

CHEMISTRY (CHEM)

CHEM 5010 - Advanced Inorganic Chemistry (3 Credits)

Covers the fundamental principles of inorganic chemistry. Topics include atomic structure and periodicity, molecular symmetry, bonding, structural chemistry, main-group chemistry, coordination chemistry, and organometallic chemistry. Requisite knowledge in Undergraduate Inorganic and Physical Chemistry assumed. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4010. Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall.

CHEM 5073 - RM-MSMSP Research Experience for Teachers - Chemistry Cohort (1-6 Credits)

The Research Experience for Teachers (RET) program will be a five-week research exploration in which twelve RM-MSMSP teachers will raise their level of relevant scientific understanding by engaging in a "hands on" workshop, transforming what they have learned into new curricular materials that will improve the scientific abilities of their students and hopefully stimulate them to consider a STEM career. Note: Credit may not apply toward any CLAS degree. Department consent required. Max Hours: 6 Credits.

Grading Basis: Letter Grade

CHEM 5110 - Advanced Analytical Chemistry (3 Credits)

Explores the fundamental principles of analytical chemistry. Topics will focus on meteorology (the science of making measurements), measurements based on energy transfer (e.g. spectroscopic analysis), and measurements based on mass transfer (e.g. chemical separations and electrochemistry). Requisite knowledge in Undergraduate Instrumental Analysis is assumed. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4110. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Spring.

CHEM 5221 - Practical Applications of Spectroscopy (3 Credits)

This course surveys spectroscopic methods in order to deduce the structure of organic compounds from an examination of spectra, with an emphasis on infrared spectroscopy, mass spectrometry, nuclear magnetic resonance spectroscopy, and ultraviolet spectroscopy. Students will be introduced to a wide array of powerful and elegant tools for obtaining qualitative information about the structure of matter. This course will require a good amount of thought, yet all of the concepts and associated mathematical manipulations are within the reach of a student who has met the prerequisites. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4221. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5310 - Advanced Organic Chemistry (3 Credits)

An exploration of structure, bonding and reactivity in organic modules that includes extensive analysis of the chemical literature, culminating in written and seminar presentations of individual projects. Requisite knowledge in Undergraduate Organic Chemistry and Physical Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4310. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Spring.

CHEM 5388 - Nucleic Acid Technologies I (2 Credits)

This laboratory is intended to provide hands-on experience on the synthesis, characterization, and analyses of oligonucleotides of DNA and RNA. The laboratory will cover the basics to understand structural aspects of these biopolymers, using UV-vis, circular dichroism, electrophoresis, HPLC and mass spectroscopy. (All students will be expected to prepare, and turn in, three written reports; and three oral presentations. Every class member will also be required to keep an organized laboratory notebook, thus the class will be exposed to basic research aspects and literature searches. The course will also require students to design a successful experiment, that will prepare them for conditions they may likely encounter in an industrial, or advanced academic setting. Specifically, each student will choose a DNA sequence and probe their oligonucleotide model towards the recognition of a particular target, e.g., metabolite, protein, or molecular ion. In assessing these concepts, every student will be exposed to the basics of DNA/RNA structure as well as the chemistry of solid-phase chemistry. Every student will be required to present current topics (from recent literature) in front of the class as a way to enhance skills in oral presentation and scientific communication, aspects that will also enrich the scientific writing experience. To enhance the writing experience and provide a broader perspective on contemporary research, that is related to the course, students will be required to attend two seminars (from the departmental seminar series) and prepare a short written report. It is worth noting that this course will provide exposure to techniques that are commonly used in an industrial setting, e.g., in the development of RNA-based drugs and therapeutics, thus preparing them for a successful transition onto their next academic/professional step). Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4388. Max hours: 2 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5411 - Bioconjugate Techniques and Theranostic Nanomedicine (3 Credits)

The selective making of chemical bonds to biological molecules in complex mixtures enables a wide variety of applications in bio- and nano-materials science, bioengineering, and diagnostic and therapeutic (nano-)medicine. This course will discuss theory and practical current methods for chemical modification and conjugation of proteins and other bio- and nano-materials: Topics include permanent and cleavable cross-linkers, protein modification reagents, immobilization of enzymes/DNA, enzyme-antibody conjugates, protein-protein interactions, PEGylation and labeling of proteins, and solid-phase peptide synthesis. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4411. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5421 - Cannabis Chemistry (3 Credits)

An exploration of the terpene to cannabinoid compounds including biosynthesis pathways; human receptor structures and mechanism; current analytical methods for Quality Assurance and Quality Control and current research in medical applications. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4421. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Spring.

CHEM 5510 - Computational Chemistry (3 Credits)

Classical and ab initio molecular dynamics are covered from theory to application. Students have access to high-performance computational resources and cover current topics in the field. Requisite knowledge in Undergraduate Physical Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4510. Term offered: fall. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall.

CHEM 5530 - Advanced Physical Chemistry (3 Credits)

Explores fundamental properties of molecules (bond length and strength, the potential energy surface, reaction rates, etc.) and examines how these properties are measured, using original literature as the primary source, and culminating in written and seminar presentations of individual projects. Requisite knowledge in Undergraduate Physical Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4530. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5538 - Physical Chemistry Laboratory: Molecular Structure (2 Credits)

CHEM 5538 explores the central principles of physical chemistry, with emphasis on quantum chemistry, spectroscopy, and computational methods. The post laboratory assignments demonstrate a writing process that follows the guidelines of the American Chemical Society. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4538

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5548 - Physical Biochemistry Laboratory (2 Credits)

Experimental techniques of physical chemistry emphasizing thermodynamics, kinetics, and spectroscopy of biological molecules. Fulfills the Physical Chemistry Lab requirement for Biochemistry Emphasis majors. Restriction: Restricted to degree-granting graduate programs. Prereq: or Recommended Preparation CHEM 4810. Cross-listed with CHEM 4548. Term offered: fall, spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring.

CHEM 5550 - Applications of Group Theory in Chemistry (3 Credits)

Introduces the basic principles of the group theoretical method as well as its applications in organic, inorganic, and physical chemistry. Covers Mo's for main-group and transition metal compounds, ligand field theory, molecular vibrations, and electron absorption spectroscopy. Requisite knowledge in Undergraduate Physical Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5580 - Molecular Informatics (3 Credits)

This course resides at the intersection between Chemistry, Biochemistry, and Data Science. The course covers fundamental concepts of Chemical and Biochemical Informatics and provides students with hands on experience in using computational tools to manipulate chemical and biochemical data. Students will learn fundamentals of data science, database management, data structure, data representation, data visualization, and data analysis as applied to Chemistry and Biochemistry. The course requires a basic understanding of programming but does not require extensive programming experience. Examples explored in class and in homework will be built using Python code within Jupyter Notebooks or Google Colab notebooks such that students can explore new topics while remaining focused on the underlying molecular concepts and computer methods which allow them to manage large amounts of molecular information and to find relationships between the structure and properties of molecules. Data mining approaches will be explored as will classification algorithms and chemical similarity analysis methods. Students will learn about the applications of cheminformatics in drug discovery, such as compound selection, virtual library generation, virtual high throughput screening which can check for potential molecules that have the potential to be developed into drugs. Note: While this course is not a pre-requisite for 4510 Computational Chemistry, CHEM 4640 AI in Chemistry and Biochemistry, or CHEM 4845 Molecular Modeling and Drug Design, the skills developed in this course will work synergistically with those courses and will allow you to get more from your experiences in those courses or from your experience in a research lab. Restriction: Restricted to students in degree-granting graduate programs or Prereq: CHEM 3411 and CHEM 4630 or MATH 1376 or BIOS 6642 or MOLB 7900 or CSCI 1410 with a C- or higher. Cross-listed with CHEM 4580. Max hours: 2 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to students in degree-granting graduate programs or Prereq: CHEM 3411 and CHEM 4630 or MATH 1376 or BIOS 6642 or MOLB 7900 or CSCI 1410 with a C- or higher.

CHEM 5600 - Graduate Topics in Chemistry (1-3 Credits)

Graduate students in chemistry or a related discipline explore a special topic in chemistry or biochemistry. A description of topics to be covered in the current semester is maintained on the Chemistry department website. Restriction: Restricted to degree-granting Graduate programs. Term offered: spring. Repeatable. Max hours: 6 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 6.

Restriction: Restricted to degree-granting graduate programs

CHEM 5610 - Understanding & Presenting Chemical Research (1-2 Credits)

This course will improve your ability to systematically search for chemical information, help you interpret the information you find, & improve your ability to summarize and present that information. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4610. Term offered: fall, spring. Repeatable. Max Hours: 2 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 2.

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring.

CHEM 5630 - Programming for Data Analysis in the Physical Sciences (1 Credit)

This course will be taught using live coding format (the instructor will code live in the classroom with the students). In this course, you will learn to process data using python scripts that you will write. Data include for example absorption spectra, protein pdb files, coordinate files. You will also learn how to use Python libraries and write functions (for example to create high resolution graphs). Finally, you will learn best coding practices, how to keep track of different versions of your code and share your code using Github. Restriction: Restricted to students enrolled degree-granting graduate programs. Cross-listed with CHEM 4630. Max hours: 1 Credit.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5640 - Artificial Intelligence in Chemistry and Biochemistry (3 Credits)

Artificial Intelligence (AI) changes every aspect of our lives. In this course, we explore AI and its applications from the perspective of a chemist/biochemist. The role of AI and the latest trends in modern chemistry and biochemistry will be taught. Students will learn how to connect modern AI techniques to their own research projects, using both experimental and computational data. Restriction: Restricted to students in degree-granting graduate programs and Prereq/Coreq: CHEM 3810/4810/5810 and CHEM 4630/5630 with a B- or higher. Cross-listed with CHEM 4640. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restricted to students in degree-granting graduate programs and Prereq/Coreq: CHEM 3810/4810/5810 and CHEM 4630/5630 with a B- or higher.

CHEM 5655 - Teaching Assistant Bootcamp (1 Credit)

This course is 4-5 8-hour days of intensive training in suitable pedagogy for general chemistry and organic chemistry laboratory classes, procedures for teaching laboratory sections, and laboratory techniques. Students must have a teaching assistant contract with the Chemistry Department in order to take this course. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4655. Term offered: fall. Repeatable. Repeatable. Max Hours: 1 Credit.

Grading Basis: Letter Grade

Repeatable. Max Credits: 2.

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall.

CHEM 5700 - Environmental Chemistry (3 Credits)

A discussion of the sources, reactions, transport, effects, and fates of chemical species in the water, soil and air environments. Requisite knowledge in Undergraduate Organic and Analytical Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 4700. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Spring.

CHEM 5810 - Graduate Biochemistry I (4 Credits)

Topics include proteins, mechanisms and kinetics of enzymes, carbohydrates, lipids and membranes, nucleic acids, genetic engineering, signaling pathways, and energetics, which are integrated with critical analysis of recent journal papers, culminating in written and seminar presentations of individual projects. Requisite knowledge in Undergraduate Organic Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Term offered: fall. Max hours: 4 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall.

CHEM 5815 - Structural Biology of Neurodegenerative Diseases (3 Credits)

Advanced course in Biochemistry/Biophysics. Principles of Protein Folding, Structure-Function Relationship, and spectroscopic techniques related to characterization of these processes as applied to neurodegenerative diseases such as Parkinson's and Alzheimer's. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4815, BIOL 4815, and BIOL 5815. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Spring.

CHEM 5825 - Biochemistry of Metabolic Disease (3 Credits)

Advanced course in biochemistry. An expanded study of selected topics in metabolism and how they relate to diseases, including inflammation, diabetes, obesity, and rare genetic disorders. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4825, BIOL 4825, and BIOL 5825. Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall.

CHEM 5830 - Graduate Biochemistry II (4 Credits)

Topics include biosynthesis & metabolism of carbohydrates, lipids& amino acids, & genetic information flow of DNA replication, transcription, translation& regulation of transcription, which are integrated with critical analysis of recent literature, culminating in written& seminar presentations of individual projects. Continuation of 5810. Prereq: CHEM 5810 with a B- or higher. Restriction: Restricted to degree-granting Graduate programs or permission of instructor. Term offered: spring. Max hours: 4 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 5810 with a B- or higher Restriction: Restricted to degree-granting Graduate programs

Typically Offered: Spring.

CHEM 5835 - Biochemistry of Gene Regulation and Cancer (3 Credits)

Explores the biochemical and molecular aspects of cancer biology. Topics include DNA mutations and repair, gene regulation, oncogenes and tumor suppressors, stem cells and differentiation, and cancer drug development. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4835, BIOL 4835, and BIOL 5835. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 5840 - Independent Study (1-3 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Term offered: fall, spring, summer. Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Typically Offered: Fall, Spring, Summer.

CHEM 5845 - Molecular Modeling and Drug Design (3 Credits)

Advanced course in biochemistry. An introductory course on modern molecular modeling techniques and their applications to computer-aided rational drug design. Restriction: Graduate standing. Cross-listed with CHEM 4845. Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall.

CHEM 5860 - Bioinorganic Chemistry: Bioinorganic compounds in medicine (3 Credits)

Explore the roles of metals in biochemistry and medicine by studying chemical/physical properties of metal coordinated compounds. The course focus on metal coordination resulting biopolymer folding and the function of macromolecules that is involved into iron cytochromes, zinc and copper enzymes, iron sulfur proteins, oxygen transport, iron storage, electron transfer, inorganic model compounds, metals in medicine, and toxicity of inorganic species. Topic is extended to biomedical application such as chemotherapy. Prereq: CHEM 3810 or CHEM 4810 or CHEM 5810 with a C- or higher. Cross-listed with CHEM 4860. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3810 or 4810 or 5810 with a C- or higher

CHEM 5880 - Directed Research (1-6 Credits)

Students will engage in original research projects supervised and mentored by faculty. Students must work with faculty prior to registration to develop a proposal for their project and receive permission to take this course. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Term offered: fall, spring, summer. Repeatable. Max hours: 6 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 6.

Typically Offered: Fall, Spring, Summer.

CHEM 5939 - Internship (1-6 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Term offered: fall, spring, summer. Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Typically Offered: Fall, Spring, Summer.

CHEM 5950 - Master's Thesis (1-8 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Repeatable. Term offered: fall, spring, summer. Max hours: 8 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 8.

Additional Information: Report as Full Time.

Typically Offered: Fall, Spring, Summer.

CHEM 6000 - Chemistry Seminar (1-3 Credits)

Faculty and student presentations of CU-Denver research projects and other current chemistry topics. Note: All chemistry students are encouraged to attend, but credit is given only to those who present seminars. Prerequisite knowledge in Undergraduate Physical or Environmental Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Term offered: fall, spring, summer. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring, Summer.

CHEM 6001 - Master's Research Seminar (1 Credit)

Students present a formal seminar to the department describing their master's research work. Note: Required for all students completing a thesis-based master's degree; optional for those completing master's projects. Prereq: CHEM 6000 with a B- or higher. Term offered: fall, spring, summer. Max hours: 1 Credit.

Grading Basis: Letter Grade

Prereq: CHEM 6000 with a B- or higher

Typically Offered: Fall, Spring, Summer.

CHEM 6002 - Chemistry Seminar I (1 Credit)

The art of listening to and giving a chemistry seminar. Introduces the chemical literature, the pedagogical techniques of seminar giving, and the critical thinking skills required to understand a technical presentation. Note: Seminar presentations by faculty, outside speakers, and advanced graduate students are analyzed by the students participating in the course. Restriction: Restricted to degree-granting Graduate programs. Max Hours: 1 Credit.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 6003 - Chemistry Seminar II (1 Credit)

Students prepare and give a chemical seminar based on a literature paper. Note: Seminar presentations by students and outside speakers are analyzed by students in the course. Restriction: Restricted to degree-granting Graduate programs. Max Hours: 1 Credit.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

CHEM 6840 - Independent Study: CHEM (1-6 Credits)

Department consent required. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

CHEM 6950 - Master's Thesis (1-6 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Repeatable. Term offered: fall, spring, summer. Max hours: 6 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 6.

Additional Information: Report as Full Time.

Typically Offered: Fall, Spring, Summer.

CHEM 6960 - Master's Report (1-6 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Term offered: fall, spring, summer. Repeatable. Max hours: 6 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 6.

Additional Information: Report as Full Time.

Typically Offered: Fall, Spring, Summer.