

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

Steven Sucheck, chair

Wei Li, associate chair

Peter Andreana, director of graduate studies

Mission

The **mission** of the Department of Chemistry and Biochemistry is (1) to present outstanding teaching and the highest quality education in chemistry to students at all levels and in all disciplines, (2) to develop and maintain leading research programs with national and international reputations, both in support of our teaching programs and to add to the scientific and technological base of the State of Ohio and the Nation, (3) to advance the development of teaching and research qualifications of the Faculty, (4) to improve our already active and high quality graduate programs with emphasis in biochemistry and materials science, and (5) to serve the University, the Community, and Society through the unique experiences and talents found in the department. Our day-to-day and our long-term activities are guided by the mission.

The Department of Chemistry and Biochemistry is a comprehensive chemistry program offering MS (both thesis and non-thesis options) and PhD degrees in chemistry.

Degrees Offered

- MS in Chemistry (<https://catalog.utoledo.edu/graduate/natural-sciences-mathematics/departments/chemistry-biochemistry/ms-chemistry/>)
- MS Chemistry - Green Chemistry and Engineering Concentration (<https://catalog.utoledo.edu/graduate/natural-sciences-mathematics/departments/chemistry-biochemistry/ms-chemistry/>)
- PhD in Chemistry (<https://catalog.utoledo.edu/graduate/natural-sciences-mathematics/departments/chemistry-biochemistry/phd-chemistry/>)
- Green Chemistry and Engineering, Graduate Certificate (<https://catalog.utoledo.edu/graduate/natural-sciences-mathematics/departments/chemistry-biochemistry/chemistry-and-engineering-graduate-certificate/>)

CHEM 5100 Principles of Organic and Inorganic Chemistry

[4 credit hours]

Study of coordination compounds with a focus on ligand bonding, electron counting, molecular orbital theory, reactivity, and catalysis. In addition, polymerization, structure-property relationships, and commercial materials will be explored. A review of undergraduate-level general and organic chemistry topics with discussions concerning teaching these subjects is also included.

Term Offered: Summer

CHEM 5160 Chemistry Laboratory Techniques Development

[2 credit hours]

Study of general and organic chemistry laboratory techniques, such as the characterization, structural determination and reactions of organic and inorganic compounds, with an emphasis on pedagogical aspects of the techniques. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

Term Offered: Summer

CHEM 5170 Chemistry Instrumentation Techniques

[2 credit hours]

The study of advanced instrumentation techniques and structural determination of organic and inorganic compounds with an emphasis on pedagogical aspects of the techniques. Approved chemical safety goggles meeting the American National Standard Z87.1-1968 must be worn by every student during every laboratory class meeting.

Prerequisites: CHEM 5160 with a minimum grade of D-

CHEM 5230 Chemistry of Sustainable Materials

[4 credit hours]

Applications of the principles of chemistry to understand the issues related to a sustainable energy future.

CHEM 6200 Green Chemistry

[3 credit hours]

Advanced topics in green chemistry, including industrial applications, atom economy, safer solvent substitutions, alternatives assessment, green metrics (PMI, E-factor), basic life cycle analysis, and an introduction to chemical toxicology.

Term Offered: Fall

CHEM 6210 Environmental Chemistry

[3 credit hours]

This course will focus on the chemistry of air, water, and soil with specific emphasis on the effects of human-made chemical products and by-products on the environment. Connections with green chemistry will be highlighted.

Term Offered: Spring

CHEM 6300 Advanced Analytical Chemistry

[4 credit hours]

An overview of new techniques in analytical chemistry. Topics include sample preparation and sampling, spectroscopic, separation, electrochemical, surface characterization and thermal methods.

Prerequisite: Permission of department.

Term Offered: Fall

CHEM 6310 Separation Methods

[3 credit hours]

The theory, design and application of separation methods. Topics include extraction techniques, gas, liquid, and supercritical fluid chromatography, affinity and chiral separation, and capillary electrophoresis.

Term Offered: Spring

CHEM 6320 Electrochemistry

[4 credit hours]

A fundamental study of electrochemical concepts, methods, instrumentation and applications.

Term Offered: Spring

CHEM 6330 Spectroscopic Methods And Analysis Of Spectra

[4 credit hours]

A comprehensive study of theory and instrumentation. Applications of spectroscopic methods including spectral interpretation. Topics include a study of absorption, emission, Raman, NMR, ESR, mass spectrometry, and related subjects. Important methodology and strategy in organic synthesis including disconnection and retrosynthetic analysis.

Term Offered: Spring**CHEM 6340 Mass Spectrometry**

[4 credit hours]

The principles and applications of mass spectrometry in chemistry, biochemistry, and related disciplines. Prerequisite: Admitted to the graduate program.

CHEM 6350 Separation Methods Laboratory

[1 credit hour]

Experiments covering topics discussed in CHEM 6310 lectures. Five hours of laboratory per week. Approved chemical safety goggles meeting the American National Standard 287.1-1968 must be worn by every student during every laboratory class meeting.

Corequisites: CHEM 6310**Term Offered:** Spring**CHEM 6400 Advanced Organic Chemistry**

[4 credit hours]

This course deals with chemical structure and reactivity correlations applied to the study of organic reaction mechanisms; stereochemical features including conformation and stereoelectronic effects; reaction dynamics, isotope effects and molecular orbital theory applied to pericyclic and photochemical reactions; and special reactive intermediates including carbenes, carbanions, and free radicals.

Term Offered: Fall**CHEM 6410 Organic Synthesis**

[4 credit hours]

Important methodology and strategy in organic synthesis including disconnection and retrosynthetic analysis.

Term Offered: Spring**CHEM 6430 Medicinal Chemistry**

[4 credit hours]

Qualitative and quantitative aspects of the design of new therapeutic agents are discussed. Approaches to the design of drugs and new therapeutic modalities directed at enzymes, receptors, membrane transport proteins and nucleic acids will be examined.

Term Offered: Fall**CHEM 6440 Carbohydrate Chemistry**

[4 credit hours]

Topics in carbohydrate chemistry, including chemical synthesis of complex oligosaccharides, complex glycoconjugates (glycolipids, glycopeptides, and glycoproteins).

Term Offered: Fall**CHEM 6450 Organic Reaction Mechanisms**

[3 credit hours]

This course focuses on a thorough treatment of synthetic chemistry through so-called Named Reactions, as well as extensive study of the underlying mechanisms. Course is often conducted as a "flipped classroom", and will require viewing pre-recorded lectures outside of the scheduled class time to allow in class time to focus on practical applications of course material.

Term Offered: Fall**CHEM 6500 Advanced Biological Chemistry**

[4 credit hours]

The chemistry of cellular and molecular transformations in biochemical systems. Molecular structure of proteins, nucleic acids and membranes. Metabolism and biosynthesis of carbohydrates, amino acids and lipids; gene regulation and replication.

Term Offered: Fall**CHEM 6510 Protein Chemistry**

[4 credit hours]

A detailed analysis of the structure and function of proteins. Current methodology for the analysis of structure, the basis for molecular associations and relationships between structure and biological function.

Prerequisites: CHEM 6500 with a minimum grade of D-**Term Offered:** Spring**CHEM 6520 Enzymology**

[4 credit hours]

Survey of current methods to study enzyme-catalyzed reactions, and application to examples from major enzyme groups. Current topics in enzymology include abzymes and ribozymes, artificial enzymes, and enzymes, and enzyme engineering.

Term Offered: Spring**CHEM 6570 Biophysical Chemistry**

[4 credit hours]

Principles and applications of physical chemistry as applied to biological macromolecules (i.e., proteins and nucleic acids in solution), including thermodynamics, kinetics and spectroscopy of macromolecular interactions.

Prerequisites: (PHYS 2080 with a minimum grade of C- or PHYS 2140 with a minimum grade of C-) and CHEM 3520 with a minimum grade of C-**Term Offered:** Fall**CHEM 6600 Physical Inorganic Chemistry**

[4 credit hours]

Symmetry, bonding theories, magnetism, and spectroscopic characterization of inorganic compounds are described. Coverage of spectroscopic techniques such as NMR, EPR, UV/VIS, IR, AND Mossbauer focus on applications to inorganic systems.

Term Offered: Fall**CHEM 6610 Chemistry of Transition and Post-Transition Elements**

[4 credit hours]

The organometallic chemistry of the transition metals, lanthanides and actinides is described. Synthesis, structure, bonding, and reactivity are considered. Applications in catalysis, bioinorganic, and materials chemistry are discussed.

Term Offered: Fall

CHEM 6620 Chemistry of the Main Group Elements

[4 credit hours]

The inorganic and organometallic chemistry of main group elements is described. Synthesis, structure, bonding, and reactivity are considered. The use of main group reagents in synthesis, catalysis, and materials chemistry are discussed.

Term Offered: Spring**CHEM 6710 Quantum Chemistry and Spectroscopy**

[4 credit hours]

Fundamental principles of quantum mechanics and their application to model systems, atoms and molecules; Introduction to molecular spectroscopy.

Term Offered: Spring**CHEM 6720 Modern Topics in Physical Chemistry**

[4 credit hours]

Advanced topics of current interest in physical chemistry. Examples of topics include nanomaterials science, spectroscopic techniques, or molecular modeling.

Term Offered: Spring, Fall**CHEM 6730 Molecular Modeling**

[4 credit hours]

Theory and techniques of contemporary molecular modeling, and their application to calculate physical and chemical properties of realistic molecular systems.

Term Offered: Fall**CHEM 6800 Advanced Materials Chemistry**

[4 credit hours]

Introduction to important classes of solids, including conductors, magnetic materials, ferroelectrics, glasses, microporous materials, organic solids. Traditional and novel synthetic approaches, structure/property relationships, and characterization methods specific to solids.

Term Offered: Spring**CHEM 6810 Materials Science I**

[4 credit hours]

A generic materials science approach to the study of crystalline structure and defects (point, line and planar) in crystalline materials. The mechanisms and kinetics of diffusion in the condensed state.

Term Offered: Fall**CHEM 6820 Materials Science II**

[4 credit hours]

A materials science approach to the thermodynamics of condensed state equilibria. Phase transformation kinetics.

Term Offered: Spring**CHEM 6830 Nanomaterials Science**

[4 credit hours]

This survey course is intended to serve as an introduction to nanotechnology for non-specialists. It is accessible to students in any technical major, including chemists (all divisions), physicists, and engineers. The fundamentals of nanotechnology will be covered, including the origin of nanoscale properties, synthesis and characterization of nanomaterials (e.g. colloids, nanoparticles, nanowires, nanotubes, DNA-based structures), fabrication of larger-scale structures (e.g. self assembly, lithography), and characterization techniques (e.g. microscopy, microanalysis, spectroscopy). Applications will also be discussed.

Term Offered: Spring, Fall**CHEM 6850 X-Ray Crystallography**

[4 credit hours]

Theory and practice of structure determination by X-ray diffraction. Basics of symmetry, diffraction, and reciprocal space. Hands-on introduction to single-crystal and powder methods.

Term Offered: Fall**CHEM 6920 Chemistry Colloquium**

[1-4 credit hours]

Presentations on research or current literature.

Term Offered: Spring, Summer, Fall**CHEM 6930 Chemistry Seminar**

[1-2 credit hours]

Seminars conducted by individual members of the Department.

Term Offered: Spring, Fall**CHEM 6940 Scientific Communication 1**

[1 credit hour]

Instruction on different modes of scientific communication focused on written communication, online resources, and scientific ethics. Tools to enable students to think and converse competently in the language of science.

Term Offered: Fall**CHEM 6950 Scientific Communication 2**

[1 credit hour]

Instruction on different modes of scientific communication: written communication, oral presentation, and research proposals, to enable students to think and converse competently in the language of science.

Term Offered: Fall**CHEM 6960 Thesis Research**

[1-15 credit hours]

Original investigations of significant chemical problems at the master's level under the guidance of a member of the faculty.

Term Offered: Spring, Summer, Fall**CHEM 6970 Graduate Professional Internship**

[1-6 credit hours]

Academic adviser approved industrial or non profit internship to provide an experiential learning component to the MS and PhD degrees in chemistry, including the Professional Science Masters Degree in Green Chemistry and Engineering.

CHEM 6980 Special Topics In Chemistry

[1-4 credit hours]

Discussions of newly developing areas in chemistry research.

Term Offered: Spring, Summer, Fall**CHEM 8200 Green Chemistry**

[3 credit hours]

Advanced topics in green chemistry, including industrial applications, atom economy, safer solvent substitutions, alternatives assessment, green metrics (PMI, E-factor), basic life cycle analysis, and an introduction to chemical toxicology.

Term Offered: Fall

CHEM 8210 Environmental Chemistry

[3 credit hours]

This course will focus on the chemistry of air, water, and soil with specific emphasis on the effects of human-made chemical products and by-products on the environment. Connections with green chemistry will be highlighted.

Term Offered: Spring**CHEM 8300 Advanced Analytical Chemistry**

[4 credit hours]

An overview of new techniques in analytical chemistry. Topics include sample preparation and sampling, spectroscopic, separation, electrochemical, surface characterization and thermal methods.

Term Offered: Fall**CHEM 8310 Separation Methods**

[3 credit hours]

The theory, design and application of separation methods. Topics include extraction techniques, gas, liquid, and supercritical fluid chromatography, affinity and chiral separation, and capillary electrophoresis.

Term Offered: Spring**CHEM 8320 Electrochemistry**

[4 credit hours]

A fundamental study of electrochemical concepts, methods, instrumentation and applications. Prerequisite: Permission of department.

Term Offered: Spring**CHEM 8330 Spectroscopic Methods And Analysis Of Spectra**

[4 credit hours]

A comprehensive study of theory and instrumentation. Applications of spectroscopic methods including spectral interpretation. Topics include a study of absorption, emission, Raman, NMR, ESR, mass spectrometry, and related subjects. Important methodology and strategy in organic synthesis including disconnection and retrosynthetic analysis.

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[4 credit hours]

The principles and applications of mass spectrometry in chemistry, biochemistry, and related disciplines. Prerequisite: Admitted to the graduate program.

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[1 credit hour]

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Corequisites: CHEM 8310**Term Offered:** Spring**CHEM 8400 Advanced Organic Chemistry**

[4 credit hours]

This course deals with chemical structure and reactivity correlations applied to the study of organic reaction mechanisms; stereochemical features including conformation and stereoelectronic effects; reaction dynamics, isotope effects and molecular orbital theory applied to pericyclic and photochemical reactions; and special reactive intermediates including carbenes, carbanions, and free radicals.

Term Offered: Fall**CHEM 8410 Organic Synthesis**

[4 credit hours]

Important methodology and strategy in organic synthesis including disconnection and retrosynthetic analysis.

Term Offered: Spring**CHEM 8430 Medicinal Chemistry**

[4 credit hours]

Qualitative and quantitative aspects of the design of new therapeutic agents are discussed. Approaches to the design of drugs and new therapeutic modalities directed at enzymes, receptors, membrane transport proteins and nucleic acids will be examined.

Term Offered: Fall**CHEM 8440 Carbohydrate Chemistry**

[4 credit hours]

Topics in carbohydrate chemistry, including chemical synthesis of complex oligosaccharides, complex glycoconjugates (glycolipids, glycopeptides, and glycoproteins).

Term Offered: Fall**CHEM 8450 Organic Reaction Mechanisms**

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[4 credit hours]

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Term Offered: Fall**CHEM 8510 Protein Chemistry**

[4 credit hours]

A detailed analysis of the structure and function of proteins. Current methodology for the analysis of structure, the basis for molecular associations and relationships between structure and biological function.

Prerequisites: CHEM 6500 with a minimum grade of D- or CHEM 8500 with a minimum grade of D-**Term Offered:** Spring**CHEM 8520 Enzymology**

[4 credit hours]

Survey of current methods to study enzyme-catalyzed reactions, and application to examples from major enzyme groups. Current topics in enzymology include abzymes and ribozymes, artificial enzymes, and enzymes, and enzyme engineering.

Term Offered: Spring

CHEM 8570 Biophysical Chemistry

[4 credit hours]

Principles and applications of physical chemistry as applied to biological macromolecules (i.e., proteins and nucleic acids in solution), including thermodynamics, kinetics and spectroscopy of macromolecular interactions.

Prerequisites: (PHYS 2080 with a minimum grade of C- and PHYS 2140 with a minimum grade of C-) or CHEM 3520 with a minimum grade of C-

Term Offered: Fall**CHEM 8600 Advanced Inorganic And Organometallic Chemistry**

[4 credit hours]

Symmetry, bonding theories, magnetism, and spectroscopic characterization of inorganic compounds are described. Coverage of spectroscopic techniques such as NMR, EPR, UV/VIS, IR, AND Mossbauer focus on applications to inorganic systems.

Term Offered: Fall**CHEM 8610 Chemistry of Transition and Post-Transition Elements**

[4 credit hours]

The organometallic chemistry of the transition metals, lanthanides and actinides is described. Synthesis, structure, bonding, and reactivity are considered. Applications in catalysis, bioinorganic, and materials chemistry are discussed.

Term Offered: Fall**CHEM 8620 Chemistry of the Main Elements**

[4 credit hours]

The inorganic and organometallic chemistry of main group elements is described. Synthesis, structure, bonding, and reactivity are considered. The use of main group reagents in synthesis, catalysis, and materials chemistry are discussed.

Term Offered: Spring**CHEM 8710 Quantum Chemistry and Spectroscopy**

[4 credit hours]

Fundamental principles of quantum mechanics and their application to model systems, atoms and molecules; Introduction to molecular spectroscopy.

Term Offered: Spring**CHEM 8720 Modern Topics in Physical Chemistry**

[4 credit hours]

Advanced topics of current interest in physical chemistry. Examples of topics include nanomaterials science, spectroscopic techniques, or molecular modeling.

Term Offered: Spring, Fall**CHEM 8730 Molecular Modeling**

[4 credit hours]

Theory and techniques of contemporary molecular modeling, and their application to calculate physical and chemical properties of realistic molecular systems.

Term Offered: Fall**CHEM 8800 Advanced Materials Chemistry**

[4 credit hours]

Introduction to important classes of solids, including conductors, magnetic materials, ferroelectrics, glasses, microporous materials, organic solids. Traditional and novel synthetic approaches, structure/property relationships, and characterization methods specific to solids.

Term Offered: Spring**CHEM 8810 Materials Science I**

[4 credit hours]

A generic materials science approach to the study of crystalline structure and defects (point, line and planar) in crystalline materials. The mechanisms and kinetics of diffusion in the condensed state.

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[4 credit hours]

Theory and practice of structure determination by X-ray diffraction. Basics of symmetry, diffraction, and reciprocal space. Hand-on introduction to single-crystal and powder methods.

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[1-4 credit hours]

Presentations on research or current literature.

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[1-2 credit hours]

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[1 credit hour]

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Term Offered: Fall**CHEM 8950 Scientific Communication 2**

[1 credit hour]

Instruction on different modes of scientific communication: written communication, oral presentation, and research proposals, to enable students to think and converse competently in the language of science.

Term Offered: Fall

CHEM 8960 Dissertation Research

[1-15 credit hours]

Original investigations of significant chemical problems at the Doctoral level under the guidance of a member of the faculty.

Term Offered: Spring, Summer, Fall

CHEM 8970 Graduate Professional Internship

[1-6 credit hours]

Academic adviser approved industrial or non profit internship to provide an experiential learning component to the M.S. and Ph.D. degrees in chemistry, including the Professional Science Masters Degree in Green Chemistry and Engineering.

Term Offered: Summer

CHEM 8980 Special Topics In Chemistry

[1-4 credit hours]

Discussions of newly developing areas in chemistry research.

Term Offered: Spring, Fall