

## CHEM - Chemistry

Courses numbered 100 to 299 = *lower-division*; 300 to 499 = *upper-division*; 500 to 799 = *undergraduate/graduate*.

### **CHEM 103. Introductory General, Organic and Biochemistry (5). †**

*General education natural science course with lab.* Surveys inorganic, organic, nuclear and biological chemistry. Recommended for the student who plans to take only one course in chemistry. Course does not meet the requirements for students who are planning to apply to medical school. Students who expect to major in the natural sciences should take the CHEM 211, CHEM 212 sequence. Credit is allowed in only one of the following: CHEM 103 or 110. Course requires a lab fee. This is a Kansas Systemwide Transfer Course. Prerequisite(s): one year of high school algebra or MATH 011. Corequisite(s): CHEM 103L.

### **CHEM 110. Preparatory Chemistry (3).**

General chemistry course for students who have not had adequate preparation in chemistry or physics. Enables students to improve their problem-solving skills and to briefly review mathematics relevant to general chemistry. Introduces the basic chemical concepts of atoms, molecules, chemical reactions, chemical equations, gas laws and solutions. Students with credit in CHEM 103 or 211 cannot also receive credit for CHEM 110. Prerequisite(s): one year of high school algebra or MATH 011.

### **CHEM 211. General Chemistry I (5). †**

*General education math and natural sciences course.* Introduces general concepts of chemistry. Includes chemical stoichiometry, atomic and molecular structure, bonding, gas laws, states of matter and chemical periodicity. CHEM 211-212 meets the needs of students who may wish to take more than one course in chemistry. Credit is allowed in only one of the following: CHEM 211 or 110. Course requires a lab fee. This is a Kansas Systemwide Transfer Course. Prerequisite(s): a college-level chemistry course such as CHEM 110, 101 or 103, or high school chemistry or physics. Corequisite(s): CHEM 211L, MATH 111 or two units of high school algebra or MATH 011.

### **CHEM 212. General Chemistry II (5). †**

*General education natural science course with lab.* Continuation of CHEM 211. Includes thermodynamics, gaseous and ionic equilibria, kinetics, nuclear chemistry, electrochemistry, qualitative analysis and an introduction to theories of bonding. Course requires a lab fee. This is a Kansas Systemwide Transfer Course. Prerequisite(s): CHEM 211 with a grade higher than C-. Corequisite(s): CHEM 212L.

### **CHEM 481. Cooperative Education (1-6).**

Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Repeatable for credit.

### **CHEM 481N. Internship (1).**

Complements and enhances the student's academic program by providing an opportunity to apply and acquire knowledge in a workplace environment as an intern. Prerequisite(s): departmental consent.

### **CHEM 514. Inorganic Chemistry (3).**

Basic inorganic chemistry emphasizing molecular symmetry and structure, fundamental bonding concepts, ionic interactions, periodicity of the elements, systematics of the chemistry of the elements, acid-base chemistry and nonaqueous solvents, classical coordination chemistry and introductory bioinorganic chemistry. Prerequisite(s): CHEM 212 with a grade higher than C-; CHEM 531 strongly suggested but not required.

### **CHEM 523. Analytical Chemistry (4).**

Evaluation of data, theory and application of gravimetric analysis and precipitation, neutralization and oxidation-reduction volumetric analysis. Course requires a lab fee. Prerequisite(s): CHEM 212 with a grade higher than C-. Corequisite(s): CHEM 523L.

### **CHEM 524. Instrumental Methods of Chemical Analysis (4).**

Introduces spectroscopic techniques (UV-Visible atomic absorption, molecular absorption, infrared, mass spectrometry and NMR), electrochemical techniques (potentiometry, voltammetry and coulometry) and separation techniques (gas chromatography and HPLC). Applications of computer and automated methods of analysis also covered. Course requires a lab fee. Prerequisite(s): CHEM 531; CHEM 532 strongly recommended but not required. Corequisite(s): CHEM 524L.

### **CHEM 531. Organic Chemistry I (5). †**

Introduces the study of carbon compounds emphasizing reaction mechanisms, stereochemistry and spectrographic analysis. Credit is not allowed for both CHEM 531 and 535. Course requires a lab fee. This is a Kansas Systemwide Transfer Course. Prerequisite(s): CHEM 212 with a grade higher than C-. Corequisite(s): CHEM 531L.

### **CHEM 532. Organic Chemistry II (5). †**

Continuation of CHEM 531 emphasizing the structure and reactions of principal functional groups and compounds of biological interest. Credit is not allowed for both CHEM 532 and 536. Course requires a lab fee. Prerequisite(s): CHEM 531 with a grade higher than C-. Corequisite(s): CHEM 532L.

### **CHEM 533. Elementary Organic Chemistry (3).**

One-semester survey of organic chemistry, examining various classes of organic compounds, organic reactions and reaction mechanisms. Establishes an understanding of the relationship between structure and reactivity, with particular emphasis on the importance of organic chemistry to the health sciences and biomedical engineering. Credit is not allowed for both CHEM 533 and 531. Course does not meet the needs of chemistry majors or premed students. Prerequisite(s): CHEM 212 with a grade higher than C-.

### **CHEM 535. Organic Chemistry I (3).**

Introduces the study of carbon compounds emphasizing reaction mechanisms, stereochemistry and spectrographic analysis. This course does not include a lab, is open only to biomedical engineering majors and does not meet the needs of chemistry majors or premed students. Credit is not allowed for both CHEM 535 and 531. Prerequisite(s): must be a biomedical engineering major and have completed CHEM 212 with a grade higher than C-.

### **CHEM 536. Organic Chemistry II (3).**

Continuation of CHEM 535 emphasizing the structure and reactions of principal functional groups and compounds of biological interest. Course does not include a lab, is open only to biomedical engineering majors and does not meet the needs of chemistry majors or premed students. Credit is not allowed for both CHEM 536 and 532. Prerequisite(s): must be a biomedical engineering major and have completed CHEM 531 or 535 with a grade higher than C-.

### **CHEM 545. Physical Chemistry I (3).**

Introduces fundamentals of thermodynamics with the goal of understanding the driving forces behind chemical and physical changes and equilibria. Covers the laws of thermodynamics and explores concepts involving work, heat and simple mechanical processes. Introduces Helmholtz and Gibbs energy as thermodynamic indicators of spontaneity/equilibria. Applies these concepts to the study of phase changes, chemical equilibria, ideal and non-ideal solutions, electrolytes

and chemical kinetics. Prerequisite(s): CHEM 212 with a grade higher than C-, one year of college physics, MATH 243 or its equivalent.

**CHEM 546. Physical Chemistry II (3).**

Covers elementary quantum mechanics and its applications to chemistry. Begins with a historical comparison between classical and quantum mechanics, then builds from the postulates of quantum mechanics to explore the Schrödinger equation and its use in solving problems involving particles, rotating bodies and vibrations. Special emphasis on spectroscopy and approximation methods relevant to chemistry. Prerequisite(s): CHEM 212 with a grade higher than C-, one year of college physics, and MATH 243 or its equivalent.

**CHEM 547. Physical Chemistry Lab (2).**

Laboratory experiments and exercises that reinforce physical chemistry concepts of thermodynamics, equilibrium, spectroscopy and error analysis. Students gain practical, hands-on experience with computerized data acquisition and learn computational techniques for data reduction and analysis. For undergraduate credit only. Course requires a lab fee. Pre- or corequisite(s): CHEM 545, CHEM 546.

**CHEM 605. Medicinal Chemistry (3).**

For students interested in chemistry related to the design, development and mode of action of drugs. Describes those organic substances used as medicinal agents and explains the mode of action and chemical reactions of drugs in the body; illustrates the importance and relevance of chemical reactions as a basis of pharmacological activity, drug toxicity, allergic reactions, carcinogenicity, etc.; and brings about a better understanding of drugs. Includes transport, basic receptor theory, metabolic transformation of drugs, discussion of physical and chemical properties in relation to biological activity, drug design, structure-activity relationships and discussion of a select number of organic medicinal agents. Prerequisite(s): CHEM 532 or equivalent; a semester of biochemistry (CHEM 661 or 662) and a year of biology are strongly recommended.

**CHEM 615. Advanced Inorganic Chemistry (3).**

Includes modern bonding theories, structure and spectra of inorganic compounds, coordination and organometallic chemistry, boranes, inorganic ring systems and polymers, inorganic environmental chemistry, mechanisms of inorganic reactions and solid state chemistry. Prerequisite(s): CHEM 514. Pre- or corequisite(s): CHEM 546.

**CHEM 616. Inorganic Chemistry Lab (2).**

Experimental methods of inorganic chemistry. An introduction to the synthetic and analytical techniques that are employed in modern inorganic chemistry. For undergraduate credit only. Course requires a lab fee. Pre- or corequisite(s): CHEM 615.

**CHEM 661. Principles of Biochemistry (3).**

Survey course for chemistry majors including chemistry/business majors and students in life sciences. Not recommended for the BS in chemistry-premedicine or biochemistry field majors for whom CHEM 662 and 663 are required. Introduces thermodynamics and biological oxidation-reduction reactions; structure, metabolism and synthesis of proteins, carbohydrates, lipids and nucleic acids; enzyme kinetics, photosynthesis and transfer of genetic information. Credit is not allowed in both CHEM 661 and 662. Prerequisite(s): CHEM 532, 533, or 536.

**CHEM 662. Biochemistry I (3).**

Study of major constituents of the cell: protein, carbohydrate, glycoprotein, lipid, nucleic acid, nucleoprotein, enzyme catalysis, biological oxidations, photosynthesis and introduction to intermediary metabolism. A fundamental background of biology or microbiology is recommended but not essential. Credit is not granted for both

CHEM 661 and 662. Prerequisite(s): CHEM 532 or equivalent. Pre- or corequisite(s): CHEM 523 or equivalent.

**CHEM 663. Biochemistry II (3).**

Studies metabolism and control of carbohydrates, lipids, phosphoglycerides, spingolipids, sterols, amino acids and proteins; synthesis of porphyrins, amides and polyamines; synthesis and metabolism of purines, pyrimidines and nucleotides; synthesis and structure of DNAs, RNAs and proteins; organization and functioning of genes; evolution of proteins and nucleic acids, hereditary disorders of metabolism, biochemistry of endocrine glands, major nutrients and vitamins, body fluids and generalized tissues. A fundamental background of biology or microbiology is recommended but not essential. Prerequisite(s): CHEM 662 with a grade higher than C-.

**CHEM 664. Biochemistry Laboratory (3).**

Practical training in biochemical procedures and literature searching; experiments include isolation, characterization and assay of biomolecules and use of centrifugation, chromatography, electrophoresis, spectrophotometry, enzyme kinetics and molecular cloning techniques. For undergraduate credit only. Prerequisite(s): CHEM 532. Pre- or corequisite(s): CHEM 662 or CHEM 663.

**CHEM 666. Special Topics in Biochemistry (3).**

An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 666A, 666B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): BIOL 211, CHEM 662, CHEM 663.

**CHEM 666C. NMR Principles and Practice (3).**

The main objective of this course is to establish a core knowledge of NMR for the undergraduate student focusing on simple one-dimensional experiments initially and then evolving into a description of two-dimensional NMR methods based on the product-operator formalism. There is a practical lab portion that utilizes the 500 MHz NMR. For undergraduate credit only. Prerequisite(s): CHEM 531. Pre- or corequisite(s): CHEM 532.

**CHEM 669. Research in Biochemistry (2).**

Cross-listed as BIOL 669. Students in the biochemistry field major participate in a biochemistry research project under the direction of a faculty member. Requires a written report summarizing the results. For undergraduate credit only. Repeatable once for credit. Prerequisite(s): BIOL 420, and CHEM 662 or 663, and CHEM 664 and instructor's consent.

**CHEM 690. Independent Study and Research (1-3).**

Studies performed must be directed by a faculty member in the department of chemistry and biochemistry. No more than 3 credit hours earned from CHEM 690 may be applied toward departmental major graduation requirements. For undergraduate credit only. Repeatable for up to 8 credit hours. Prerequisite(s): departmental consent.

**CHEM 700. Chemistry Seminar (1).**

Students give seminars on either papers recently published in the literature or on their own research. Repeatable for credit.

**CHEM 701. Chemistry Colloquium (1).**

Speakers for the colloquium consist of outstanding chemists from other institutions and faculty. Repeatable for credit.

**CHEM 709. Special Topics in Chemistry (2-3).**

An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 709A, 709B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

**CHEM 709G. Applied Computational Chemistry (3).**

The objective of this course is to build a working knowledge of the theoretical models and software used in modern computational chemistry. Beyond the study of the methods themselves, students develop a clear link from the application of the methods to answering chemical questions in a research environment and providing insight to experimental observations. Prerequisite(s): one year of college level physics or CHEM 546; or graduate standing.

**CHEM 709X. Materials Chemistry of Functional Materials (3).**

Provides a comprehensive introduction to functional materials, covering core topics such as synthetic methods, materials growth theory, crystallography, defect chemistry, and electronic structure (band theory). Students also explore key characterization techniques including X-ray and neutron diffraction, scanning and transmission electron microscopy (SEM, TEM), Raman spectroscopy, and more. In addition, the course discusses the diverse applications of functional materials in electronic, magnetic and optical systems, along with selected examples of current research in the field. By the end of the course, students understand the full development pipeline of functional materials—from theoretical design and synthesis to characterization and practical application. Prerequisite(s): CHEM 212 or graduate standing.

**CHEM 709Z. Special Topics in Biochemistry: Protein Folding and Human Disease (3).**

Biochemical understanding of proteins and nucleic acids is fueling the revolution in medicine, demonstrating how the basic principles of biochemical structure govern molecular regulation in normal human health or malfunction in disease. This course introduces students to the relevant concepts of protein structure and function, protein folding, and diseases associated with protein misfolding and/or dysfunction. Special attention is focused on protein misfolding and aggregation as this has been associated with over 40 human diseases. This course includes lectures, directed readings and student presentations to cover seminal and current papers on the biochemistry of conformational diseases including topics such as protein folding and misfolding, protein degradation pathways, effects of protein aggregation on cell function, model systems to study protein aggregation and novel approaches to prevent protein aggregation. Prerequisite(s): CHEM 661 or CHEM 662; or graduate standing.

**CHEM 715. Advanced Spectroscopy (3).**

Introduces <sup>1</sup>H and <sup>13</sup>C NMR spectroscopy including basic concepts such as integration, chemical shifts, diamagnetic shielding, magnetic anisotropy, spin-spin coupling (first and second-order), coupling constants, proton decoupled <sup>13</sup>C NMR interpretation of <sup>1</sup>H and <sup>13</sup>C NMR spectra. More advanced topics include NOE and protein structural mapping, and multidimensional techniques such as COSY, DEPT, INEPT, molecular motion by NMR, coupling to I>0 metal centers, including those with <100 percent natural abundance, virtual coupling in metal complexes, NMR of paramagnetic systems and use of paramagnetic shift reagents. Introduces mass spectroscopy including instrumentation-magnetic sector, quadrupole, ion trap, MS-MS; sample preparation and interfaces-GC-MS, LC-MS, electrospray, MALDI; methods of ionization-electron impact, chemical ionization, electrospray, interpretation of mass spectra-basic concepts, fragmentation patterns. Introduces the interpretation of mid-infrared spectroscopy of complex molecules and ionic compounds followed by the synthesis of results from NMR, MS and mid IR spectra to determine structure. Emphasizes the interpretation of results for understanding electronic and molecular properties of chemical compounds related to their symmetry. Prerequisite(s): CHEM 532 or equivalent; or admission to a chemistry graduate program.

**CHEM 717. Advanced Spectroscopy II (3).**

Introduces electronic and vibrational spectroscopy, EPR and magnetic properties of compounds. Studies the electric field interaction of radiation, electronic and vibrational spectroscopy, and the magnetic field interaction of radiation, EPR and magnetism, with molecular systems examining the different changes in state that molecules can undergo. Emphasizes the interpretation of results for understanding electronic and molecular properties of chemical compounds related to their symmetry and structure. Prerequisite(s): CHEM 532, 546, 615, or their equivalents; or admission to a chemistry graduate program.

**CHEM 719. Modern Synthetic Methods (3).**

Introduces modern synthetic methods in chemistry. Detailed investigation of the synthetic chemistry of anions is followed by a detailed survey of functional group interconversions, then oxidation and reduction reactions. Introduces the topic of retrosynthetic analysis. Topics in inorganic synthesis include organometallic bond forming and breaking reactions, ligand synthesis and replacement, solid state synthesis and topics in bioinorganic synthesis. Prerequisite(s): CHEM 532 and 615, or their equivalents; or admission to a chemistry graduate program.

**CHEM 721. Advanced Biochemistry (3).**

Introduces advanced biochemical concepts, processes and techniques. A comprehensive survey of structure and functions of biomolecules including proteins, nucleic acids, lipids, DNA replication and translation. Covers biological membrane and membrane transport. Enzyme mechanisms and kinetics and protein structure/function are discussed in detail. Biochemical, molecular biological, biophysical and chemical techniques that are commonly used in the study of biochemical processes are introduced and discussed. Prerequisite(s): CHEM 661 or 663 or their equivalents; or admission to a chemistry graduate program.

**CHEM 722. Advanced Physical Chemistry (3).**

In-depth overview of the fundamentals of thermodynamics, kinetics, quantum mechanics and statistical mechanics as they apply to chemistry. Special emphasis is placed on solution thermodynamics, kinetics of coupled reactions, statistical mechanics of macromolecules and quantum mechanics as it applies to spectroscopy. Prerequisite(s): CHEM 545 and 546, or their equivalents; or admission to a chemistry graduate program.

**CHEM 734. Instrumental Methods for Research (3).**

Designed to prepare graduate students or other researchers to perform spectroscopy experiments relevant to their research. The identity of organic compounds can be determined by the information provided by several types of spectra: mass, infrared, nuclear magnetic resonance, fluorescence and ultraviolet. Students learn to operate such instruments as the Varian 2200 GC/MS mass spectrometer, the ThermoNicolet Avatar FTIR spectrophotometer, the Varian Mercury 300 and Inova 400 NMR spectrometers, the Fluorolog fluorescence spectrophotometer and the Hitachi U-2010 and Varian Cary 100 UV-Vis spectrophotometers in the department's NMR and analytical facilities. Focuses on technique and not the interpretation of spectra. On successful completion of this course, students are authorized to use departmental instruments. Prerequisite(s): CHEM 524 or equivalent, or departmental consent, or admission to a chemistry graduate program.

**CHEM 781. Cooperative Education (1-4).**

Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Repeatable for credit.