offer a graduate degree program but does offer graduate-level coursework.

### Pre-Professional

**See The Department of Biology or Chemistry, Biochemistry & Physics sections of this catalog for curriculum descriptions.**

In order to complete degree requirements in four years and be prepared for professional school admission tests at the end of three, it is essential that students are enrolled in college-level chemistry and biology courses at the inception of their pre-professional curriculum. Thus preparation at the high school level should include one year each of biology, chemistry and physics as well as three or four years each of English and mathematics (through pre-calculus). Alternatively, taking a gap year between college and matriculation to a professional program is common and give applicants more time to complete undergraduate courses and also provides opportunity to gain more volunteer and clinical experience, as well as prepare for professional school entrance exams. Students transferring from other institutions including community colleges should consult with Eastern's Admissions Office for information regarding course equivalencies. Students are encouraged to contact Eastern's pre-

professional advisors prior to enrollment. Students must realize that admission to professional school is highly competitive and thus uncertain—nothing assures admission.

#### **Department of Biology**

E: biology@ewu.edu  
P. 509.359.7499

#### **Department of Chemistry, Biochemistry & Physics**

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P. 509.359.2447

### **PRE-VETERINARY MEDICINE**

#### **Program Description**

Generally, students will apply to a Veterinary Medicine College for their professional training and will thus tailor their programs accordingly. We strongly recommend that students planning a career in veterinary medicine contact the school(s) of their choice to learn their most current admission requirements. Contacting the program advisor is strongly advised.

#### **General Admissions Requirements For Pre-Veterinary Medicine**

In general, all programs require a year of general biology, a year of general chemistry, and at least two quarters of organic chemistry. Many programs also require genetics, physics and biochemistry as prerequisite courses. In addition, significant practical experience, under the supervision of a graduate veterinarian, is an essential requirement in the selection process for most colleges. Publications such as the American Association of Veterinary Medical Colleges Applicant Guide provide profile information on a school-by-school basis regarding admitted students.

### **PRE-DENTISTRY AND PRE-MEDICINE**

#### **Undergraduate Programs**

Admission requirements for Schools of Medicine, Dentistry or Veterinary Medicine are typically satisfied by a Bachelor of Science degree in either biology or chemistry with substantial coursework from both disciplines. The requirements of these professional schools are so demanding and frequently variable that it is imperative students contact a pre-medical, pre-dental or pre-veterinary medicine advisor immediately upon deciding to earn a degree in one of these areas and work closely with that advisor in developing a complete curriculum. The program of study may vary for each student dependent on their preparation, background or specific interests. Other majors may be chosen if the basic requirements are met (two years each of biology and chemistry, one year of physics with supporting mathematics and typically one year of biochemistry and/or molecular biology).

As a part of the selection process for admission to professional school, pre-medical and pre-dental students must also take a nationally administered evaluative test (Medical College Admission Test or Dental College Admission Test respectively). Since the MCAT or DAT is typically taken either at the end of the third or fourth academic year, it is imperative that students complete the basic science requirements during the first three years of study. For additional curriculum information and a complete list of courses required in a four-year program of study leading to the Bachelor of Science degree, see "Pre-Med" and "Biochemistry" major option descriptions under the Biology or Chemistry, Biochemistry & Physics Departments.

### **General Admissions Requirements For Majors In Pre-Medicine or Pre-Dentistry**

Because admission requirements can vary between individual professional schools, it is imperative that students directly contact schools of interest and ascertain specific requirements prior to the application process. Publications such as Medical School Admission Requirements and Admission Requirements of American Dental Schools provide profile information on a school-by-school basis regarding admitted students. Students must realize that admission to professional school is highly competitive and thus uncertain—nothing assures admission.

### **PRE-PHARMACY**

Pharmacy occupies both a unique and varied position within the health sciences. Undergraduate pharmacy education is largely founded in the biological and chemical sciences and is integrated with coursework in the humanities and social sciences. The curriculum of a school of pharmacy is designed to prepare graduates for a variety of professional careers. These include the practice of community retail and hospital pharmacy, clinical pharmacy, research or sales in the pharmaceutical industry and regulatory and administrative positions at either the state or federal level. Traditionally the pharmacist has been among the most accessible of the health-care team, serving as the first source of advice and assistance for common medical disorders. At present, due to an increased clinical emphasis in pharmacy education, pharmacists are more frequently involved in a direct, patient-oriented practice that includes responsibilities such as selecting and dispensing drug products, monitoring drug interactions and counseling patients.

#### **Degree Information For Pharmacy**

Most schools of pharmacy offer only one degree in pharmacy: the Doctor of Pharmacy (Pharm. D.). The Pharm. D. degree qualifies the student to take the State Board of Pharmacy Licensing Examination, a requirement for the practice of pharmacy in any state. The academic program leading to the Pharm. D. degree is divided in two parts. The first, termed the pre-professional program provides coursework in the basic sciences, mathematics, English, humanities and social sciences. The second, termed the professional program (four years) provides academic exposure to the practice of pharmacy and includes coursework in areas such as biochemistry, medicinal chemistry, pharmacology, anatomy, physiology, dispensing, law, therapeutics, pharmacokinetics and biostatistics. In addition, clerkships in community and clinical settings are required. Students should contact pharmacy schools of interest to determine specific pre-professional course requirements, and should also contact EWU pre-pharmacy advisors.

#### **General Admissions Requirements**

Admission to a school of pharmacy is highly competitive. Application to a school is normally initiated one year prior to transfer and may include application to both the university and the school. In addition to completion of pre-professional course requirements with a satisfactory GPA, the school will likely require a personal interview and/or successful completion of the Pharmacy College Admission Test (PCAT), a nationally administered evaluative test.

## **Chemistry Courses**

**CHEM 100. INTRODUCTION TO CHEMISTRY. 5 Credits.**

**Notes:** laboratory work is included.

**Pre-requisites:** MTHD 104 with a grade  $\geq$ C, or concurrent enrollment in MATH 114.

This course prepares those who have not had a satisfactory background in high school chemistry to take CHEM 161 and CHEM 161L, or CHEM 171 and CHEM 171L. Topics include the scientific method, SI and metric systems, unit conversions, atomic structure, periodic table, bonding, and stoichiometry.

**CHEM 121. CHEMISTRY AND ITS ROLE IN SOCIETY. 5 Credits.**

**Notes:** laboratory work is included.

**Satisfies:** a BACR for natural sciences.

Basic chemical principles are used to examine some of the chemistry that most directly impacts individuals and society on a day-to-day basis. The course is designed to develop in students an appreciation for the chemical basis of their bodies and their environment. Emphasis is placed on the dynamic nature of the field of chemistry and efforts are made to dispel many of the common misconceptions that nonscientists often have about chemistry and other natural sciences.

**CHEM 140. CRIMINALISTICS AND FORENSIC CHEMISTRY. 5 Credits.**

**Notes:** Laboratory work is included. Labs will focus on current forensic techniques.

**Pre-requisites:**  $\geq$ C in CHEM 100 or  $\geq$ C in CHEM 161 and CHEM 161L or  $\geq$ C in CHEM 171; or one year of high school chemistry.

This course provides an overview of forensic science and criminalistics including history and the modern role of forensic science in the judicial system. Topics covered include DNA typing, trace evidence analysis, firearms and tool marks, and impression evidence.

**CHEM 141. SUSTAINABLE CHEMISTRY. 5 Credits.**

**Cross-listed:** SUST 141.

**Notes:** lecture and lab.

**Pre-requisites:** MTHD 104 with a grade  $\geq$ C, or concurrent enrollment in MATH 114.

**Satisfies:** a BACR for natural science.

This course is an introduction to environmental chemistry, which looks at sustainability on an atomic level, tackling issues such as ocean acidification, climate change, and energy issues. Emphasis will focus on how chemistry can help us understand, approach and solve contemporary environmental problems.

**CHEM 161. GENERAL CHEMISTRY FOR THE HEALTH SCIENCES. 4 Credits.**

**Pre-requisites:** concurrent enrollment in or completion of MTHD 104 or math placement score. A high school chemistry course or CHEM 100 is highly recommended.

**Satisfies:** the completion of CHEM 161 and CHEM 161L combined counts as one BACR for natural science.

Course provides students pursuing pre-nursing, pre-dental hygiene, and allied health professions with a broad-based knowledge of the major concepts in general and inorganic chemistry. In addition, students will use instruments and techniques to analyze as well as demonstrate knowledge of safe practices in handling chemicals. Students who successfully complete the course will demonstrate analytical thinking and quantitative literacy.

**CHEM 161L. GENERAL CHEMISTRY LABORATORY FOR THE HEALTH SCIENCES. 1 Credit.**

**Notes:** quantitative and qualitative laboratory course.

**Pre-requisites:** completion of CHEM 161 or concurrent enrollment.

**Satisfies:** the completion of CHEM 161 and CHEM 161L combined counts as one BACR for natural science.

This course is a general chemistry laboratory for pre-nursing, pre-dental hygiene, and allied health science students. Students will use instruments and techniques to analyze as well as demonstrate knowledge of safe practices in handling chemicals.

**CHEM 162. ORGANIC CHEMISTRY FOR THE HEALTH SCIENCES. 4 Credits.**

**Pre-requisites:**  $\geq$ C- in CHEM 161 or permission from instructor; completion of MTHD 104 or math placement score.

**Satisfies:** the completion of CHEM 162 and CHEM 162L combined counts as one BACR for natural science.

The course is a survey of organic chemistry for pre-nursing, pre-dental hygiene and allied health science students. Topics include naming, properties and reactions of hydrocarbons, alcohols, ethers, amines and carbonyl compounds.

**CHEM 162L. ORGANIC CHEMISTRY LABORATORY FOR THE HEALTH SCIENCES. 1 Credit.**

**Notes:** quantitative and qualitative laboratory course.

**Pre-requisites:** completion of CHEM 162 or concurrent enrollment.

**Satisfies:** the completion of CHEM 162 and CHEM 162L combined counts as one BACR for natural science.

This course is an organic chemistry laboratory for pre-nursing, pre-dental hygiene and allied health science students. Topics include naming, properties and reactions of hydrocarbons, alcohols, ethers, amines and carbonyl compounds.

**CHEM 163. BIOCHEMISTRY FOR THE HEALTH SCIENCES. 4 Credits.**

**Pre-requisites:**  $\geq$ C- in CHEM 162 or permission from instructor; completion of MTHD 104 or math placement score.

This course is a survey of biochemistry for pre-nursing, pre-dental hygiene, and allied health science students. Topics include amino acids, proteins, enzymes, lipids, carbohydrates, nucleic acids, biotechnology, and metabolic pathways.

**CHEM 163L. BIOCHEMISTRY LAB FOR THE HEALTH SCIENCES. 1 Credit.**

**Notes:** quantitative and qualitative laboratory course.

**Pre-requisites:** completion of CHEM 163 or concurrent enrollment.

This course is a biochemistry laboratory for pre-nursing, pre-dental hygiene, and allied health science students. Topics include amino acids, proteins, enzymes, lipids, carbohydrates, nucleic acids, biotechnology, and metabolic pathways.

**CHEM 171. GENERAL CHEMISTRY I. 4 Credits.**

**Cross-listed:** HONS 171.

**Pre-requisites:**  $\geq$ C in MATH 141 or concurrent enrollment;  $\geq$ C in CHEM 100 or  $\geq$ C in CHEM 161 or one year of high school chemistry.

**Satisfies:** the completion of CHEM 171 and CHEM 171L combined counts as one BACR for natural science.

Introduces chemistry concepts such as uncertainty in measurements, nomenclature, structure of matter, chemical equations and stoichiometry, introductory thermochemistry, periodic properties and chemical bonding.

**CHEM 171L. GENERAL CHEMISTRY LABORATORY I. 1 Credit.**

**Pre-requisites:** completion or concurrent enrollment in CHEM 171, or HONS 171.

**Satisfies:** the completion of CHEM 171 or HONS 171 and CHEM 171L combined counts as one BACR for natural science.

Provides hands-on approaches to chemistry topics covered in CHEM 171.

**CHEM 172. GENERAL CHEMISTRY II. 4 Credits.**

**Pre-requisites:**  $\geq$ C- in CHEM 171, or HONS 171, and a  $\geq$ C in MATH 141.

**Satisfies:** the completion of CHEM 172 and CHEM 172L combined counts as one BACR for natural science.

Continuation of general chemistry topics, including properties of gases, liquids, and solids; intermolecular forces; properties of solutions; and chemical equilibrium, including acid-base and solubility equilibrium.

**CHEM 172L. GENERAL CHEMISTRY LABORATORY II. 1 Credit.**

**Pre-requisites:** completion or concurrent enrollment in CHEM 172.

**Satisfies:** the completion of CHEM 172 and CHEM 172L combined counts as one BACR for natural science.

Provides hands-on approaches to chemistry topics covered in CHEM 172.

**CHEM 173. GENERAL CHEMISTRY III. 4 Credits.**

**Pre-requisites:**  $\geq$ C- in CHEM 172.

Continuation of general chemistry topics, including chemical kinetics, thermodynamics, electrochemistry, transition metals and coordination chemistry.

**CHEM 173L. GENERAL CHEMISTRY LABORATORY III. 1 Credit.**

**Pre-requisites:** completion or concurrent enrollment in CHEM 173.

Provides hands-on approaches to chemistry topics covered in CHEM 173.

**CHEM 196. EXPERIMENTAL. 1-5 Credits.****CHEM 297. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-10 Credits.****CHEM 304. QUANTITATIVE ANALYSIS. 3 Credits.**

**Notes:** this course must be taken concurrently with CHEM 304L. This lecture meets three hours per week.

**Pre-requisites:** CHEM 173 and CHEM 173L and concurrent enrollment with CHEM 304L.

Theory and principles of analytical chemistry including statistical treatment of data, complex equilibria, gravimetric, and titrimetric analysis with an introduction to some elements of instrumental analysis.

**CHEM 304L. QUANTITATIVE ANALYSIS LAB. 3 Credits.**

**Notes:** this course must be taken concurrently with CHEM 304. This laboratory meets nine hours per week.

**Pre-requisites:** CHEM 173 and CHEM 173L and concurrent enrollment with CHEM 304.

Practice and principles of analytical chemistry including statistical treatment of data, complex equilibria, gravimetric, and titrimetric analysis with an introduction to some elements of instrumental analysis.

**CHEM 316. ENVIRONMENTAL CHEMISTRY. 4 Credits.**

**Notes:** Only students who have an ENVS-Chemistry option are required to take the concurrent lab course CHEM 316L. However it is open to any student enrolled in CHEM 316.

**Pre-requisites:** CHEM 163 and CHEM 163L, or CHEM 173 and CHEM 173L, and MATH 141 with a grade  $\geq$ C.

The course is an introduction to environmental chemistry covering both fundamental chemical principles and societal implications.

**CHEM 316L. ENVIRONMENTAL CHEMISTRY LAB. 1 Credit.**

**Pre-requisites:** concurrent enrollment in CHEM 316 or instructor approval.

This laboratory course demonstrates techniques used for monitoring substances in the environment.

**CHEM 319. MODERN INORGANIC CHEMISTRY. 4 Credits.**

**Pre-requisites:** CHEM 173 and CHEM 173L.

This course covers periodicity, group trends, structure-reactivity relationships of the elements and chemical reactions.

**CHEM 351. ORGANIC CHEMISTRY. 4 Credits.**

**Pre-requisites:** CHEM 173 and CHEM 173L.

An integrated study of fundamental organic chemistry for Chemistry majors and students planning on careers in medicine, dentistry, pharmacology, engineering, or related fields. Emphasizes nomenclature, bonding, reactivity, stereochemistry, synthetic methods, reaction mechanisms, physical properties, and spectrometric identification of the principal classes of organic compounds, including biochemical examples.

**CHEM 352. ORGANIC CHEMISTRY. 4 Credits.**

**Pre-requisites:** CHEM 351.

An integrated study of fundamental organic chemistry for Chemistry majors and students planning on careers in medicine, dentistry, pharmacology, engineering, or related fields. Emphasizes nomenclature, bonding, reactivity, stereochemistry, synthetic methods, reaction mechanisms, physical properties, and spectrometric identification of the principal classes of organic compounds, including biochemical examples.

**CHEM 353. ORGANIC CHEMISTRY. 3 Credits.**

**Pre-requisites:** CHEM 352.

A comprehensive study of the chemistry of polyfunctional carbon compounds.

**CHEM 371. PRE-MEDICAL, DENTAL, VETERINARY AND PHARMACY PREPARATION. 1 Credit.**

**Pre-requisites:**  $\geq$ C in CHEM 352 or concurrent enrollment.

Prepare students for their application to medical, dental, veterinary or pharmacy school and for professional activities.

**CHEM 372. ORGANIC CHEMISTRY LABORATORY I. 3 Credits.**

**Pre-requisites:** CHEM 351.

This course is an introduction to the elementary techniques of the organic laboratory; including synthesis, application of chromatography, and spectrometry. This is a laboratory course.

**CHEM 373. ORGANIC CHEM LABORATORY II. 3 Credits.**

**Pre-requisites:** CHEM 352 and CHEM 372.

This course emphasizes spectrometry, synthesis, structure determination and advanced techniques in isolation, purification and analysis. This is a laboratory course.

**CHEM 395. INTERNSHIP. 1-10 Credits.**

**Pre-requisites:** permission of the instructor, department chair and college dean.

**CHEM 396. EXPERIMENTAL COURSE. 1-6 Credits.****CHEM 397. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-10 Credits.****CHEM 399. DIRECTED STUDY. 1-10 Credits.**

**Pre-requisites:** permission of the instructor, department chair and college dean.

Library or laboratory study of a chemical problem.

**CHEM 416. ADVANCED ENVIRONMENTAL CHEMISTRY. 3 Credits.**

**Pre-requisites:** CHEM 304, CHEM 304L, CHEM 316 and CHEM 352 (or concurrent), or permission of the instructor.

This course includes a detailed study of atmospheric, soil, water, and waste water chemistry. Aspects of environmental/analytical chemistry will be introduced. Laboratory work will cover aspects of sampling, instrumental and automated analysis, and regulatory requirements. Students will concentrate in the area of their particular interest, leading to a comprehensive written research report and presentation. Laboratory work is included.

**CHEM 418. MODERN ANALYTICAL CHEMISTRY. 5 Credits.**

**Pre-requisites:** CHEM 304 and CHEM 304L.

Principles of recently developed methods of analytical chemistry.

**CHEM 419. ADVANCED INORGANIC CHEMISTRY OR SENIOR CAPSTONE. 5 Credits.**

**Cross-listed:** CHEM 490.

**Notes:** quantitative and qualitative laboratory work is included.

**Pre-requisites:** CHEM 319 and CHEM 422.

**Satisfies:** a university graduation requirement—senior capstone.

The course covers ionic, covalent and metallic bonding, complexes, symmetry, acids and bases, molecular structure, and thermodynamics of inorganic reactions. It also introduces mechanisms and organometallic chemistry of selected groups of elements.

**CHEM 420. INSTRUMENTAL ANALYSIS. 5 Credits.**

**Notes:** this is a laboratory course.

**Pre-requisites:** CHEM 304 and CHEM 304L or permission of the instructor.

This course introduces instrumental methods of analysis.

**CHEM 421. PHYSICAL CHEMISTRY. 4 Credits.**

**Notes:** for CHEM 421, completion of a computer programming course is strongly recommended.

**Pre-requisites:** PHYS 153, MATH 162.

Introduction to chemical thermodynamics. Gas properties, laws of thermodynamics and applications to chemical equilibria and phase equilibria.

**CHEM 422. PHYSICAL CHEMISTRY. 4 Credits.**

**Pre-requisites:** CHEM 421.

Chemical kinetics and introduction to quantum mechanics.

**CHEM 423. PHYSICAL CHEMISTRY. 3 Credits.**

**Pre-requisites:** CHEM 422.

Continuation of quantum mechanics of atoms and molecules. Vibrational, rotational and electronic spectroscopy.

**CHEM 431. PHYSICAL CHEMISTRY LABORATORY. 1 Credit.**

**Notes:** for CHEM 421, completion of a computer programming course is strongly recommended.

**Pre-requisites:** concurrent enrollment in CHEM 421.

(See your Chemistry/Biochemistry advisor.) These courses cover data treatment, current physicochemical techniques, computer applications to chemical systems. These are laboratory courses

**CHEM 432. PHYSICAL CHEMISTRY LABORATORY. 2 Credits.**

**Pre-requisites:** concurrent enrollment in CHEM 422.

These courses cover data treatment, current physicochemical techniques, computer applications to chemical systems. These are laboratory courses

**CHEM 433. PHYSICAL CHEMISTRY LABORATORY. 2 Credits.**

**Pre-requisites:** concurrent enrollment in CHEM 423.

These courses cover data treatment, current physicochemical techniques, computer applications to chemical systems. These are laboratory courses

**CHEM 440. ADVANCED PHYSICAL CHEMISTRY. 4 Credits.**

**Pre-requisites:** concurrent enrollment or completion of CHEM 423.

Further development of principles underlying molecular symmetry, group theory and quantum chemistry, with applications to molecular orbitals and molecular spectroscopy. Introduction to semi-empirical calculations of electronic properties of molecules and analysis of spectroscopic data.

**CHEM 445. TOPICS IN FORENSIC CHEMISTRY. 5 Credits.**

**Pre-requisites:** acceptance into BS forensic option.

This course includes a detailed investigation of current topics in forensic chemistry and forensic science. Topics will include courtroom testimony, laboratory accreditation, and analyst certification. Laboratory work is included.

**CHEM 450. ADVANCED FORENSIC CHEMISTRY. 5 Credits.**

**Pre-requisites:** acceptance into BS forensic option.

This course includes a detailed examination of the techniques of forensic chemistry including organic, inorganic, and instrumental analysis. Topics include gunshot residue, drugs and toxicology, paint, arson and explosives, and biochemical methods such as electrophoresis. Advanced topics in crime scene procedures, chain-of-custody, and quality assurance, will be discussed. Laboratory work is included.

**CHEM 465. ADVANCED ORGANIC CHEMISTRY. 2 Credits.**

**Pre-requisites:** CHEM 353 and CHEM 421 or permission of the instructor.

This course is an in-depth study of the mechanisms of organic reactions in vitro and in vivo, coupled to a detailed investigation of current techniques in structural analysis of organic compounds.

**CHEM 466. STRUCTURAL ANALYTICAL TECHNIQUES IN ORGANIC CHEMISTRY. 2 Credits.**

**Pre-requisites:** CHEM 353 and CHEM 421, or permission of the instructor.

This course is an in-depth study of modern analytical techniques used in the structural analysis of organic compounds. This course will comprise both theory and practical experience with the instruments. Topics covered include UV, IR, NMR, mass spectrometry, and chromatography. This is a laboratory course with lecture included.

**CHEM 480. BIOCHEMISTRY. 5 Credits.**

**Notes:** For the Biochemistry Option only. See your Chemistry/Biochemistry advisor.

**Pre-requisites:** CHEM 352 with a grade  $\geq$  C-.

This course covers elements of biochemistry, including the structures, activities and biological functions of the major classes of proteins, nucleic acids, carbohydrates and lipids.

**CHEM 481. INTERMEDIARY METABOLISM. 5 Credits.**

**Pre-requisites:** CHEM 480 with a grade  $\geq$  C-.

Biosynthesis and metabolism of nucleotides, carbohydrates, lipids, amino acids, and steroids; regulation and integration of biochemical pathways.

**CHEM 482. INTEGRATED TOPICS IN BIOCHEMISTRY AND BIOPHYSICS. 3 Credits.****Pre-requisites:** CHEM 480.

Explores energy pathways, signal transduction pathways and genetic information pathways in living organisms. Provides a chemical perspective of the key principles of bioenergetics and membrane transport. Specific topics, discussed at a molecular level, are selected from, but not limited to, the following: electron transport, proton pumping, and ATP production in mitochondria and chloroplasts; hormone induced signal transduction; RNA synthesis and processing, and protein synthesis and processing.

**CHEM 483. BIOCHEMISTRY LABORATORY 1. 2 Credits.****Pre-requisites:** CHEM 480, may be taken concurrently.

Analytical biochemistry with an emphasis on separation techniques and quantitation of proteins.

**CHEM 484. BIOCHEMISTRY LABORATORY 2. 2 Credits.****Pre-requisites:** CHEM 480.

Analytical biochemistry with an emphasis on enzymes and DNA.

**CHEM 490. ADVANCED INORGANIC CHEMISTRY OR SENIOR CAPSTONE. 5 Credits.****Cross-listed:** CHEM 419.**Notes:** quantitative and qualitative laboratory work is included.**Pre-requisites:** CHEM 319 and CHEM 422.**Satisfies:** a university graduation requirement—senior capstone.

The course covers ionic, covalent and metallic bonding, complexes, symmetry, acids and bases, molecular structure, and thermodynamics of inorganic reactions. It also introduces mechanisms and organometallic chemistry of selected groups of elements.

**CHEM 491. SENIOR THESIS. 4-6 Credits.****Notes:** 12-18 hours of lab per week. Students should expect to complete a CHEM 499 project with the professor prior to beginning CHEM 491.

CHEM 491 and CHEM 499 credits are not allowed in the same term with the same instructor.

**Pre-requisites:** senior standing, CHEM 499.**Satisfies:** a university graduation requirement—senior capstone.

Directed research in your area of chemistry leading to an oral presentation and written report. See your advisor for further information.

**CHEM 495. INTERNSHIP. 1-10 Credits.****Pre-requisites:** permission of the instructor, department chair and college dean.

Supervised chemistry-related experiences with a professional or business organization.

**CHEM 496. EXPERIMENTAL COURSE. 1-15 Credits.****CHEM 497. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-10 Credits.****CHEM 498. SEMINAR. 1-2 Credits.****Pre-requisites:** permission of the instructor.

Oral presentation of a chemical topic.

**CHEM 499. DIRECTED STUDY. 1-5 Credits.**

**Notes:** CHEM 491 and CHEM 499 credits are not allowed in the same term with the same instructor. Only 4 credits of CHEM 499 are applicable to any chemistry major track.

**Pre-requisites:** permission of the instructor, department chair and college dean.

Research on a chemical problem.

**CHEM 597. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-15 Credits.****CHEM 599. INDEPENDENT STUDY. 2-6 Credits.****Pre-requisites:** permission of the instructor, department chair and college dean.