Chemistry

Degrees Offered

Bachelor of Science in Chemistry (three tracks) certified by American Chemical Society (ACS)

- Chemistry
- Biochemistry
- Environmental Chemistry

Bachelor of Science in Biochemistry (non-ACS)

Program Description

Chemistry is the field of science associated with atoms and molecules, hence nanoscience and beyond. Overall, chemists focus their efforts to understand the behavior and properties of matter, the reactions and transformations that dictate chemical processes, and the creation of new substances. Chemistry is often considered the central science linking the physical sciences with engineering, medicine, and life sciences. The subject of chemistry is typically organized into more focused subdisciplines, including organic chemistry, physical chemistry, inorganic chemistry, biochemistry, analytical chemistry, theoretical/computational chemistry, and materials chemistry. A degree in chemistry examines these topics to promote a fundamental understanding of the world and an application toward technological problems. Professional chemists apply their knowledge in many different areas ranging from environmental and biochemical processes to the development of new materials. They work in academic environments, high-tech start-ups, and research and development laboratories associated with practically every advanced technological field including medicine, energy, biotechnology, computing, and agriculture.

The BS degree program in chemistry is approved by the American Chemical Society (ACS) with a more traditional chemistry track that can be tailored to optimize preparation consistent with a student's individual career goals offered along with specific curricular tracks emphasizing environmental chemistry or biochemistry. These degree tracks are designed to educate professionals for the varied career opportunities this central scientific discipline affords. The curricula are therefore founded in rigorous fundamental science complemented by application of these principles to the materials, energy, minerals, biochemical and/or environmental fields. It is strongly encouraged that those aspiring to enter PhD programs in chemistry or biochemistry are strongly advised to include undergraduate research among their elective hours. Others interested in industrial chemistry choose area of special interest elective courses, in both chemistry and other departments. A number of students complete a dual degree in chemistry and chemical engineering as an excellent preparation for industrial careers.

There is a separate BS degree in Biochemistry which is also offered. The BS degree program in biochemistry is designed to educate professionals for the varied career opportunities this scientific discipline affords, e.g. medicine, veterinary etc. Biochemistry is the field of science concerned with the chemical and physicochemical processes that occur within living organisms. It focuses on molecular genetics, protein science, and metabolism. Almost all areas of the life sciences are being uncovered and developed by biochemical methodology and research. Biochemistry focuses on understanding how biological molecules give rise to the processes that occur within living cells and between cells, which in turn relates greatly to the study and understanding of tissues, organs, organism and microorganism structure and function.

A degree in biochemistry examines these topics to promote a fundamental understanding of the fusion of chemistry and biology and an application toward technological problems. Professional biochemists apply their knowledge in many different areas ranging from environmental processes to the development of new biomaterials, to drug development and even novel renewable bioenergy systems. They work in academic environments, high-tech startups, and research and development laboratories associated with practically every advanced technological field including medicine, energy, biotechnology, computing, and agriculture.

The instructional and research laboratories located in Coolbaugh Hall are state-of-the-art facilities with modern instrumentation for synthesis and characterization of molecules and materials. Instrumentation includes gas chromatographs (GC), high-performance liquid chromatographs (HPLC), inductively coupled-plasma-atomic emission spectrometers (ICP-AES), field-flow fractionation (FFF) equipment, mass spectrometry equipment (MS, GC/MS, GC/MS/MS, PY/MS, PY/GC/MS, SFC/MS, MALDI-TOF), 400 MHz and 500 MHz nuclear magnetic resonance spectrometers (NMR), infrared spectrometers (FTIR), ultraviolet-visible (UV) spectrometers, thermogravimetric analyzers (TGA), differential scanning calorimeters (DSC), and others including equipment for microscopy, light scattering, and elemental analysis. In addition, the campus provides access to the Mines 2,144 core 23 teraflop supercomputer for computational research.

Program Educational Objectives (Bachelor of Science in Chemistry)

In addition to contributing toward achieving the educational objectives described in the Mines Graduate Profile and the ABET accreditation criteria, the BS curricula in chemistry are designed to:

- Impart mastery of chemistry fundamentals.
- Develop ability to apply chemistry fundamentals in solving open-ended problems.
- Impart knowledge of and ability to use modern tools of chemical analysis and synthesis.
- Develop ability to locate and use pertinent information from the chemical literature.
- Develop ability to interpret and use experimental data for chemical systems.
- Develop ability to effectively communicate in both written and oral formats.
- Prepare students for entry to and success in professional careers.
- Prepare students for entry to and success in graduate programs.
- Prepare students for responsible contribution to society.

Curriculum

The BS chemistry curricula, in addition to the strong basis provided by the common core, contain three components: chemistry fundamentals, laboratory and communication skills, and applications courses.

Chemistry fundamentals

- Analytical chemistry – sampling, method selection, statistical data analysis, error sources, theory of operation of analytical instruments (atomic and molecular spectroscopy, mass spectrometry, nuclear magnetic resonance spectroscopy, chromatography and other separation methods, electroanalytical methods, and thermal

methods), calibration, standardization, stoichiometry of analysis, equilibrium, and kinetic principles in analysis.

- Inorganic chemistry – atomic structure and periodicity, crystal lattice structure, molecular geometry and bonding (VSEPR, Lewis structures, VB and MO theory, bond energies, and lengths), metals structure and properties, acid-base theories, main-group element chemistry, coordination chemistry, term symbols, ligand field theory, spectra and magnetism of complexes, organometallic chemistry, and nanomaterials chemistry and design.
- Organic chemistry – bonding and structure, structure- physical property relationships, reactivity-structure relationships, reaction mechanisms (nucleophilic and electrophilic substitution, addition, elimination, radical reactions, rearrangements, redox reactions, photochemical reactions, and metal-mediated reactions), chemical kinetics, catalysis, major classes of compounds and their reactions, and design of synthetic pathways.
- Physical chemistry – thermodynamics (energy, enthalpy, entropy, equilibrium constants, free energy, chemical potential, non-ideal systems, standard states, activity, phase rule, phase equilibria, phase diagrams), electrochemistry, kinetic theory (Maxwell-Boltzmann distribution, collision frequency, effusion, heat capacity, equipartition of energy), kinetics (microscopic reversibility, relaxation processes, mechanisms and rate laws, collision and absolute rate theories), quantum mechanics (Schroedinger equations, operators and matrix elements, particle-in-a-box, simple harmonic oscillator, rigid rotor, angular momentum, hydrogen atom, hydrogen wave functions, spin, Pauli principle, LCAO method, MO theory, bonding), spectroscopy (dipole selection rules, rotational spectra, term symbols, atomic and molecular electronic spectra, magnetic spectroscopy, Raman spectroscopy, multiphoton selection rules, lasers), statistical thermodynamics (ensembles, partition functions, Einstein crystals, Debye crystals), group theory, surface chemistry, X-ray crystallography, electron diffraction, dielectric constants, dipole moments, and elements of computational chemistry.

Laboratory and communication skills

- Analytical methods – gravimetry, titrimetry, sample dissolution, quantitative spectroscopy, GC, HPLC, GC/MS, potentiometry, NMR, AA, ICP-AES
- Synthesis techniques – batch reactor assembly, inert-atmosphere manipulations, vacuum line methods, high-temperature methods, high-pressure methods, distillation, recrystallization, extraction, sublimation, chromatographic purification, product identification
- Physical measurements – refractometry, viscometry, colligative properties, FTIR, NMR
- Information retrieval – Chemical Abstracts online searching, CA registry numbers, Beilstein, Gmelin, handbooks, organic syntheses, organic reactions, inorganic syntheses, primary sources, ACS Style Guide
- Reporting – lab notebook, experiment and research reports, technical oral reports
- Communication – scientific reviews, seminar presentations, publication of research results

Applications

- Elective courses – application of chemistry fundamentals in chemistry elective courses or courses in another discipline e.g., chemical engineering, environmental science, materials science.
- Internship – summer or semester experience in an industrial or governmental organization working on real-world problems.
- Undergraduate research – open-ended problem solving in the context of a research project.

Degree Requirements for Bachelor of Science in Chemistry

Degree Requirements (Chemistry Track)

Freshman

Fall		lec	lab	sem.hrs
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
EDNS151	CORNERSTONE - DESIGN I			3.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
S&W	SUCCESS AND WELLNESS			1.0
				16.0

Spring		lec	lab	sem.hrs
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
PHGN100	PHYSICS I - MECHANICS			4.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				16.0

Sophomore

Fall		lec	lab	sem.hrs
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CHGN209	INTRODUCTION TO CHEMICAL THERMODYNAMICS			3.0
CHGN221	ORGANIC CHEMISTRY I			3.0
CHGN223	ORGANIC CHEMISTRY I LABORATORY			1.0
				15.0

Spring		**lec**	**lab**	**sem.hrs**
EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
HASS200	GLOBAL STUDIES			3.0
CHGN222	ORGANIC CHEMISTRY II			3.0
CHGN224	ORGANIC CHEMISTRY II LABORATORY			1.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
CHGN335	INSTRUMENTAL ANALYSIS			3.0
				16.0

Junior

Fall		**lec**	**lab**	**sem.hrs**
CHGN336	ANALYTICAL CHEMISTRY			3.0
CHGN337	ANALYTICAL CHEMISTRY LABORATORY			1.0
CHGN341	INORGANIC CHEMISTRY I			3.0
CHGN351	PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE I			4.0
CHGN395	INTRODUCTION TO UNDERGRADUATE RESEARCH			1.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
FREE	Free Elective			3.0
				18.0

Spring		**lec**	**lab**	**sem.hrs**
CHGN353	PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE II			4.0
CHGN323	QUALITATIVE ORGANIC ANALYSIS AND APPLIED SPECTROSCOPY			2.0
CHGN428	BIOCHEMISTRY			3.0
TECH ELECT	Technical Elective*			3.0
TECH ELECT	Technical Elective*			3.0
				15.0

Summer		**lec**	**lab**	**sem.hrs**
CHGN490	CHEMISTRY FIELD SESSION		18.0	6.0
				6.0

Senior

Fall		**lec**	**lab**	**sem.hrs**
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
CHGN ELECT	Chemistry Elective**			3.0
TECH ELECT	Technical Elective*			3.0
TECH ELECT	Technical Elective*			3.0
FREE	Free Elective			3.0
				15.0

Spring		**lec**	**lab**	**sem.hrs**
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective			3.0
CHGN401	INORGANIC CHEMISTRY II			3.0
CHGN ELECT	Chemistry Elective**			2.0
TECH ELECT	Technical Elective*			3.0
FREE	Free Elective			3.0
				14.0

Total Semester Hrs: 131.0

* Technical electives are courses in any technical field. HASS, PAGN, Military Science, ROTC, McBride and the business courses of EBGN are ***not*** accepted technical electives. Examples of possible electives that will be recommended to students are:

CEEN301	FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING: WATER	3.0
CHGN411	APPLIED RADIOCHEMISTRY	3.0
CHGN430	INTRODUCTION TO POLYMER SCIENCE	3.0
CHGN462	MICROBIOLOGY	3.0
EBGN305	FINANCIAL ACCOUNTING	3.0
EBGN306	MANAGERIAL ACCOUNTING	3.0
EBGN310	ENVIRONMENTAL AND RESOURCE ECONOMICS	3.0
MATH201	INTRODUCTION TO STATISTICS	3.0
MATH332	LINEAR ALGEBRA	3.0
MNGN210	INTRODUCTORY MINING	3.0
MTGN211	STRUCTURE OF MATERIALS	3.0
PEGN201	PETROLEUM ENGINEERING FUNDAMENTALS	3.0
PHGN300	PHYSICS III-MODERN PHYSICS I	3.0
PHGN419	PRINCIPLES OF SOLAR ENERGY SYSTEMS	3.0

** Chemistry electives are non-required courses taught within the Chemistry Department. In addition, graduate-level Chemistry and Geochemistry courses taught within the department are acceptable.

CHGN495 SENIOR UNDERGRADUATE RESEARCH is taught as a possible chemistry elective. Those aspiring to enter PhD programs in Chemistry or related fields are strongly advised to include undergraduate research in their curricula. The objective of CHGN495 is that students successfully perform an open-ended research project under the direction of a CSM faculty member. Students must demonstrate through the preparation of a proposal, prepared in consultation with the potential faculty research advisor and the CHGN495 instructor, that they qualify for enrollment in CHGN495.

Degree Requirements (Environmental Chemistry Track)

Freshman

Fall		lec	lab	sem.hrs
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
GEGN101	EARTH AND ENVIRONMENTAL SYSTEMS or CBEN 110			4.0
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
				16.0

Spring		lec	lab	sem.hrs
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
PHGN100	PHYSICS I - MECHANICS			4.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				16.0

Sophomore

Fall		lec	lab	sem.hrs
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CHGN209	INTRODUCTION TO CHEMICAL THERMODYNAMICS			3.0
CHGN221	ORGANIC CHEMISTRY I			3.0
CHGN223	ORGANIC CHEMISTRY I LABORATORY			1.0
HASS200	GLOBAL STUDIES			3.0
				18.0

Spring		lec	lab	sem.hrs
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
CHGN222	ORGANIC CHEMISTRY II			3.0
CHGN224	ORGANIC CHEMISTRY II LABORATORY			1.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
CHGN335	INSTRUMENTAL ANALYSIS			3.0
				16.0

Junior

Fall		lec	lab	sem.hrs
CHGN336	ANALYTICAL CHEMISTRY			3.0
CHGN337	ANALYTICAL CHEMISTRY LABORATORY			1.0
CHGN341	INORGANIC CHEMISTRY I			3.0
CHGN351	PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE I			4.0
CHGN395	INTRODUCTION TO UNDERGRADUATE RESEARCH			1.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
CHEV ELECT	Environmental Elective**			3.0
				18.0

Spring		lec	lab	sem.hrs
CHGN353	PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE II			4.0
CHGN323	QUALITATIVE ORGANIC ANALYSIS AND APPLIED SPECTROSCOPY			2.0
CHGN428	BIOCHEMISTRY			3.0
CHEV ELECT	Environmental Elective**			3.0
TECH ELECT	Technical Elective*			3.0
				15.0

Summer		lec	lab	sem.hrs
CHGN490	CHEMISTRY FIELD SESSION		18.0	6.0
				6.0

Senior

Fall		lec	lab	sem.hrs
CHEV ELECT	Environmental Elective**			3.0
CHEV ELECT	Environmental Elective**			3.0
CHGN ELECT	Chemistry Elective**			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
FREE	Free Elective			3.0
				15.0

Spring		lec	lab	sem.hrs
CHGN410	SURFACE CHEMISTRY			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective			3.0

CHGN403	INTRODUCTION TO ENVIRONMENTAL CHEMISTRY			3.0
CHGN ELECT	Chemistry Elective**			2.0
S&W	SUCCESS AND WELLNESS			1.0
FREE	Free Elective	3.0		3.0
				15.0

Total Semester Hrs: 135.0

* Technical electives are courses in any technical field. HASS, PAGN, Military Science and ROTC, McBride and the business courses of EBGN are ***not*** accepted technical electives.

** Chemistry electives are non-required courses taught within the Chemistry department. In addition, graduate-level Chemistry and Geochemistry courses taught within the department are acceptable.

Environmental electives are courses that are directly or indirectly related to Environmental Chemistry. Examples include environmental CEEN courses and CHGN462. Students can consult their advisors for further clarification.

CHGN495 SENIOR UNDERGRADUATE RESEARCH is taught as a possible chemistry elective. Those aspiring to enter PhD programs in Chemistry or related fields are strongly advised to include undergraduate research in their curricula. The objective of CHGN495 is that students successfully perform an open-ended research project under the direction of a CSM faculty member. Students must demonstrate through the preparation of a proposal, prepared in consultation with the potential faculty research advisor and the CHGN495 instructor, that they qualify for enrollment in CHGN495.

Degree Requirements (Biochemistry Track)

Freshman

Fall		**lec**	**lab**	**sem.hrs**
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
CBEN110	FUNDAMENTALS OF BIOLOGY I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
				16.0
Spring		**lec**	**lab**	**sem.hrs**
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
PHGN100	PHYSICS I - MECHANICS			4.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				16.0

Sophomore

Fall		**lec**	**lab**	**sem.hrs**
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III	4.0		4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CHGN209	INTRODUCTION TO CHEMICAL THERMODYNAMICS			3.0
CHGN221	ORGANIC CHEMISTRY I			3.0
CHGN223	ORGANIC CHEMISTRY I LABORATORY			1.0
HASS200	GLOBAL STUDIES			3.0
				18.0
Spring		**lec**	**lab**	**sem.hrs**
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
CHGN222	ORGANIC CHEMISTRY II			3.0
CHGN224	ORGANIC CHEMISTRY II LABORATORY			1.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
CHGN335	INSTRUMENTAL ANALYSIS			3.0
				16.0

Junior

Fall		**lec**	**lab**	**sem.hrs**
TECH ELECT	Technical Elective*			4.0
CHGN336	ANALYTICAL CHEMISTRY			3.0
CHGN337	ANALYTICAL CHEMISTRY LABORATORY			1.0
CHGN341	INORGANIC CHEMISTRY I			3.0
CHGN351	PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE I			4.0
CHGN395	INTRODUCTION TO UNDERGRADUATE RESEARCH			1.0
				16.0
Spring		**lec**	**lab**	**sem.hrs**
CHGN353	PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE II			4.0
CHGN323	QUALITATIVE ORGANIC ANALYSIS AND APPLIED SPECTROSCOPY			2.0
CHGN428	BIOCHEMISTRY			3.0

ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
CBEN120	FUNDAMENTALS OF BIOLOGY II			4.0
				16.0
Summer		**lec**	**lab**	**sem.hrs**
CHGN490	CHEMISTRY FIELD SESSION		18.0	6.0
				6.0
Senior				
Fall		**lec**	**lab**	**sem.hrs**
CHGN429	BIOCHEMISTRY II			3.0
CHGN ELECT	Chemistry Elective**			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
TECH ELECT	Technical Elective*			3.0
FREE	Free Elective			3.0
				15.0
Spring		**lec**	**lab**	**sem.hrs**
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective			3.0
CHGN401	INORGANIC CHEMISTRY II			3.0
CHGN ELECT	Chemistry Elective**			2.0
S&W	SUCCESS AND WELLNESS			1.0
FREE	Free Elective	3.0		3.0
FREE	Free Elective	3.0		3.0
				15.0

Total Semester Hrs: 134.0

* Technical electives are courses in any technical field. HASS, PAGN, Military Science and ROTC, McBride and the business courses of EBGN are ***not*** accepted technical electives. * Possible technical electives that will be recommended to students are:

CHGN403	INTRODUCTION TO ENVIRONMENTAL CHEMISTRY	3.0
CHGN462	MICROBIOLOGY	3.0
CBEN304	ANATOMY AND PHYSIOLOGY	3.0
CBEN320	CELL BIOLOGY AND PHYSIOLOGY	3.0
CBEN321	INTRO TO GENETICS	4.0

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Degree Requirements for Bachelor of Science in Biochemistry

Freshman				
Fall		**lec**	**lab**	**sem.hrs**
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CBEN110	FUNDAMENTALS OF BIOLOGY I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
EDNS151	CORNERSTONE - DESIGN I			3.0
				16.0
Spring		**lec**	**lab**	**sem.hrs**
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
PHGN100	PHYSICS I - MECHANICS			4.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				16.0
Sophomore				
Fall		**lec**	**lab**	**sem.hrs**
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CHGN209	INTRODUCTION TO CHEMICAL THERMODYNAMICS			3.0
CHGN221	ORGANIC CHEMISTRY I			3.0
CHGN223	ORGANIC CHEMISTRY I LABORATORY			1.0
HASS200	GLOBAL STUDIES			3.0
				18.0
Spring		**lec**	**lab**	**sem.hrs**
MATH225	DIFFERENTIAL EQUATIONS			3.0
CHGN335	INSTRUMENTAL ANALYSIS			3.0

EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
CHGN222	ORGANIC CHEMISTRY II			3.0
CHGN224	ORGANIC CHEMISTRY II LABORATORY			1.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
				16.0

Junior

Fall		**lec**	**lab**	**sem.hrs**
CHGN341	INORGANIC CHEMISTRY I			3.0
CHGN351	PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE I			4.0
CHGN395	INTRODUCTION TO UNDERGRADUATE RESEARCH			1.0
CHGN336	ANALYTICAL CHEMISTRY			3.0
CHGN337	ANALYTICAL CHEMISTRY LABORATORY			1.0
TECH ELECT	Technical Elective			4.0
				16.0

Spring		**lec**	**lab**	**sem.hrs**
CHGN428	BIOCHEMISTRY			3.0
CHGN323	QUALITATIVE ORGANIC ANALYSIS AND APPLIED SPECTROSCOPY			2.0
CHGN431	INTRODUCTORY BIOCHEMISTRY LABORATORY			2.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective I			3.0
CBEN120	FUNDAMENTALS OF BIOLOGY II			4.0
CHGN ELECT	Chemistry Elective			3.0
				17.0

Summer		**lec**	**lab**	**sem.hrs**
CHGN490	CHEMISTRY FIELD SESSION			6.0
				6.0

Senior

Fall		**lec**	**lab**	**sem.hrs**
CHGN429	BIOCHEMISTRY II			3.0
CHGN ELECT	Chemistry Elective			3.0
TECH ELECT	Technical Elective			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective II			3.0
FREE ELECT	Free Elective			3.0
				15.0

Spring		**lec**	**lab**	**sem.hrs**
CHGN ELECT	Chemistry Elective			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective III			3.0
FREE ELECT	Free Elective			3.0
FREE ELECT	Free Elective			3.0
S&W	SUCCESS AND WELLNESS			1.0
				13.0

Total Semester Hrs: 133.0

CHGN Electives:

CHGN311	INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY	3.0
CHGN403	INTRODUCTION TO ENVIRONMENTAL CHEMISTRY	3.0
CHGN409	BIOLOGICAL INORGANIC CHEMISTRY	3.0
CHGN441	THE CHEMISTRY AND BIOCHEMISTRY OF PHARMACEUTICALS	3.0
CHGN445	CHEMICAL BIOLOGY	3.0
CHGN462	MICROBIOLOGY	3.0
CHGN495	UNDERGRADUATE RESEARCH	1-5

Tech Electives:

CBEN304	ANATOMY AND PHYSIOLOGY	3.0
CBEN305	ANATOMY AND PHYSIOLOGY LAB	1.0
CBEN311	INTRODUCTION TO NEUROSCIENCE	3.0
CBEN320	CELL BIOLOGY AND PHYSIOLOGY	3.0
CBEN321	INTRO TO GENETICS	4.0
CBEN322	BIOLOGICAL PSYCHOLOGY	3.0
CBEN411	NEUROSCIENCE, MEMORY, AND LEARNING	3.0
CBEN431	IMMUNOLOGY FOR ENGINEERS AND SCIENTISTS	3.0

Major GPA

During the 2016-2017 academic year, the Undergraduate Council considered the policy concerning required major GPAs and which courses are included in each degree's GPA. While the GPA policy has not been officially updated, in order to provide transparency, council members agreed that publishing the courses included in each degree's GPA is beneficial to students.

The following list details the courses that are included in the GPA for this degree:

- CHGC100 through CHGC599 inclusive
- CHGN100 through CHGN599 inclusive

The Mines guidelines for Minor/ASI can be found in the Undergraduate Information section of the Mines Catalog.

Chemistry Minor and ASI Programs

No specific course sequences are suggested for students wishing to include chemistry minors or areas of special interest in their programs. Rather, those students should consult with the Chemistry department head (or designated faculty member) to design appropriate sequences. For the purpose of completing a minor in Chemistry, the Organic Chemistry sequence is exempt from the 100–200-level limit.

ASI programs include Chemistry, Polymer Chemistry, Environmental Chemistry, and Biochemistry. Refer to the main ASI section of the Bulletin for applicable rules for Areas of Special Interest.

Courses

CHGN111. INTRODUCTORY CHEMISTRY. 3.0 Semester Hrs.
(S) Introductory college chemistry. Elementary atomic structure and the periodic chart, chemical bonding, chemical reactions and stoichiometry of chemical reactions, chemical equilibrium, thermochemistry, and properties of gases. Must not be used for elective credit. Does not apply toward undergraduate degree or g.p.a. 3 hours lecture and 3 hours lab; 3 semester hours.

CHGN121. PRINCIPLES OF CHEMISTRY I. 4.0 Semester Hrs.
Study of matter and energy based on atomic structure, correlation of properties of elements with position in periodic chart, chemical bonding, geometry of molecules, phase changes, stoichiometry, solution chemistry, gas laws, and thermochemistry. 3 hours lecture, 3 hours lab; 4 semester hours. Approved for Colorado Guaranteed General Education transfer. Equivalency for GT-SC1.

CHGN122. PRINCIPLES OF CHEMISTRY II (SC1). 4.0 Semester Hrs.
Continuation of CHGN121 concentrating on chemical kinetics, gas laws, thermodynamics, electrochemistry and chemical equilibrium (acid- base, solubility, complexation, and redox). Laboratory experiments emphasizing quantitative chemical measurements. 3 hours lecture; 3 hours lab, 4 semester hours. Prerequisite: Grade of C- or better in CHGN121.

CHGN125. MOLECULAR ENGINEERING & MATERIALS CHEMISTRY. 4.0 Semester Hrs.
Studies of the interactions of matter and energy in chemical reactions and physical processes. Building on principles from CHGN121, the course systematically explores the relationships between processes, structures and properties, starting from the atomic and molecular level. It provides a framework to apply knowledge of chemical bonding and material properties to engineering design, with an emphasis on the Engineering Grand Challenges and the discovery of new process-structure-property relationships. There is a strong focus on the underlying principles of kinetics and equilibrium, and their general applicability, strongly rooted in the first and second law of thermodynamics. Examples of these principles come primarily from solid-state systems. Laboratory experiments emphasize conceptual understanding of structure-property relationships through both hands-on and computational analysis, reinforced by quantitative chemical measurements. Prerequisite: Grade of C- or better in CHGN121. 3 hours lecture; 3 hours lab; 4 semester hours.
Course Learning Outcomes

- Knowledge: A student will be able to:
- Comprehension: A student will be able to:
- Application: A student will be able to:
- Analysis: A student will be able to:

CHGN198. SPECIAL TOPICS. 6.0 Semester Hrs.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CHGN199. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: "Independent Study" form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

CHGN209. INTRODUCTION TO CHEMICAL THERMODYNAMICS. 3.0 Semester Hrs.
Introduction to the fundamental principles of classical thermodynamics, with particular emphasis on chemical and phase equilibria. Volume-temperature-pressure relationships for solids, liquids, and gases; ideal and non-ideal gases. Introduction to kineticmolecular theory of ideal gases and the Maxwell-Boltzmann distributions. Work, heat, and application of the First Law to closed systems, including chemical reactions. Entropy and the Second and Third Laws; Gibbs Free Energy. Chemical equilibrium and the equilibrium constant; introduction to activities & fugacities. One- and two-component phase diagrams; Gibbs Phase Rule. May not also receive credit for CBEN210 or GEGN330. Prerequisites: CHGN121, CHGN122 or CHGN125, MATH111, MATH112, PHGN100. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- No change

CHGN221. ORGANIC CHEMISTRY I. 3.0 Semester Hrs.
Structure, properties, and reactions of the important classes of organic compounds, introduction to reaction mechanisms. Prerequisites: Grade of C- or better in CHGN122 or CHGN125. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- No change

CHGN222. ORGANIC CHEMISTRY II. 3.0 Semester Hrs.
Continuation of CHGN221. 3 hours lecture; 3 semester hours. Prerequisite: Grade of C- or better in CHGN221.

CHGN223. ORGANIC CHEMISTRY I LABORATORY. 1.0 Semester Hr.
Laboratory exercises including purification techniques, synthesis, and characterization. Experiments are designed to support concepts presented in the CHGN221. Students are introduced to Green Chemistry principles and methods of synthesis and the use of computational software. 3 hours laboratory, 1 semester hour. Prerequisite: CHGN221 or concurrent enrollment.

CHGN224. ORGANIC CHEMISTRY II LABORATORY. 1.0 Semester Hr.
Laboratory exercises using more advanced synthesis techniques. Experiments are designed to support concepts presented in CHGN222.

CHGN298. SPECIAL TOPICS. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CHGN299. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: "Independent Study" form

must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

CHGN311. INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY. 3.0 Semester Hrs.
The primary objective of this course is to provide all students a suitable background to understand the role nanotechnology will play in future technologies and the underpinning principals involved. 3 hours lecture; 3 semester hours. Prerequisite: CHGN121.
Course Learning Outcomes

- None

CHGN323. QUALITATIVE ORGANIC ANALYSIS AND APPLIED SPECTROSCOPY. 2.0 Semester Hrs.
Identification, separation and purification of organic compounds including use of modern physical and instrumental methods. 1 hour lecture; 3 hours lab; 2 semester hours. Prerequisite: Grade of C- or better in CHGN222, CHGN224.

CHGN335. INSTRUMENTAL ANALYSIS. 3.0 Semester Hrs.
Principles of AAS, AES, Visible-UV, IR, NMR, XRF, XRD, XPS, electron, and mass spectroscopy; gas and liquid chromatography; data interpretation. Prerequisite: CHGN122 with a grade of C- or better or CHGN125 with a grade of C- or better.

CHGN336. ANALYTICAL CHEMISTRY. 3.0 Semester Hrs.
Theory and techniques of gravimetry, titrimetry (acid-base, complexometric, redox, precipitation), electrochemical analysis, chemical separations; statistical evaluation of data. Prerequisite: CHGN221, CHGN122 with a grade of C- or better or CHGN125 with a grade of C- or better.

CHGN337. ANALYTICAL CHEMISTRY LABORATORY. 1.0 Semester Hr.
Laboratory exercises emphasizing sample preparation and instrumental methods of analysis. Prerequisite: CHGN221 (C- or better), CHGN 223. Co-requisite: CHGN336.

CHGN340. COOPERATIVE EDUCATION. 3.0 Semester Hrs.
(I, II, S) Supervised, full-time, chemistry-related employment for a continuous six-month period (or its equivalent) in which specific educational objectives are achieved. Prerequisite: Second semester sophomore status and a cumulative grade-point average of at least 2.00. 0 to 3 semester hours. Cooperative Education credit does not count toward graduation except under special conditions.

CHGN341. INORGANIC CHEMISTRY I. 3.0 Semester Hrs.
The chemistry of the elements and periodic trends in reactivity is discussed. Particular concepts covered include group theory, symmetry, bonding in ionic and metallic crystal, acid-base theories, coordination chemistry, ligand field theory and radioactivity. 3 hours lecture; 3 semester hours. Prerequisite: CHGN222 and CHGN209 or CBEN210.
Course Learning Outcomes

- Students should be able to assess, evaluate or apply periodic trends, group theory, coordination chemistry, molecular orbital theory and crystal field theory.

CHGN351. PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE I. 4.0 Semester Hrs.
A study of chemical systems from a molecular physical chemistry perspective. Includes an introduction to quantum mechanics, atoms and molecules, spectroscopy, bonding and symmetry, and an introduction to modern computational chemistry. Prereqs: MATH225, PHGN200, CHGN209 with a grade of C- or better or CBEN210.
Course Learning Outcomes

- No change

CHGN353. PHYSICAL CHEMISTRY: A MOLECULAR PERSPECTIVE II. 4.0 Semester Hrs.
A continuation of CHGN351. Includes statistical thermodynamics, chemical kinetics, chemical reaction mechanisms, electrochemistry, and selected additional topics. 3 hours lecture; 3 hours laboratory; 4 semester hours. Prerequisite: CHGN351.

CHGN395. INTRODUCTION TO UNDERGRADUATE RESEARCH. 1.0 Semester Hr.
(I) (WI) Introduction to Undergraduate Research is designed to introduce students to the research endeavor. Topics include ethics, hypothesis testing, critical evaluation of the scientific literature, scientific writing, bibliographic software, and proposal preparation. Prerequisites: Completion of the chemistry curriculum through the Spring semester of the sophomore year. Credit: 1 semester hour.

CHGN396. UNDERGRADUATE RESEARCH. 1-5 Semester Hr.
(I,II,S) Individual research project for freshman, sophomores or juniors under direction of a member of the departmental faculty. Prerequisites: None. Variable credit; 1 to 5 credit hours. Repeatable for credit. Seniors should take CHGN495 instead of CHGN396.

CHGN398. SPECIAL TOPICS IN CHEMISTRY. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CHGN399. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: "Independent Study" form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

CHGN401. INORGANIC CHEMISTRY II. 3.0 Semester Hrs.
The chemistry of the elements and several applications are related to inorganic chemistry are considered in this course. Particular concepts covered include experimental techniques, chemistry specific to groups of elements, catalysis and industrial processes, inorganic materials and nanotechnology, and other applications of inorganic chemistry. Prerequisite: CHGN341. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Students should be able to apply fundamental considerations of inorganic chemistry to "real world" scenarios.

CHGN403. INTRODUCTION TO ENVIRONMENTAL CHEMISTRY. 3.0 Semester Hrs.
Equivalent with CHGC505,
Processes by which natural and anthropogenic chemicals interact, react and are transformed and redistributed in various environmental compartments. Air, soil and aqueous (fresh and saline surface and groundwaters) environments are covered, along with specialized environments such as waste treatment facilities and the upper atmosphere. Prerequisites: CHGN209 or CBEN210. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- NA

CHGN406. INTRODUCTION TO GEOCHEMISTRY. 3.0 Semester Hrs.
A comprehensive introduction to the basic concepts and principles of geochemistry, coupled with a thorough overview of related principles of thermodynamics and kinetics. Topics covered include: chemical bonding, key chemical reactions, mineral chemistry, soils and nanogeoscience, differentiation of the earth, controls on natural waters, stable and radiogenic isotopes and organic and biogeochemistry. Prerequisite: CHGN122 or CHGN125, GEGN101.
Course Learning Outcomes

- None

CHGN409. BIOLOGICAL INORGANIC CHEMISTRY. 3.0 Semester Hrs.
This course starts with a short introduction to inorganic chemistry and biology. The course then focuses on core bioinorganic chemistry topics, including metalloprotein structure and function; characterization of bioinorganic systems; metal assimilation, metabolism, and homeostasis; and metals in medicine. We also briefly cover special topics, such as metallo-endocrinology, extremophiles, biomineralization, and supramolecular bioinorganic chemistry. We investigate recent advances in the field of bioinorganic chemistry, introduce many leading scientists in the field, and explore scientific literature. Students are assessed through two open-resource, take-home exams (midterm and final) covering course material. Students also explore a topic of their choice through a class presentation and a writing assignment. Students will benefit from having taken at least one of the following courses: organic chemistry, inorganic chemistry, or biochemistry.

CHGN410. SURFACE CHEMISTRY. 3.0 Semester Hrs.
Equivalent with MLGN510,
Introduction to colloid systems, capillarity, surface tension and contact angle, adsorption from solution, micelles and micro - emulsions, the solid/gas interface, surface analytical techniques, van der Waal forces, electrical properties and colloid stability, some specific colloid systems (clays, foams and emulsions). Students enrolled for graduate credit in MLGN510 must complete a special project. Prerequisite: CHGN209 or CBEN210.

CHGN411. APPLIED RADIOCHEMISTRY. 3.0 Semester Hrs.
This course is designed for those who have a budding interest radiochemistry and its applications. A brief overview of radioactivity and general chemistry will be provided in the first three weeks of the course. Follow-on weeks will feature segments focusing on the radiochemistry in the nuclear fuel cycle, radioisotope production, nuclear forensics and the environment. Prerequisite: CHGN122 or CHGN125.

CHGN422. POLYMER CHEMISTRY LABORATORY. 1.0 Semester Hr.
Prerequisites: CHGN221, CHGN223. 3 hours lab; 1 semester hour.

CHGN423. SOLID-STATE CHEMISTRY. 3.0 Semester Hrs.
Dependence of properties of solids on chemical bonding and structure; principles of crystal growth, crystal imperfections, reactions and diffusion in solids, and the theory of conductors and semiconductors Prerequisite: CHGN 121.
Course Learning Outcomes

- 1. Develop foundational understanding of the atomic structure of crystalline solid-state materials, including symmetry, crystal systems, Bravais lattices, space groups, and Miller indices. Connect these concepts to diffraction and scattering
- 2. Connect bonding and electronic structure to functional properties, i.e. electronic transport, light absorption and emission, phonons/ lattice dynamics, etc.
- 3. Develop the ability to critically read, synthesize, and discuss the literature corpus surrounding concepts in solid-state materials chemistry.

CHGN428. BIOCHEMISTRY. 3.0 Semester Hrs.
Introductory study of the major molecules of biochemistry: amino acids, proteins, enzymes, nucleic acids, lipids, and saccharides- their structure, chemistry, biological function, and biosynthesis. Stresses bioenergetics and the cell as a biological unit of organization. Discussion of classical genetics, molecular genetics, and protein synthesis. Co-requisite: CHGN222.

CHGN429. BIOCHEMISTRY II. 3.0 Semester Hrs.
A continuation of CHGN428. Topics include: nucleotide synthesis; DNA repair, replication and recombination; transcription, translation and regulation; proteomics; lipid and amino acid synthesis; protein target and degradation; membranes; receptors and signal transduction. Prerequisite: CHGN428.

CHGN430. INTRODUCTION TO POLYMER SCIENCE. 3.0 Semester Hrs.
Equivalent with MLGN530,
An introduction to the chemistry and physics of macromolecules. Topics include the properties and statistics of polymer solutions, measurements of molecular weights, molecular weight distributions, properties of bulk polymers, mechanisms of polymer formation, and properties of thermosets and thermoplastics including elastomers. Pre requisite: CHGN222. 3 hour lecture, 3 semester hours.

CHGN431. INTRODUCTORY BIOCHEMISTRY LABORATORY. 2.0 Semester Hrs.
The link between the structure of a material and its properties is ubiquitous across all fields. Throughout the Biochemistry lab course, we will have the opportunity to explore both protein and nucleic acids through various techniques and analyses that probe the structure-property relationship of biomolecules that subsequently allows us to tap into molecular function. The selection of experiments is intentionally designed to provide exposure to a broad range of modern experimental strategies to enrich and solidify material covered within the CHGN428/429 sequence. Co-requisite: CHGN428.
Course Learning Outcomes

- Students will gain proficiency in basic biochemistry laboratory techniques.
- Students will generate hypotheses and analyze data.

CHGN435. PHYSICAL BIOCHEMISTRY. 3.0 Semester Hrs.
Apply physical chemical principles to understand property-function relationships of biochemical molecules, and investigate biochemical instrumentation and quantitative analyses common to biochemistry. Methods discussed include light/fluorescence microscopy, biomolecular structure determination, i.e., X-ray crystallography, cryo-electron microscopy and NMR, scattering techniques, biomolecular motors, and more. Prerequisite: CHGN 428 + CHGN 209 or equivalent (CBEN 210 or BIOL 301) Co-requisite: N/A.
Course Learning Outcomes

- 1) Demonstrate basic knowledge of thermodynamics and statistical mechanics, and their applications in biochemistry
- 2) Demonstrate basic knowledge of quantum mechanics and its applications in biochemistry
- 3) Demonstrate basic knowledge of common spectroscopic and imaging methods used in biochemistry

- 4) Develop grant-writing skills, particularly in relation to explaining scientific concepts clearly and concisely
- 5) Develop oral presentation skills when disseminating scientific information

CHGN441. THE CHEMISTRY AND BIOCHEMISTRY OF PHARMACEUTICALS. 3.0 Semester Hrs.
This course will examine a broad range of pharmaceuticals, including but not limited to controlled substances, treatments for cardiovascular, respiratory, and infectious diseases, as well as cannabinoids and performance-enhancing substances. The history, pharmacology, and, in some cases, the synthesis of these pharmaceuticals will be covered. Prerequisite: CHGN222, CHGN428.
Course Learning Outcomes

- Students will be able to describe different general mechanisms of action of pharmaceuticals
- Describe different chemical treatments to specific ailments and diseases along with side effects
- Differentiate site and mechanism of action and how agonists and antogonist drugs interact at drug receptor sites
- Explain nomenclature used to name and classify drugs

CHGN445. CHEMICAL BIOLOGY. 3.0 Semester Hrs.
The analysis of biological systems from the perspective of organic/inorganic and physical chemistry, including chemical reactions for the synthetic preparation of biomolecules and the chemistry behind different biotechnological developments and tools. A strong emphasis on the mechanistic basis of biochemical transformations is included. Strategies for directing pharmaceuticals or diagnostics to different subcellular locales will be presented. A survey of key advancements in the field of chemical biology will be drawn from the primary literature. Prerequisite: CHGN 222, CHGN 428.
Course Learning Outcomes

- 1. Understand the molecular-level and atomistic origins of how structure imparts reactivity, based on principles from organic and physical organic chemistry.
- 2. Develop a working knowledge of strategies to direct chemical reagents to different subcellular locales.
- 3. Become familiar with the primary literature describing key advances in the field of chemical biology.
- 4. Be able to use the theories, concepts, and tools of chemical biology to predict how compounds may interact with biological systems.
- 5. Propose novel research to address an outstanding question in the field.

CHGN462. MICROBIOLOGY. 3.0 Semester Hrs.
Equivalent with CHGN562,
(II) This course will cover the basic fundamentals of microbiology, such as structure and function of prokaryotic versus eukaryotic cells; viruses; classification of microorganisms; microbial metabolism, energetics, genetics, growth and diversity, microbial interactions with plants, animals, and other microbes. Special focus will be on pathogenic bacteriology, virology, and parasitology including disease symptoms, transmission, and treatment. Prerequisite: none. 3 hours lecture, 3 semester hours.

CHGN475. COMPUTATIONAL CHEMISTRY. 3.0 Semester Hrs.
This class provides a survey of techniques of computational chemistry, including quantum mechanics (both Hartree-Fock and density functional approaches) and molecular dynamics. Emphasis is given to the integration of these techniques with experimental programs of molecular design and development. Prerequisites: CHGN351, CHGN401. 3 hours lecture; 3 semester hours.

CHGN490. CHEMISTRY FIELD SESSION. 6.0 Semester Hrs.
(WI) Professional-level chemistry experience featuring modules including organic/polymer synthesis and characterization, inorganic nanomaterial investigations, computational chemistry, environmental chemical analysis , biochemistry and technical report writing. 6-week summer session; 6 semester hours. Prerequisite: CHGN323, CHGN341, and CHGN351.

CHGN495. UNDERGRADUATE RESEARCH. 1-5 Semester Hr.
(I, II, S) (WI) Individual research project under direction of a member of the Departmental faculty. Prerequisites: selection of a research topic and advisor, preparation and approval of a research proposal, completion of chemistry curriculum through the junior year. Variable credit; 1 to 5 credit hours. Repeatable for credit.

CHGN497. INTERNSHIP. 1-6 Semester Hr.
(I, II, S) Individual internship experience with an industrial, academic, or governmental host supervised by a Departmental faculty member. Prerequisites: Completion of chemistry curriculum through the junior year. Variable credit; 1 to 6 credit hours.

CHGN498. SPECIAL TOPICS IN CHEMISTRY. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

CHGN499. INDEPENDENT STUDY. 0.5-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: "Independent Study" form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

Professors

Thomas Albrecht-Schönzart, Distinguished Professor

Thomas Gennett, Department Head

Richard C. Holz, Provost

Mark P. Jensen, Grandey University Chair in Nuclear Science & Engineering

Daniel M. Knauss, Associate Dean of Energy and Materials

Matthew C. Posewitz

James F. Ranville

Ryan M. Richards

Alan S. Sellinger

Jenifer C. Shafer

Bettina M. Voelker

David T. Wu

Associate Professors

Svitlana Pylypenko

Brian G. Trewyn

Shubham Vyas

Assistant Professors

Dylan Domaille

Annalise Maughan

C. Michael McGuirk

Christine Morrison

Teaching Professors

Renee L. Falconer, Associate Department Head

Angela Sower

Teaching Assistant Professors

Christian Beren

Amanda Jameer

Kara Metzger

Jonathan Miorelli

Research Professors

Mark E. Eberhart

Kim R. Williams

Research Assistant Professors

Shane Galley

Jessica Jackson

Yuan Yang

Joint Appointees

Matthew Beard

Todd Deutsch

Jesse Hensley

Justin Johnson

Calvin Mukarakate

Bryan Pivovar

David Robichaud

Daniel Ruddy

Professors Emeriti

Scott W. Cowley

Dean W. Dickerhoof

Mark E. Eberhart

Ronald W. Klusman

Donald Langmuir

Donald L. Macalady

Patrick MacCarthy

Michael J. Pavelich

Mark R. Seger

E. Craig Simmons

Kent J. Voorhees

Thomas R. Wildeman