

CHEMISTRY

Chemistry

College of Science, Engineering and Technology

Department of Chemistry & Geology

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Chair: Mary Hadley

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The department is recognized by the American Chemical Society (ACS) and offers a BS major that is approved by that organization. Anyone considering a chemistry major or chemistry minor should choose a departmental faculty member as an advisor and consult that advisor often throughout the course of study.

Admission to Major. Admission to a program is necessary before enrolling in 300- and 400-level courses. Admission is granted by the department. To be eligible for admission to the chemistry program, a student must have declared Chemistry or Chemistry Teaching as a first major, completed 32 credits including CHEM 201 and CHEM 202 and achieved a minimum GPA of 2.0. Students should also have an assigned chemistry advisor with whom they have discussed the program. Applications for admission to the chemistry program are available in the College Student Advising Center, 125 Trafton Center.

POLICIES/INFORMATION

GPA Policy. Students obtaining a major or minor in chemistry must maintain an overall GPA of 2.2 in all courses required for their selected program with no more than 4 credits of "D" (1.0) work in chemistry courses.

P/N Grading Policy. Courses leading to a major or minor in chemistry or biochemistry may not be taken on a P/N basis except where P/N grading is mandatory.

The first year of coursework for all chemistry majors should include two semesters of chemistry (CHEM 201, CHEM 202) and two semesters of mathematics (selection of courses depends on mathematics background). During the second year, the recommended courses include organic chemistry, advanced mathematics, physics, analytical chemistry. For BS chemistry majors, it is important that the calculus and physics sequences be completed by the end of the second year since they are prerequisites for physical chemistry. Physical chemistry and instrumental analysis should be taken during the third year. The advanced courses in chemistry and biochemistry can be taken in the junior and senior years. Participation in senior seminar is required of all majors. The coursework in mathematics and physics that is required for a major may be credited toward a major or minors in these areas. For this reason it is often desirable and convenient to choose a joint major or minor with physics or mathematics.

Transfer students who are considering one of the Chemistry BS options should note that before taking physical chemistry in the third (junior) year, students must successfully complete with a grade of "C" (2.0) or higher an analytical chemistry course in addition to appropriate mathematics and physics courses either here at Minnesota State Mankato or transferable to Minnesota State Mankato. Completion of an Associate's degree may not meet the physical chemistry prerequisites and may add up to one year to the program of study.

CHEMISTRY BA

Required General Education

MATH 121 Calculus I (4)

(Choose 4 credits)

PHYS 211 Principles of Physics I (4)

PHYS 221 General Physics I (4)

Major Common Core

CHEM 201 General Chemistry I (5)

CHEM 202 General Chemistry II (5)

CHEM 305 Analytical Chemistry (4)
CHEM 312 Intermediate Inorganic (2)
CHEM 320 Organic Chemistry I (with lab) (5)
CHEM 321 Organic Chemistry II (3)
CHEM 331 Organic Chemistry II Lab (1)
CHEM 381 Introduction to Research (2)
CHEM 440 Physical Chemistry (3)
CHEM 495 Senior Seminar (1)

(Choose 4 credits)

PHYS 212 Principles of Physics II (4)

PHYS 223 General Physics III (3)

PHYS 233 General Physics III Lab (1)

Major Restricted Electives

Choose a minimum of 6 credits. These electives must include at least one of the following required elective courses.

Required Elective Course Options

(Choose 1-6 credits)

These electives must include at least one of these required elective course options.

CHEM 360 Principles of Biochemistry (4)
CHEM 407 Environmental Chemistry (3)
CHEM 415 Inorganic Preparations (2)
CHEM 423 Spectroscopic Determination of Structure (4)
CHEM 424 Advanced Organic Chemistry (3)
CHEM 437 Food Chemistry (4)
CHEM 450 Physical Chemistry Laboratory I (1)
CHEM 451 Physical Chemistry Laboratory II (1)
CHEM 465 Biochemical Techniques I (1)
CHEM 466 Biochemical Techniques II (2)
CHEM 474 Chromatography (2)
CHEM 475 Instrumental Analysis (4)

Additional Elective Course Options

(Choose 0-5 credits)

As long as one of the required elective courses listed is chosen, these electives may supplement the course(s) above to meet the 6 credit elective minimum.

CHEM 413 Advanced Inorganic Chemistry (3)
CHEM 434 Industrial Chemistry (2)
CHEM 441 Physical Chemistry II (3)
CHEM 460 Biochemistry I (3)
CHEM 461 Biochemistry II (3)
CHEM 477 Special Topics in Instrumental Analytical Chemistry (1-3)
CHEM 485 Seminar in Environmental Chemistry (1-2)
CHEM 490 Workshop (1-6)
CHEM 496 Senior Thesis (1-6)
CHEM 497 Internship (1-16)
CHEM 498 Undergraduate Research (1-6)
CHEM 499 Individual Study (1-6)

Required for Bachelor of Arts (BA) degree ONLY: Language (8 credits)

Required Minor: Yes. Any but Chemistry.

CHEMISTRY BS

Required General Education

MATH 121 Calculus I (4)

PHYS 221 General Physics I (4)

Major Common Core

CHEM 201 General Chemistry I (5)
CHEM 202 General Chemistry II (5)
CHEM 305 Analytical Chemistry (4)
CHEM 320 Organic Chemistry I (5)
CHEM 321 Organic Chemistry II (3)
CHEM 331 Organic Chemistry II Lab (1)
CHEM 381 Introduction to Research (2)
CHEM 413 Advanced Inorganic Chemistry (3)
CHEM 423 Spectroscopic Determination of Structure (4)

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CHEM 440	Physical Chemistry I (3)
CHEM 441	Physical Chemistry II (3)
CHEM 450	Physical Chemistry Laboratory I (1)
CHEM 451	Physical Chemistry Laboratory II (1)
CHEM 495	Senior Seminar (1)
MATH 122	Calculus II (4)
PHYS 223	General Physics III (3)
PHYS 233	General Physics III Laboratory (1)

Major Emphasis: A.C.S. Approved

The BS Chemistry, American Chemical Society (A.C.S.) Approved Emphasis is intended for professional chemists and provides an excellent preparation for graduate or professional school, industry or business. Any deviation from this program requires prior approval from the department.

CHEM 415	Inorganic Preparations (2)
CHEM 475	Instrumental Analysis (4)
(Choose 3-4 credits)	
CHEM 360	Principles of Biochemistry (4)
CHEM 460	Biochemistry I (3)

Required CHEM Elective for A.C.S. Approved Emphasis

(Choose 1-3 credits)

Students opting for CHEM 460 must choose at least 1 credit from the following.

CHEM 312	Intermediate Inorganic Chemistry (2)
CHEM 407	Environmental Chemistry (3)
CHEM 424	Advanced Organic Chemistry (3)
CHEM 434	Industrial Chemistry (2)
CHEM 461	Biochemistry II (3)
CHEM 465	Biochemical Techniques I (1)
CHEM 474	Chromatography (2)
CHEM 485	Seminar in Environmental Chemistry (1-2)
CHEM 496	Senior Thesis (1-6)
CHEM 497	Internship (1-16)
CHEM 498	Undergraduate Research (1-6)
CHEM 499	Individual Study (1-6)

Required MATH/PHYS Electives for A.C.S. Approved Emphasis

(Choose 3-4 credits)

Choose a minimum of 3 credits from the following courses

MATH 321	Ordinary Differential Equations (4)
MATH 455	Theory of Statistics I (4)
PHYS 441	Mechanics (4)
PHYS 447	Electricity & Magnetism I (3)
PHYS 453	Solid State Physics (3)
PHYS 473	Statistical Physics (3)

Major Emphasis: Generalized

The Generalized Emphasis is for students who want a rigorous preparation in chemistry, but do not need as comprehensive a program as that prescribed for the A.C.S. Approved Emphasis.

Choose at least 5 additional upper division credits to meet graduation requirements. 4 of these credits must be chemistry courses other than CHEM 492 and CHEM 482.

Required CHEM Electives for Generalized Emphasis

(Choose 4 credits)

Choose a minimum of 4 credits EXCEPT CHEM 479 and CHEM 482
CHEM 300-499

Required Minor: None.

CHEMISTRY MINOR

Minor Core

CHEM 201	General Chemistry I (5)
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CHEM 202	General Chemistry II (5)
CHEM 305	Analytical Chemistry (4)
CHEM 320	Organic Chemistry I (with lab) (5)
CHEM 321	Organic Chemistry II (3)

Minor Electives

These elective credits must be taken at Minnesota State Mankato for the minor.

Choose a minimum of three credits from CHEM courses except CHEM 381, CHEM 479, CHEM 482 and CHEM 495.

CHEM 300 - CHEM 499

CHEMISTRY TEACHING BS

Requirements for the Chemistry Teaching BS can be found in the SCIENCE TEACHING section of the bulletin. For information, consult the chemistry education advisor, Jeffrey Pribyl.

COURSE DESCRIPTIONS

CHEM 100 (4) Chemistry in Society

This lecture and laboratory course investigates the world of chemistry, the nature of matter and our interactions with chemicals on a daily basis. Lab included. This course is intended for non-science majors and is not a preparation for CHEM 111 or CHEM 201.
Fall, Spring
GE-3

CHEM 104 (3) Introduction to Chemistry

This course is an introduction to general chemistry. It is a non-laboratory class designed to prepare students for CHEM 201 or to be utilized as a general education course. This course will address more mathematical relationships than CHEM 106.
GE-3

CHEM 106 (3) Introduction to Chemistry (for Allied Health)

This course is an introduction to general and organic chemistry. This is a non-laboratory class designed to prepare students for CHEM 111 or to be utilized as a general education course.
GE-3

CHEM 111 (5) Chemistry of Life Processes

This course is an introduction to organic chemistry and biological chemistry for students in nursing, dental hygiene, dietetics, and athletic training. The laboratory will reinforce lecture concepts.
Pre: CHEM 106 or high school chemistry
Fall, Spring
GE-2, GE-3

CHEM 131 (3) Forensic Science

This chemistry course explores the scientific methods used in criminal investigations. Course topics will include discussions of different kinds of evidence, how to select and analyze samples, and especially how to interpret results of scientific tests. Specific topics will include the analysis of DNA, drugs, accelerants and explosives, and other organic and inorganic compounds. Case studies will be used as examples throughout the course. There will also be discussions concerning the ethics analysis, and uses of forensic data.
Variable
GE-3, GE-9

CHEM 132 (3) Chemistry of Energy

This course explores and evaluates energy sources from a chemical perspective. In addition to discussion of chemical processes associated with traditional energy sources such as fossil fuels, alternative sources such as solar energy and "next generation" batteries will be presented. In conjunction with this information the environmental and societal consequences for each alternative will be explored.
Variable

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CHEM 134 (3) Mind Altering Substances

This course will explore the scientific, pharmacological, neurochemical and cultural aspects of psychoactive substances. The material is presented intuitively, with no mathematics. Course topics will include discussions of the major classes of pharmaceutical and psychoactive substances, basic neurochemistry, the role of psychoactive substances in medicine, the ritual use of psychoactive substances by traditional cultures, the FDA approval process, the significance and implications of drug testing, the controversy of drug-induced behavioral modification, national and global perspectives of substance abuse and the ethics of legalization.

Variable
GE-3

CHEM 135 (3) Science of Sport

An online course introducing the science related to sports issues including nutrition, movement, equipment selection, and healthy exercising/training.

Variable
GE-3

CHEM 191 (3) Chemistry for Engineers

This course covers basic chemistry and applications relevant to students interested in the engineering fields.

Pre: high school chemistry or "C" (2.0) or higher in CHEM 104, placement into MATH 115 or MATH 121

Fall
GE-2, GE-3

CHEM 201 (5) General Chemistry I

Introduction to the basic principles of chemistry including atomic and molecular structure, bonding, chemical reactions, stoichiometry, thermodynamics and states of matter. Laboratory will reinforce lecture concepts.

Pre: "C" (2.0) or higher in MATH 112 or the equivalent; high school chemistry or "C" (2.0) or higher in CHEM 104.

Fall, Spring
GE-2, GE-3

CHEM 202 (5) General Chemistry II

Continuation of the basic principles of chemistry including properties of solutions, kinetics, acids and bases, equilibria, buffers, precipitation reactions, electron transfer reactions, electrochemistry, entropy and free energy. Laboratory will reinforce lecture concepts.

Pre: "C" (2.0) or higher in CHEM 201
Fall, Spring

CHEM 299 (1-6) Individual Study

CHEM 305 (4) Analytical Chemistry

Introduction to the principles of chemical analysis, with emphasis on classical methods of analysis. Lectures will stress the theory of chemical measurements and sample handling. Laboratory exercises will provide students with opportunities to explore calibration methods, method development, and established procedures for volumetric and gravimetric analyses. Basic atomic spectroscopy is also presented.

Pre: "C" (2.0) or higher in CHEM 202
Fall, Spring

CHEM 312 (2) Intermediate Inorganic Chemistry

This course is designed to emphasize the descriptive aspects of inorganic chemistry. Course topics include nuclear chemistry, reactivity patterns of selected s and p block elements and a brief introduction to coordination chemistry.

Pre: "C" (2.0) or higher in CHEM 202
Spring

CHEM 320 (5) Organic Chemistry I

Introduction to organic structure, bonding, chemical reactivity, reactions as acids and bases, mechanisms and stereochemistry. The chemistry of alkanes, alkyl halides, alkenes, alkynes, alcohols, ethers, aldehydes and ketones, carboxylic acids and their derivatives, and amines will be covered. Laboratory illustrates synthetic techniques and the preparation and reactions of functional groups discussed during lecture.

Pre: "C" (2.0) or higher in CHEM 202
Fall

CHEM 321 (3) Organic Chemistry II

The chemistry of aromatic compounds, free radicals, polyenes, macromolecules, heterocyclic compounds, carbohydrates, amino acids, peptides, and proteins will be covered. This will include a study of mechanisms, synthetic transformations, concerted reactions, and spectroscopy.

Pre: "C" (2.0) or higher in CHEM 320
Spring

CHEM 331 (1) Organic Chemistry II Lab

Laboratory illustrating electrophilic aromatic substitutions and other reactions of aromatic compounds, synthetic transformations as well as qualitative organic analysis.

Pre: CHEM 321 previously or concurrently
Spring

CHEM 360 (4) Principles of Biochemistry

Analysis of the structure and metabolism of biologically important compounds. This intermediate-level course is designed for students in the medical technology, food science, chemistry education, chemistry and pre-professional health majors. The laboratory teaches basic biochemical techniques.

Pre: "C" (2.0) or higher in CHEM 320
Spring

CHEM 381 (2) Introduction to Research

Introduction to the use of chemical literature (in print and electronic media), current departmental faculty research interests, safe and ethical conduct of laboratory research, and proper recording of research results in laboratory notebooks. Students perform a literature search and write a proposal for an undergraduate research project.

Pre: CHEM 321
Fall

CHEM 407 (3) Environmental Chemistry

The sources of various elements and chemical reactions between them in the atmosphere and hydrosphere are treated. Current research topics relevant to the field of environmental chemistry will also be addressed. Laboratory exercises will emphasize proper sampling technique and various analytical methods for quantifying environmentally important components.

Pre: "C" (2.0) or higher in CHEM 305
Variable

CHEM 413 (3) Advanced Inorganic Chemistry

A survey of topics in inorganic chemistry including quantum mechanics, symmetry and group theory, solid state chemistry, molecular structure and geometry, bonding theories, and coordination chemistry, emphasizing the theoretical foundation.

Pre: "C" (2.0) or higher in CHEM 441
Fall

CHEM 415 (2) Inorganic Preparations

The preparation and study of inorganic/organometallic compounds utilizing a variety of synthetic techniques including common Schlenk techniques. The studies will include characterization by common instrumental methods such as IR, NMR and UV-vis spectroscopy. Additional studies using instrumental techniques such as IR, NMR, UV-vis, electrochemistry and magnetic susceptibility will also be conducted.

Pre: "C" (2.0) or higher in CHEM 413
Spring

CHEM 423 (4) Spectroscopic Determination of Structure

Spectroscopic techniques including nuclear magnetic resonance, infrared, and mass spectrometry for determining structural features of molecules will be covered. Spectroscopic methods emphasize interpretation of spectra, and also provide hands-on operation of the corresponding electronic instruments. The laboratory uses these techniques for the determination of the structures of a series of unknown compounds.

Pre: "C" (2.0) or higher in CHEM 321 and CHEM 331
Spring

CHEM 424 (3) Advanced Organic Chemistry

Advanced synthetic organic reactions and their mechanisms. Laboratory will include examples of some of this chemistry, and techniques for reaction monitoring and product purification.

Pre: "C" (2.0) or higher in CHEM 321
Spring-EVEN

CHEM 434 (2) Industrial Chemistry

The synthesis and properties of organic macromolecules, especially industrially important polymers, and the chemistry of other industrially important chemical reactions and processes.

Pre: "C" (2.0) or higher in CHEM 321
Spring-ODD

CHEM 437 (4) Food Chemistry

This lecture laboratory course will cover the fundamental principles of food chemistry. Chemical and physical properties of major and minor food components will be discussed. The laboratory will involve both traditional wet chemical methods and more sophisticated instrumental analyses.

Pre: "C" (2.0) or higher in CHEM 305, "C" (2.0) or higher in CHEM 320;
Pre or Co: CHEM 360 or CHEM 460
Variable

CHEM 440 (3) Physical Chemistry I

Detailed treatment of thermodynamics and chemical kinetics. Topics include equations of state, laws of thermodynamics, statistical thermodynamics, phase and reaction equilibrium, thermodynamics of solutions and electrochemistry, transport properties, and reaction kinetics.

Pre: "C" (2.0) or higher in CHEM 305, "C" (2.0) or higher in MATH 121, "C" (2.0) or higher in either PHYS 212 or PHYS 221
Fall

CHEM 441 (3) Physical Chemistry II

Detailed treatment of quantum mechanics, spectroscopy, and statistical mechanics. Topics include the foundations of quantum mechanics, application of quantum mechanics to atomic and molecular structure, foundations of spectroscopic techniques and statistical mechanics.

Pre: Must have a "C" (2.0) or higher in CHEM 440, MATH 122, PHYS 223
Spring

CHEM 450 (1) Physical Chemistry Laboratory I

Laboratory to accompany CHEM 440. An advanced treatment of measurement theory and data analysis precedes a series of thermodynamic and kinetic experiments designed to complement topics treated in lecture to help students' independence and sophistication in planning, performing, and reporting experimental work.

Pre: CHEM 440 previously or concurrently
Fall

CHEM 451 (1) Physical Chemistry Laboratory II

Laboratory to accompany CHEM 441. Experiments and computational projects in quantum mechanics, spectroscopy, and statistical mechanics. The experiments and projects will continue to work toward the goal of increasing the students' independence and sophistication.

Pre: "C" (2.0) or higher in CHEM 440
Pre or Co: CHEM 441
Spring

CHEM 460 (3) Biochemistry I

Detailed analysis of the structures, properties, and functions of proteins, carbohydrates, and lipids; introduction to carbohydrate metabolism; theory for the purification and analysis of proteins. Concurrent enrollment in CHEM 465 is recommended.

Pre: "C" (2.0) or higher in BIOL 106 or permission, "C" (2.0) or higher in CHEM 321
Fall

CHEM 461 (3) Biochemistry II

Detailed analysis of the reactions involved in intermediary metabolism, translation, transcription, and replication.

Pre: CHEM 460
Spring

CHEM 465 (1) Biochemical Techniques I

A lecture/laboratory course which presents methodology and instrumentation used to purify and analyze biomolecules. Techniques include chromatography, autoradiography and radioisotope techniques, polyacrylamide gel electrophoresis, and spectrophotometry.

Pre: CHEM 460 previously or concurrently. CHEM 305 is recommended.
Fall

CHEM 466 (2) Biochemical Techniques II

Students work in teams to solve biochemical research problems by analyzing data from experiments which they design.

Pre: CHEM 460 and CHEM 465
Spring

CHEM 474 (2) Chromatography

Theory and applications of thin layer, paper, liquid, gas and supercritical fluid chromatography and capillary electrophoresis.

Pre: CHEM 320 previously or concurrently is recommended
Fall-EVEN

CHEM 475 (4) Instrumental Analysis

Theory and practice of modern instrumental methods including basic electronics. Special emphasis placed on sampling methods, analog and digital electronics, electrochemistry, spectrophotometric and chromatographic methods, surface and thin-film analysis and computer acquisition and data processing techniques.

Pre: "C" (2.0) or higher in CHEM 305; PHYS 212 or PHYS 222 is recommended
Spring

CHEM 477 (1-3) Special Topics in Instrumental Analytical Chemistry

Detailed study and focused discussion of a specific analytical technique such as electrochemistry, X-ray analysis, etc. or an area of analysis such as metals, bioanalytical, etc. This course may be taken more than once for credit.

Pre: CHEM 305
Variable

CHEM 479 (4) Teaching Physical Science

Methods and materials for teaching physical sciences in middle school through high school. Clinical experiences are required for the course.

Pre: Consent
Spring

CHEM 482 (1-3) Problems in Teaching Science

Variable

CHEM 485 (1-2) Seminar in Environmental Chemistry

Study of current environmental problems or issues with emphasis on the relevant chemical needs and understanding necessary to monitoring or alleviating the problems.

Pre: CHEM 305
Variable

CHEM 490 (1-6) Workshop

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CHEM 495 (1) Senior Seminar

Capstone course for majors in Chemistry, Biochemistry and Chemistry Teaching. During this course, students will present the results of their research in several different forums including oral presentations and poster sessions.

Pre: CHEM 440, CHEM 460

Spring

CHEM 496 (1-6) Senior Thesis

CHEM 497 (1-16) Internship

CHEM 498 (1-6) Undergraduate Research

CHEM 499 (1-6) Individual Study