

# Chemistry

## Courses

### **CHEM 1000 Chemistry: The Central Science: 1 semester hour**

This course introduces chemistry majors to the broad nature of the chemical enterprise, including career areas for chemists, trends in chemistry related opportunities in research and industry, and provides an overview of the relevance of chemistry as a discipline. The course reviews the chemistry curriculum and the role of chemistry as a central science and includes presentations from selected current faculty and departmental alumni about research opportunities and other resources within the department. The course is required of all chemistry majors, and is to be taken no later than their second semester of enrollment as a chemistry major at UMSL.

### **CHEM 1011 Chemistry in the Environment: 3 semester hours**

This course examines the role of chemistry in the environment and the application of chemistry to our understanding of society. The focus of the course will be the relationship between chemistry and the world around us including topics such as the chemistry of air, global climate change, water and energy. The course is designed for non-science, non-engineering and non-allied health majors and can be used to fulfill a general education requirement for undergraduate degrees. The course consists of two hours of lecture per week and, on alternate weeks, one hour of discussion or two hours of laboratory.

### **CHEM 1021 Beer Brewing: Chemical and Biochemical Principles: 3 semester hours**

This course examines the process of beer brewing as it relates to general topics of chemistry, biochemistry and biology. Each aspect of the brewing process will be examined in detail and the underlying scientific principles identified and discussed. The course is designed for non-science, non-engineering and non-allied health majors and can be used to fulfill a general education requirement for undergraduate degrees. The course consists of two hours of lecture and three hours of lab per week.

### **CHEM 1022 Principles of Fermentation Science: 3 semester hours**

Prerequisites: CHEM 1021 or a 3 credit-hour 1000 level science course or consent of instructor. This course is designed primarily for students that want to gain insight into the fermentation process from the initial ingredients to the final product. Students will be engaged in analysis of ingredients, impact on the process and evaluation of various styles of beer. Laboratory evaluation will include analysis of water, hops, carbohydrates, alcohol content and sensory science. The course consists of two hours of lecture and three hours of lab per week.

### **CHEM 1052 Chemistry for the Health Professions (MOTR CHEM 100): 4 semester hours**

An introduction to general, nuclear, structural organic, organic reactions and biochemistry. This course is designed primarily for students in nursing and related health professions, and should not be taken by students majoring in the physical or biological sciences. Chemistry majors may include neither CHEM 1052 or CHEM 1062 in the 120 hours required for graduation. Four hours of lecture per week.

### **CHEM 1062 Organic and Biochem for the Health Professions: 2 semester hours**

Prerequisites: Any college Chemistry course. An introduction to organic reactions and biochemistry. CHEM 1062 is offered during the second half of the semester. Four hours of lecture per week.

### **CHEM 1081 Introductory Chemistry I-A (MOTR CHEM 100): 3 semester hours**

Prerequisites: MATH 1030 (or a score of 26 or higher on either the Math ACT or the Math Placement Test). This course is designed for students who want to have an in depth understanding of introductory concepts in Chemistry. CHEM 1081 covers the topics taught in the first half of CHEM 1111 but at a slower pace, thus allowing students time to fully integrate the concepts and thereby build a stronger foundation for their subsequent Chemistry courses. CHEM 1081 consists of the first half of CHEM 1111 (excluding laboratory experiments), whereas CHEM 1091 covers all the laboratory experiments and second half of lecture part of CHEM 1111. Three hours of lecture or workshop per week.

### **CHEM 1091 Introductory Chemistry I-B (MOTR CHEM 150L): 3 semester hours**

Prerequisites: CHEM 1081. CHEM 1091 is the completion of CHEM 1111 for students who have completed CHEM 1081. The laboratory portion of this course will start at the beginning of the semester. The lecture part of the course starts in mid-semester and students join an ongoing CHEM 1111 class. Students who completed CHEM 1081 must complete CHEM 1091 to be considered as having completed the equivalent of CHEM 1111. Three hours of lecture and one and one half hours of workshop during the second half of the semester, and three hours of laboratory per week during the entire semester.

### **CHEM 1111 Introductory Chemistry I (MOTR CHEM 150L): 5 semester hours**

Prerequisite: MATH 1030 (or a score of 26 or higher on either the Math ACT or the Missouri Math Placement Test) and MATH 1035 (MATH 1035 may be taken concurrently). Presents an introduction to the fundamental laws and theories of chemistry. Laboratory experiments are designed to demonstrate some aspects of qualitative and quantitative analysis and to develop skills in laboratory procedures. Chemistry majors may not include both CHEM 1011 and CHEM 1111 in the 120 hours required for graduation. Three hours of lecture, one and one-half hours of workshop, and three hours of laboratory per week.

### **CHEM 1111A CHEM 1111A-Introductory Chemistry 1 - Modular Format: 1 semester hour**

Prerequisites: MATH 1030 (or a score equivalent to completion of MATH 1030 on the UMSL mathematics placement assessment). These courses (1111A-1111L) are identical in content to CHEM 1111 but are offered in a modular format. Each credit hour deals with the lecture or laboratory material covered in CHEM 1111. Completion of all five modules with a grade in each of C- or above is equivalent to completion of CHEM 1111. CHEM 1111A covers the first quarter of lecture material covered in CHEM 1111.

### **CHEM 1111B CHEM 1111B-Introductory Chemistry 1 - Modular Format: 1 semester hour**

Prerequisites: CHEM 1111A. Concurrent registration with CHEM 1111A is permitted. CHEM 1111B covers the second quarter of lecture material covered in CHEM 1111.

### **CHEM 1111C CHEM 1111C-Introductory Chemistry 1 - Modular Format: 1 semester hour**

Prerequisites: CHEM 1111B. Concurrent registration with CHEM 1111B is permitted. CHEM 1111C covers the third quarter of lecture material covered in CHEM 1111.

### **CHEM 1111D CHEM 1111D-Introductory Chemistry 1 - Modular Format: 1 semester hour**

Prerequisites: CHEM 1111C. Concurrent registration with CHEM 1111C is permitted. CHEM 1111D covers the final quarter of lecture material covered in CHEM 1111.

**CHEM 1111L CHEM 1111L-Introductory Chemistry 1 - Modular****Format: 1 semester hour**

Prerequisites: CHEM 1111D. Concurrent registration with CHEM 1111D is permitted. CHEM 1111L covers laboratory portion of CHEM 1111.

**CHEM 1121 Introductory Chemistry II: 5 semester hours**

Prerequisite: CHEM 1111 or advanced placement. Lecture and laboratory are a continuation of CHEM 1111. Three hours of lecture, one and one-half hours of workshop and three hours laboratory per week.

**CHEM 1134 Special Topics in Introductory Chemistry: 1-5 semester hours**

Prerequisite: Consent of instructor. A lecture and/or laboratory course to assist transfer students to complete the equivalent of CHEM 1111 and CHEM 1121. Students enrolling in this course should contact the instructor prior to the first day of class for guidelines on course requirements, to choose a lab or workshop section, and to request enrollment in the course website.

**CHEM 2010 Introduction to Inquiry Approaches to STEM Education (STEP I): 1 semester hour**

Same as BIOL 2010, PHYSICS 2010, MATH 2010, and SEC ED 2010. Prerequisites: Concurrent enrollment BIOL 1821, BIOL 1831, CHEM 1111, CHEM 1121, PHYSICS 2111, PHYSICS 2112, MATH 1800, or MATH 1900 or have a declared STEM major. Students who want to explore teaching careers become familiar with lesson plan development by writing, teaching and observing lessons in a local school class. Students build and practice inquiry-based lesson design skills and become familiar with and practice classroom management in the school setting. As a result of the STEP I experiences students should be able to decide whether to continue to explore teaching as a career and ultimately finishing the remainder of the WE TEACH MO curriculum leading to teacher certification. The classroom observations and teaching represent a major field component and requires at least one two hour block of free time during the school day once a week.

**CHEM 2011 Designing Inquiry-Based STEM Experiences (STEP II): 1 semester hour**

Same as BIOL 2011, PHYSICS 2011, MATH 2011, and SEC ED 2011. Prerequisites: BIOL 2010, CHEM 2010, PHYSICS 2010, MATH 2010, or SEC ED 2010. Students explore teaching careers, become familiar with STEM school setting through observing and discussing the school environment and by developing and teaching inquiry-based lessons.

**CHEM 2223 Quantitative Analysis in Chemistry: 3 semester hours**

Prerequisites: CHEM 1121. This course covers basic analytical chemistry theory and techniques, principles of experimental error analysis, and the application of statistics to data treatment. A significant proportion of the laboratory experiments emphasize quantification of unknown samples.

**CHEM 2612 Organic Chemistry I: 3 semester hours**

Prerequisite: CHEM 1121 (may be taken concurrently). An introduction to the structure, properties, synthesis, and reactions of aliphatic and aromatic carbon compounds. Three hours of lecture per week.

**CHEM 2622 Organic Chemistry II: 3 semester hours**

Prerequisite: CHEM 2612. A systematic study of organic reactions and their mechanisms; organic synthetic methods. Three hours of lecture per week.

**CHEM 2633 Organic Chemistry Laboratory: 2 semester hours**

Prerequisite: CHEM 2612. An introduction to laboratory techniques and procedures of synthetic organic chemistry including analysis of organic compounds. One hour of lecture and four and one-half hours of laboratory per week.

**CHEM 3022 Introduction to Chemical Literature: 1 semester hour**

Prerequisites: CHEM 2622 (CHEM 2622 may be taken concurrently). This course will familiarize the student with the literature of chemistry and its use. One hour of lecture per week.

**CHEM 3302 Physical Chemistry for The Life Sciences: 3 semester hours**

Prerequisites: CHEM 2612 and MATH 1800 or MATH 1100, and PHYSICS 1012. Principles and applications of physical chemistry appropriate to students pursuing degree programs in the life sciences. Topics will include thermodynamics, equilibria, kinetics, and spectroscopy. This course is intended for undergraduates seeking the B.S. degree in Biochemistry and Biotechnology and does not fulfill the physical chemistry required for other Chemistry B.A. and B.S. degree programs.

**CHEM 3312 Physical Chemistry I: Thermodynamics and Kinetics: 3 semester hours**

Prerequisites: CHEM 1121 and MATH 2000 (MATH 2000 may be taken concurrently), and PHYSICS 2111. This course discusses the principles of physical chemistry, focusing on thermodynamics, theory of gases, phase equilibria, solution behavior, and kinetics.

**CHEM 3322 Physical Chemistry II: Quantum Chemistry and Spectroscopy: 3 semester hours**

Prerequisites: CHEM 1121, MATH 2000 and PHYSICS 2111. This course discusses the principles of physical chemistry, focusing on atomic and molecular structure, spectroscopy, and quantum mechanics.

**CHEM 3333 Physical Chemistry Laboratory I: 2 semester hours**

Prerequisites: CHEM 2223 and CHEM 3312 (CHEM 3312 may be taken concurrently). This course involves experiments designed to illustrate principles introduced in CHEM 3312.

**CHEM 3412 Basic Inorganic Chemistry: 3 semester hours**

Prerequisite: CHEM 1121. This course reviews the principles of atomic structure and studies covalent and ionic bonding. Topics include properties of the elements and synthesis, reactions and bonding aspects of important main group and transition metal compounds. Two hours lecture per week.

**CHEM 3643 Advanced Organic Chemistry Laboratory: 2 semester hours**

Prerequisites: CHEM 2223, CHEM 2622, CHEM 2633, and CHEM 3022 (may be taken concurrently). Identification of organic compounds by classical and spectroscopic methods; advanced techniques in synthesis and separation of organic compounds. One hour of lecture and four and one-half hours of laboratory per week. Not for graduate credit.

**CHEM 3905 Chemical Research: 1-10 semester hours**

Prerequisite: Consent of instructor. Independent laboratory and library study, in conjunction with faculty member, of fundamental problems in chemistry. A written report describing the research is required.

**CHEM 4212 Instrumental Analysis: 3 semester hours**

Prerequisites: CHEM 3312 and CHEM 3322. This course studies the principles and applications of modern methods of instrumental analysis for analytical chemistry measurements. Topics may be selected from the areas of electrochemistry, absorption and emission spectroscopy, chromatography, mass spectrometry, surface analysis, and nuclear magnetic resonance.

**CHEM 4233 Laboratory in Instrumental Analysis: 2 semester hours**

Prerequisites: CHEM 4212, CHEM 3333. Experiments designed to illustrate the principles and practices of instrumental analysis, involving the use of modern instrumentation in analytical chemistry applications. One hour of discussion and four and one-half hours of laboratory per week.

**CHEM 4302 Survey of Physical Chemistry with Applications to the Life Sciences: 3 semester hours**

Prerequisites: CHEM 2612 and MATH 1800 or MATH 1100, and PHYSICS 1012. This course covers the principles of physical chemistry with applications to the life sciences. Topics will include thermodynamics, equilibria, kinetics, and spectroscopy. This course will be taught simultaneously with CHEM 3302, but students in CHEM 4302 will have additional assignments or projects. No student may receive credit for both CHEM 3302 and CHEM 4302. No student may receive credit for both 4302 and 5302.

**CHEM 4343 Physical Chemistry Laboratory II: 2 semester hours**

Prerequisites: CHEM 2223 and CHEM 3322 (CHEM 3322 may be taken concurrently). This course involves experiments designed to illustrate principles introduced in CHEM 3322.

**CHEM 4412 Advanced Inorganic Chemistry: 3 semester hours**

Prerequisites: CHEM 3322 (may be taken concurrently), CHEM 3412, and CHEM 2622. This course introduces the chemistry of the elements, including atomic and molecular structure, acids and bases, the chemistry of the solid state, and main group and transition metal chemistry. Three hours of lecture per week. Students may not receive credit for both CHEM 4412 and CHEM 5412.

**CHEM 4433 Inorganic Chemistry Laboratory: 2 semester hours**

Prerequisites: CHEM 3333, CHEM 3643, and CHEM 4412 (CHEM 3643 may be taken concurrently). The more sophisticated techniques of physical and analytical chemistry will be used to study inorganic compounds and their reactions. One hour of lecture and four and one half hours of laboratory per week. Not for graduate credit.

**CHEM 4612 Introduction to Macromolecular, Supramolecular, and Nanoscale Chemistry: 1 semester hour**

Prerequisites: CHEM 2622, CHEM 3412, and CHEM 3312. This course introduces students to macromolecular, supramolecular, and nanoscale chemistry. Structure, synthesis and/or preparation, characterization, and physical properties of these systems will be introduced. May not be taken for graduate credit.

**CHEM 4712 Biochemistry: 3 semester hours**

Same as BIOL 4712. Prerequisites: CHEM 2612 and either BIOL 1831 or CHEM 2622. Examines the chemistry and function of cell constituents, and the interaction and conversions of intracellular substances. Students may not receive credit for both BIOL 4712 and CHEM 4712.

**CHEM 4722 Advanced Biochemistry: 3 semester hours**

Prerequisite: CHEM 4712. This course covers selected advanced topics in the chemistry of life processes. Students may not receive credit for both CHEM 4722 and CHEM 5722.

**CHEM 4733 Biochemistry Laboratory: 2 semester hours**

Prerequisites: CHEM 4712 (may be taken concurrently), and CHEM 2223. Laboratory study of biochemical processes in cellular and subcellular systems with emphasis on the isolation and purification of proteins (enzymes) and the characterization of catalytic properties. One hour of lecture and four and one-half hours of laboratory per week.

**CHEM 4772 Physical Biochemistry: 3 semester hours**

Prerequisites: CHEM 3312 or CHEM 4712 or BIOL 4712. This course is designed to acquaint students with concepts and methods in biophysical chemistry. Topics that will be discussed include protein and DNA structures, forces involved in protein folding and conformational stability, protein-DNA interactions, methods for characterization and separation of macromolecules, and biological spectroscopy. Students may not receive credit for both CHEM 4772 and CHEM 5772.

**CHEM 4774 Introduction to Bioinformatics: 3 semester hours**

Prerequisites: CHEM 4712 or equivalent. This course introduces modern approaches in bioinformatics and computational biochemistry. Topics covered include a survey of biological databases, predictions from protein and DNA sequences, sequence alignment and sequence database searches, building phylogenetic trees, three-dimensional protein structure prediction, molecular modeling and simulation, and computational genomics. Students may not receive credit for both CHEM 4774 and CHEM 5774.

**CHEM 4797 Biochemistry and Biotechnology Seminar: 1 semester hour**

Same as CHEM 4797. Prerequisites: Senior standing in the Biochemistry and Biotechnology program and consent of faculty advisor. This course will focus on selected publications related to biochemistry and biotechnology from both refereed journals and news sources. Students are expected to participate in discussions and to prepare oral and written presentations. Completion of the Major Field Achievement Test in Biochemistry & Biotechnology is a course requirement. May not be taken for graduate credit.

**CHEM 4814 Special Topics in Chemistry: 1-10 semester hours**

A reading and seminar course in selected advanced topics.

**CHEM 4897 Seminar in Chemistry: 2 semester hours**

Prerequisites: CHEM 3022 and senior standing. This course will provide students with the opportunity to listen to talks presented by students, faculty, and invited speakers. Students must complete a comprehensive examination before the end of the course. Chemistry majors should enroll during the semester in which they intend to graduate, or during their next-to-last semester before graduation.

**CHEM 5302 Foundations of Physical Chemistry: 3 semester hours**

Prerequisites: Consent of Instructor. A survey of fundamental and advanced topics in physical chemistry including thermodynamics, kinetics, quantum chemistry, and spectroscopy. Three hours of lecture per week. Additional independent study work is required. Students may not receive credit for both CHEM 4302 and CHEM 5302.

**CHEM 5394 Special Topics in Physical Chemistry: 1-3 semester hours**

Prerequisite: Consent of instructor. The topic for this course may change from semester to semester, and more than one course or topic can be offered in a given semester. The course may be taken more than once for credit provided that the topic is different in each case. The course can have more than one instructor.

**CHEM 5396 Directed Readings in Physical Chemistry: 1-3 semester hours**

Prerequisites: Consent of Physical Chemistry Faculty. A series of readings of monographs, review papers, and/or research publications for a particular student directed at providing that student with appropriate background preparation for experimental or theoretical Ph.D.-level research in an area of physical chemistry. The particular readings will be selected by the physical chemistry staff. Potential topics include but are not limited to advances in Electrochemistry, Surface Chemistry, Thermodynamics, Molecular Spectroscopy, Quantitative Absorption Spectroscopy using new Methodologies, Applications of Group Theory in Spectroscopy, and Computational Chemistry. Assessment may be in various forms including by assignments and seminars. Students may take this course more than once for credit through the particular topic must be different in each case.

**CHEM 5412 Advanced Graduate Inorganic Chemistry: 3 semester hours**

Prerequisites: Graduate standing and consent of instructor. An introduction to the chemistry of the elements, including atomic and molecular structure, acids and bases, the chemistry of the solid state, and main group and transition metal chemistry. Additional independent study work is required. Three hours of lecture per week. Students may not receive credit for both CHEM 4412 and CHEM 5412.

**CHEM 5422 Coordination Chemistry: 3 semester hours**

Prerequisite: CHEM 4412 or an equivalent course. Chemistry of the coordination compounds of the transition metals including such topics as kinetics and mechanisms of reaction, stereochemistry, ligand field theory, stability and electronic spectra. Three hours of lecture per week.

**CHEM 5462 Organometallic Chemistry of the Transition Elements: 3 semester hours**

Prerequisites: CHEM 4412 or an equivalent course. A study of transition metal compounds containing metal-carbon bonds and related metal-element bonds, including their synthesis, structure and bonding, and reactions. Applications in organic synthesis and catalysis will also be presented. Three hours of lecture per week.

**CHEM 5494 Special Topics in Inorganic Chemistry: 1-3 semester hours**

Prerequisite: Consent of instructor. The topic for this course may change from semester to semester, and more than one course or topic can be offered in a given semester. The course may be taken more than once for credit provided that the topic is different in each case. The course can have more than one instructor.

**CHEM 5602 Advanced Organic Chemistry I - Physical Organic: 3 semester hours**

Prerequisites: CHEM 2622 and CHEM 3322. Mechanism and theory of organic chemistry. Topics to include kinetics, transition state theory, reaction intermediates, and stereochemical analysis. Three hours of lecture per week.

**CHEM 5612 Advanced Organic Chemistry II - Reactions And Synthesis: 3 semester hours**

Prerequisite: CHEM 2622. This course will examine a variety of organic transformations typically utilized in organic synthesis. Topics will include carbon-carbon bond formation, pericyclic reactions, oxidation, reduction, and functional group interconversions. Mechanism and stereochemistry will be emphasized. Three hours of lecture per week.

**CHEM 5652 Spectroscopic Identification of Organic Compounds: 3 semester hours**

Prerequisites: Graduate standing or CHEM 3643. An applied approach to the use of spectroscopic techniques in organic chemistry. Topics to include integrated applications of infrared and Raman spectroscopy,  $^{13}\text{C}$  and  $^1\text{H}$  nuclear magnetic resonance spectroscopy and mass spectroscopy for the purpose of elucidating the structure and dynamics of organic compounds. Three hours of lecture per week.

**CHEM 5694 Special Topics in Organic Chemistry: 1-3 semester hours**

Prerequisite: Consent of instructor. The topic for this course may change from semester to semester, and more than one course or topic can be offered in a given semester. The course may be taken more than once for credit provided that the topic is different in each case. The course can have more than one instructor.

**CHEM 5722 Advanced Graduate Biochemistry: 3 semester hours**

Prerequisites: CHEM 4712 or BIOL 4712. Selected advanced topics in the chemistry of life processes. Three hours of lecture per week. Students may not receive credit for both CHEM 4722 and CHEM 5722.

**CHEM 5772 Advanced Physical Biochemistry: 3 semester hours**

Prerequisites: CHEM 3312 or CHEM 4712 or BIOL 4712. Designed to acquaint students with concepts and methods in biophysical chemistry. Topics that will be discussed include protein and DNA structures, forces involved in protein folding and conformational stability, protein-DNA interactions, methods for characterization and separation of macromolecules, and biological spectroscopy. Three hours of lecture per week. Students may not receive credit for both CHEM 4772 and CHEM 5772.

**CHEM 5774 Bioinformatics: 3 semester hours**

Prerequisites: CHEM 4712 or equivalent. This course introduces modern approaches in bioinformatics and computational biochemistry. Topics to be covered include a survey of biological databases, predictions from protein and DNA sequences, sequence alignment and sequence database searches, building phylogenetic trees, three-dimensional protein structure prediction, molecular modeling and simulation, and computational genomics. Additional independent study work is required. Students may not receive credit for both CHEM 4774 and CHEM 5774.

**CHEM 5794 Special Topics in Biochemistry: 1-3 semester hours**

Prerequisites: Consent of instructor. The topic for this course may change from semester to semester, and more than one course or topic can be offered in a given semester. The course may be taken more than once for credit provided that the topic is different in each case. The course can have more than one instructor.

**CHEM 5798 Practicum in Science in Business: 1-2 semester hours**

Same as: BIOL 5798. Prerequisites: Graduate standing and enrollment in a Professional Science emphasis in Chemistry, Biochemistry & Biotechnology, or Biology. Students will integrate and apply their scientific expertise to a practical, business-related problem. The course will emphasize interdisciplinary team-work as well as both written and oral communication skills.

**CHEM 5799 Internship in Science in Business: 1-2 semester hours**

Same as: BIOL 5799. Prerequisites: Graduate standing and enrollment in a Professional Science emphasis area in Chemistry, Biochemistry & Biotechnology, or Biology. The internship will consist of period of on-the-job training at a local company. Credit hours will be determined by the number of hours the student works each week and in consultation between the intern's supervisor and the course instructor. Internship assignments will be commensurate with the education and experience of the student, with an emphasis on work at the interface between the scientific and business components of the company. A written report describing the internship project is required.

**CHEM 6487 Problem Seminar in Inorganic Chemistry: 1 semester hour**

Prerequisite: Consent of the inorganic chemistry staff. Problems from the current literature, presentations and discussions by faculty, students and visiting scientists. Ph.D. students may take more than once for credit. Up to three credits may be applied to the M.S. degree program.

**CHEM 6687 Problem Seminar in Organic Chemistry: 1-3 semester hours**

Prerequisite: Consent of the organic chemistry staff. Problems from the current literature, presentations and discussions by faculty, students and visiting scientists. Ph.D. Students may take more than once for credit. Up to three credits may be applied to the M.S. degree programs.

**CHEM 6787 Problem Seminar in Biochemistry: 1 semester hour**

Prerequisite: Consent of the biochemistry staff. Problems from the current literature, presentations and discussions by faculty, students and visiting scientists. Ph.D. students may take more than once for credit. Up to three credits may be applied to the M.S. degree program.

***CHEM 6812 Introduction to Graduate Study in Chemistry: 1 semester hour***

Prerequisite: Consent of Graduate Advisor. Topics to be covered include: techniques of teaching of chemistry in colleges and universities, methods of instruction and evaluation; role and responsibilities of the Graduate Teaching Assistant in laboratory instruction; safety in the undergraduate laboratory, safety practices, emergency procedures; selection of a research project and thesis advisor.

***CHEM 6822 Introduction to Graduate Research in Chemistry: 1 semester hour***

Prerequisite: Consent of instructor. Topics to include: safety in the research laboratory, safety practices, emergency procedures, hazardous materials, waste disposal, radiation safety; research ethics, chemistry information retrieval, computer assisted information retrieval, types of databases, searching bibliographic data bases.

***CHEM 6832 Strategies for Independent Research Proposal Development: 1 semester hour***

Prerequisites: CHEM 6822 and Consent of Graduate Advisor. Topics include: strategies for identification of research topics in chemistry and biochemistry, techniques for database literature search, critical analysis of existing research knowledge, introduction to standard grant proposal formats, technical aspects in preparation of a research plan and accompanying sections, use of bibliographical software, and overview and practice of the peer review process.

***CHEM 6887 Graduate Student Seminar in Chemistry: 1 semester hour***

Prerequisites: Graduate standing. Scientific presentations by students. One hour per week.

***CHEM 6897 Chemistry Colloquium: 1 semester hour***

Presentation of papers by students, faculty and invited speakers. One hour per week.

***CHEM 6905 Graduate Research in Chemistry: 1-10 semester hours***