Chemistry

College of Science, Engineering and Technology
Department of Chemistry & Geology
241 Ford Hall • 507-389-1963

Chair: Mary Hadley

Faculty: Brian Groh, Michael J. Lusch, Rebecca Moen, Marie K. Pomije, Jeffrey R. Pribyl, Danaé Quirk Dorr, James Rife, Theresa Salerno, Lyudmyla Stackpool, Daniel Swart, John D. Thoemke, Trent Vorlicek

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Accreditation. American Chemical Society (ACS).

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.

Academic Map/Degree Plan at www.mnsu.edu/programs/#All

POLICIES/INFORMATION

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 Science Center.

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.

For students who choose to obtain a BS in Chemistry or a BA in Chemistry, CHEM 495 must be taken at Minnesota State Mankato. This course will not be substituted. This policy does not apply to students who chose to obtain a BS in Chemistry Teaching.

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 and 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 minor 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 the Chemistry BS 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

Degree completion = 120 credits

Required General Education

MATH	121	Calculus I (4)

Physics (choose 4 credits - choose 1 from the following)

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	322	Organic Chemistry I (4)
CHEM	324	Organic Chemistry II (3)
CHEM	325	Organic Chemistry II Laboratory (1)
CHEM	340	Quantitative Skills for Chemistry and Biochemistry I (1)
CHEM	341	Quantitative Skills for Chemistry and Biochemistry II (1)
CHEM	381W	Introduction to Research (2)
CHEM	440	Physical Chemistry I (3)
CHEM	495	Senior Seminar (1)

Major Restricted Electives

Physics (choose 4 credits)
(choose either PHYS 212 or PHYS 223 and PHYS 233)

PHYS	212	Principles of Physics II (4)
PHYS	223	General Physics III (3)
PHYS	233	General Physics III Laboratory (1)

Biochemistry Foundation (choose 3-4 credits)
(choose 1 course from the following)

CHEM	360	Principles of Biochemistry (4)
CHEM	460	Biochemistry I (3)

Inorganic Foundation (choose 3 credits)
(choose 1 course from the following)

CHEM	316	Descriptive Inorganic Main Group Chemistry (3)
CHEM	317	Transition Metal Chemistry (3)

Major Unrestricted Electives

Choose a minimum of 6 credits and at least 2 different courses from the 300-400 level CHEM courses other than CHEM 323, CHEM 479, and CHEM 482. No CHEM courses can be double-counted in the degree.

Other Graduation Requirements

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

Required Minor: Yes. Any but Chemistry.

CHEMISTRY BS

Degree completion = 120 credits

Required General Education

MATH	121	Calculus I (4)

Physics (choose 4 credits from one of the following)

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	322	Organic Chemistry I (4)
CHEM	324	Organic Chemistry II (3)
CHEM	325	Organic Chemistry II Laboratory (1)
CHEM	340	Quantitative Skills for Chemistry and Biochemistry I (1)
CHEM	341	Quantitative Skills for Chemistry and Biochemistry II (1)
CHEM	381W	Introduction to Research (2)
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)

Biochemistry Foundation (choose from the 3-4 credits) (choose 1 course)

CHEM	360	Principles of Biochemistry (4)
CHEM	460	Biochemistry I (3)

Inorganic Foundation (choose 3 credits) (choose 1 course)

CHEM	316	Descriptive Main Group Chemistry (3)
CHEM	317	Transition Metal Chemistry (3)

Major Restricted Electives

Math Electives (choose 4 credits) (choose 1 course)

MATH	223	Calculus III (4)
MATH	247	Linear Algebra I (4)
MATH	321	Ordinary Differential Equations (4)

Physics (choose 4 credits)
(choose either PHYS 212 or PHYS 223 and PHYS 233)
PHYS 212 Principles of Physics II (4)
PHYS 223 General Physics III (3)
PHYS 233 General Physics III Laboratory (1)

Major Unrestricted Electives
Choose 12 credits and at least 3 different courses from the 300-400 level CHEM courses other than CHEM 323, CHEM 479 and CHEM 482. No CHEM courses can be double-counted in the degree.

Required Minor: None.

CHEMISTRY MINOR

Minor Core
CHEM 201 General Chemistry I (5)
CHEM 202 General Chemistry II (5)
CHEM 305 Analytical Chemistry (4)
CHEM 322 Organic Chemistry I (4)
CHEM 324 Organic Chemistry II (3)

Minor Electives
Choose a minimum of 4 credits from the 300-400 level CHEM courses except CHEM 323, CHEM 479, CHEM 482, or CHEM 495. Core courses cannot count as electives. A minimum of 4 credits of chemistry courses must be taken at Minnesota State University Mankato for the minor.

CHEMISTRY TEACHING BS

Requirements for the Chemistry Teaching BS can be found in the SCIENCE TEACHING section of the catalog. 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. This course is intended for non-science majors and is not a preparation for CHEM 111 or CHEM 201. Credit will not be given to students who have previously taken a chemistry course at or above CHEM 111 and received a passing grade.
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. Credit will not be given to students who have previously taken a chemistry course at or above CHEM 111 and received a passing grade.
GE-3

CHEM 106 (3) Chemistry of Life Process Part I (General)
This course covers fundamental concepts required to understand the general chemistry in living organisms. This is a non-laboratory class. This chemistry course will not prepare students for any Chemistry course at or above the 200 level.
Prerequisite: MATH 098. Students seeking enrolling in CHEM 106 must demonstrate readiness to succeed in the course through one of the following means: 1. ACT mathematics sub-score of 19 or higher, or 2. ACCUPLACER Elementary Algebra Test score of 75.5 or higher AND ACCUPLACER College-Level Math Test score of 49.50 or higher.
GE-3

CHEM 111 (5) Chemistry of Life Process Part II (Organic & Biochemistry)
This course is an introduction to organic chemistry and biological chemistry. The laboratory will reinforce lecture.
Prerequisite: 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 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 Applications
From an engineering perspective, concepts of general chemistry will be investigated. Topics include atomic structure, stiochiometry, gas laws, periodic trends chemical bonds, thermodynamics, kinetics and organic chemistry.
Prerequisite: 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 200 (1) GC1 Laboratory Component
General chemistry lab for students who have completed CHEM 191 and need to fulfill the laboratory pre-requisite for CHEM 202 due to a change in academic major. This course requires special permission.
Prerequisite: CHEM 191
Variable

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

CHEM 316 (3) Descriptive Inorganic Main Group Chemistry
This course is designed to survey descriptive main group chemistry and augment General Chemistry's introduction to solid state and nuclear chemistry.
Prerequisite: "C" (2.0) or higher in CHEM 202
Alt-Fall

CHEM 317 (3) Transition Metal Chemistry
This course is designed to address transition metal chemistry, introduce bonding theory, nomenclature, reactivity and mechanisms for transition metal compounds. It will also address and use examples from bioinorganic chemistry and catalysis.
Prerequisite: "C" (2.0) or higher in CHEM 202
Alt-Fall

CHEM 322 (4) Organic Chemistry I
Introduction to organic nomenclature, structure, bonding, chemical reactivity, organic acid-base reactions, mechanisms and stereochemistry. IR, MS, and NMR spectroscopy will be introduced. The chemistry of alkanes, alkyl halides, alkenes, alkynes, and alcohols will be covered. Laboratory illustrates synthetic techniques and the preparation and reactions of functional groups discussed during lecture.
Prerequisite: CHEM 202, "C" (2.0) or higher in CHEM 202.
Fall

CHEM 323 (1) Supplemental Organic Functional Group Chemistry
This course is a supplement to CHEM 322 and includes a brief coverage of functional groups and their chemistry not previously covered that are important in biochemistry. This course is intended only for students taking, or who have taken, only one semester of organic chemistry and who plan to take CHEM 360, Principles of Biochemistry.
Prerequisite: CHEM 322
Co-requisite: CHEM 322
Fall

CHEM 324 (3) Organic Chemistry II
This course is a continuation CHEM 322 and includes organic nomenclature, structure, bonding, chemical reactivity, organic acid-base reactions, and reaction mechanisms; the chemistry of ethers, aromatic and heterocyclic compounds, polyenes, ketones, aldehydes, amines, carboxylic acids and their derivatives, and alpha carbonyl compounds and synthetic transformations is covered.
Pre CHEM 322, "C" (2.0) or higher.
Spring

CHEM 325 (1) Organic Chemistry II Lab
Laboratory will highlight common techniques including recrystallization, melting point determination, simple and fractional distillation, extraction, gas and thin layer chromatography, and chemical and spectroscopic qualitative analysis. Single and multi-step syntheses illustrating aromatic and carbonyl chemistry will be performed.
Prerequisite: CHEM 324
Co-requisite: CHEM 324
Spring

CHEM 340 (1) Quantitative Skills for Chemistry and Biochemistry I
Students will use chemical and biochemical experimental case studies to learn how to analyze, interpret, and critically evaluate experimental data. Software tools will be used to perform linear least squares and other fitting procedures. Intended to be taken prior to, or concurrent with CHEM 341.
Prerequisite: CHEM 202, MATH 121 ("C" (2.0) or higher in CHEM 202, MATH 121)
Spring

CHEM 341 (1) Quantitative Skills for Chemistry and Biochemistry II
Application of differential and integral calculus to chemical and biochemical problem-solving. Use of software tools to implement numerical methods for integration and approximation. Intended to be taken following completion of, or concurrent with CHEM 340.
Prerequisite: CHEM 202, MATH 121, PHYS 211 or PHYS 221 ("C" (2.0) or higher in CHEM 202, MATH 121, PHYS 211 or PHYS 221) 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.
Prerequisite: Either CHEM 322 and CHEM 324 or CHEM 322 and CHEM 323. "C" (2.0) or higher in all prerequisites
Spring

CHEM 381W (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.
Prerequisite: CHEM 322. "C" (2.0) or higher
Fall
WI

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

CHEM 419 (2) Physical Inorganic Chemistry Foundations
This course is designed to emphasize the theoretical foundations of physical inorganic chemistry. Course topics include: bonding theory, quantum mechanics and periodic trends, symmetry and group theory.
Prerequisite: "C" (2.0) or higher in CHEM 322, MATH 121
Alt-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.
Prerequisite: CHEM 324, CHEM 325. "C" (2.0) or higher in all prerequisites
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.
Prerequisite: CHEM 324. "C" (2.0) or higher
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.
Prerequisite: CHEM 324. "C" (2.0) or higher
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.
Prerequisite: CHEM 305, CHEM 322 "C" (2.0) or higher in all prerequisites
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.
Prerequisite: CHEM 305, CHEM 340, CHEM 341, MATH 121 and PHYS 211 or PHYS 221. "C" (2.0) or higher in all prerequisites
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.
Prerequisite: Must have a "C" (2.0) or higher in CHEM 440 and MATH 122, and a "C" (2.0) or higher in PHYS 212 or 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.
Prerequisite: 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.
Prerequisite: "C" (2.0) or higher in CHEM 440
Pre or Co-requisite: 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.
Prerequisite: BIOL 106, CHEM 324. BIOL 106 or permission "C" (2.0) or higher in all prerequisites.
Fall

CHEM 461 (3) Biochemistry II
Detailed analysis of the reactions involved in intermediary metabolism, translation, transcription, and replication.
Prerequisite: CHEM 460
Spring

CHEM 465 (2) Biochemical Techniques I
A lecture/laboratory course, which presents methodology and instrumentation used to purify and analyze biomolecules. Techniques include chromatography, radioisotope techniques, polyacrylamide gel electrophoresis, spectrophotometry, and PCR analysis.
Prerequisite: Concurrent registration in CHEM 460 or completion of CHEM 460 with "C" or higher. CHEM 305 is highly recommended.
Fall

CHEM 466W (2) Biochemical Techniques II
Students work in teams to solve biochemical research problems by analyzing data from experiments which they design.
Prerequisite: CHEM 460 and CHEM 465
Spring
WI

CHEM 474 (2) Chromatography
Theory and applications of thin layer, paper, liquid, gas and supercritical fluid chromatography and capillary electrophoresis.
Prerequisite: CHEM 322. "C" (2.0) or higher
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.
Prerequisite: "C" (2.0) or higher in CHEM 305; PHYS 212 or PHYS 222 is recommended
Spring

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.
Prerequisite: Consent
Spring

CHEM 482 (1-3) Problems in Teaching Science
Variable

CHEM 490 (1-6) Workshop

CHEM 494 (1) Biochemistry Capstone Experience
This course is designed for the BS Biochemistry major or the BA Biochemistry major who chooses to do research. Requirements include submission of an undergraduate research grant, and after completion of the research, presentation of the results in poster format at a research conference such as the URC and as an oral presentation to peers. This capstone experience will also include the submission of a formal research paper. Students are required to attend capstone experience seminars for at least two semesters. Students should enroll for this course in their final semester.
Prerequisite: CHEM 466, by permission only

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.
Prerequisite: (Select 1 Course) CHEM 440 or 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