

# MASTER OF SCIENCE IN CHEMISTRY

## Program Director

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## Program Description

The Department of Chemistry offers a program of study leading to the M.S. degree with concentrations available in:

- analytical,
- biochemistry,
- inorganic,
- materials,
- organic, and
- physical chemistry.

The program prepares the student for practice as a professional chemist by teaching academic fundamentals, creative and independent thinking through independent study and research, and leadership skills through interaction with undergraduate students as graduate teaching assistants. The program is also excellent preparation for further advanced study at other institutions, leading to the Ph.D. degree in chemistry or professional degrees in chemistry-related fields. The department has state-of-the-art instrumentation facilities and a wide assortment of instruments readily available for student and faculty research including: two powder- and three single-crystal X-ray diffractometers, a transmission electron microscope, a Focused Ion Beam/Scanning Electron Microscopy system, two 400 MHz NMRs, FTIR, ICP-AES, AA, GC-MS, LC-MS, high resolution MS, several HPLCs, X-ray fluorescence, thermogravimetric analyzers, differential scanning calorimeter, gel permeation chromatograph, diode array spectrophotometers, and electrochemical systems.

## Advisement

Entering students are advised by the program director. Within the first semester of full-time graduate studies, the student should select a thesis advisor, who will assist the student in planning the remainder of the program. Within the first year of full-time graduate studies, the student should select a thesis advisory committee in consultation with the thesis advisor. The committee, including the advisor, will meet periodically with the student to evaluate the progress of the research and to provide guidance.

## Combined Bachelors/Masters Program

Highly qualified undergraduate students completing degrees in chemistry, biochemistry, or forensic science can apply for admission into the combined "4+1" Bachelors/Masters program for the MS in Chemistry. See the descriptions in the undergraduate catalog.

## Admission Requirements

In addition to the minimum admission requirements of Graduate Studies, an applicant for admission to the M.S. degree program in the Department of Chemistry must present an undergraduate major that includes a minimum of 20 semester hour equivalents of undergraduate chemistry course work.

In those cases where the undergraduate preparation is slightly deficient, the applicant may be admitted with provisional status with the approval of the chair of the Chemistry Department and Graduate Studies.

Applicants need to provide the names and contact information of three references and responses, of less than one page, to the following four statements;

1. Describe your academic background. Indicate major and minor(s) in college study, any honors attained or special activities engaged in, and degrees, titles or certificates earned.
2. Describe your employment experience in chronological order, including name and location of employer, kinds of positions held, and responsibilities involved.
3. Describe any research experience or if you have an interest in a specialized field within chemistry.
4. Describe your purpose in working for a master's degree, including your occupational plans and goals.

## Graduate Faculty

**Ganesaratnam K. Balendiran**, Ph.D., Professor

Biomolecular structural biochemistry; structure and function of biological molecules and manipulation of their physiological properties with novel chemicals for health benefits

**Susan Citrak**, Ph.D., Assistant Professor

**Douglas T. Genna**, Ph.D., Professor

Metal-organic frameworks; Synthesis of new materials; Mechanistic investigations of self-assembly; targeted materials for water and blood detoxification

**Brian D. Leskiw**, Ph.D., Professor

Mass spectrometric investigation of various compounds, including chemical vapor deposition precursors, substituted phenols, and trace analysis of pyrazines/haloanisoles

**Clovis Linkous**, Ph.D., Professor

Ceramic electrolytes, polymer membrane electrolytes, solid state hydrogen storage, photovoltaic materials, photocatalysis; flexible and optically transparent conductors

**Peter Norris**, Ph.D., Professor

Synthesis of novel monomers, oligomers, and polymers derived from carbohydrates; environmentally friendly methods to organic synthesis; catalytic decomposition of natural azide nad diazo

**Michael A. Serra**, Ph.D., Associate Professor

Effects of free radicals on proteins

**Josef B. Simeonsson**, Ph.D., Professor

Analytical atomic and molecular spectroscopy; trace and ultratrace analysis; laser induced fluorescence spectroscopy; laser ionization spectroscopy; Raman spectroscopy; environmental analysis

**Nina V. Stourman**, Ph.D., Professor

Studies of bacterial functional genomics during response to stress; bacterial glutathione metabolism and the mechanism and biological role of bifunctional enzyme glutathionyl spermidine synthetase/amidase (GSS) and its products in E. coli

**Robert E. Wardle**, M.S., Associate Professor

Forensic science education; forensic chemistry; drug analysis; ethics in forensic science; investigation of the "CSI Effect"; fingerprint science

A minimum of 30 semester hours of credit is required for the M.S. degree.

COURSE	TITLE	S.H.
<b>Required Courses</b>		
CHEM 6980	Introduction to Chemical Research (taken the first year)	3
CHEM 6981	Seminar 1	1

CHEM 6982	Seminar 2	1
<b>Content Chemistry Courses</b>		
CHEM 6921	Advanced Biochemistry 1	3
CHEM 6941	Advanced Organic Chemistry 1	3
CHEM 6911	Advanced Analytical Chemistry 1	3
or CHEM 6912	Advanced Analytical Chemistry 2	
Two courses in CHEM 5800 or 6900		6
<b>Thesis (Graduate Assistantship program requires 9 hours, non-assistantship program requires 10 hours)</b>		
CHEM 6990	Thesis	9-10
CHEM 6975	An Introduction to Teaching Chemistry (Required only for Graduate Assistantship students)	1
<b>Total Semester Hours</b>		<b>30-31</b>

For graduation, the student must achieve a grade point average of 3.0 or higher in chemistry and must complete an acceptable research proposal, written thesis, and oral defense of the thesis.

## Teaching Assistants

COURSE	TITLE	S.H.
<b>Required Courses</b>		
CHEM 6980	Introduction to Chemical Research (taken the first year)	3
CHEM 6981	Seminar 1	1
CHEM 6982	Seminar 2	1
CHEM 6975	An Introduction to Teaching Chemistry (taken the first year)	1
Register for one of the following each semester (does not count towards the degree):		
CHEM 6976	Teaching Practicum in General Chemistry	
CHEM 6977	Teaching Practicum in Chemistry for Allied Health Sciences Lab	
CHEM 6978	Teaching Practicum in Organic Chemistry	
CHEM 6979	Teaching Practicum for Chemistry in Modern Living Lab	
<b>Content Chemistry Courses</b>		
Must include 6921, 6941, and either 6911 or 6912		15
<b>Electives</b>		
CHEM 6990	Thesis	9
<b>Total Semester Hours</b>		<b>30</b>

For graduation, the student must achieve a grade point average of 3.0 or higher in chemistry and must complete an acceptable research proposal, written thesis, and oral defense of the thesis.

## Non-thesis Option

COURSE	TITLE	S.H.
<b>Required Courses</b>		
CHEM 6980	Introduction to Chemical Research	3
CHEM 6911	Advanced Analytical Chemistry 1	3
CHEM 6912	Advanced Analytical Chemistry 2	3
CHEM 6921	Advanced Biochemistry 1	3
CHEM 6931	Advanced Inorganic Chemistry 1	3
CHEM 6941	Advanced Organic Chemistry 1	3
CHEM 6991Q	Special Topics Quantum Chemistry	3
<b>Electives (up to 6 hours can be used for 6991T Internship) up to 6 hours can be used for 6991T Internship</b>		<b>6</b>

Non-thesis Research	3
<b>Total Semester Hours</b>	<b>30</b>

### Learning Outcomes

1. Graduate students will demonstrate a thorough understanding of the chemical principles related to their chosen area of Chemistry or Biochemistry.
2. Graduate students will demonstrate the ability to search and critically assess the scientific literature.
3. Graduate students will demonstrate a thorough understanding of the applications and basic principles of the chemical instrumentation, techniques, and/or software that is commonly used in their sub-discipline.
4. Graduate students will effectively communicate their research ideas and findings both orally and in writing.

## Graduate Courses

### CHEM 5804 Chemical Instrumentation 4 s.h.

The theoretical foundations of instrumental procedures and the use of instruments in analytical work. Two hours lecture, six hours lab.

**Prereq.:** CHEM 3739.

### CHEM 5804L Chemical Instrumentation Laboratory 0 s.h.

Chemical Instrumentation Laboratory.

### CHEM 5821 Intermediate Organic Chemistry 3 s.h.

An intermediate treatment of organic chemistry building on the principles introduced at the sophomore level. Emphasis on curved arrow notation in mechanism and the planning of organic syntheses. Structural analysis of organic compounds using NMR, IR and MS and the application of structural knowledge to questions of mechanism.

**Prereq.:** CHEM 3720.

### CHEM 5822 Advanced Organic Laboratory 4 s.h.

An advanced approach to the applications of organic chemistry in the laboratory. Synthesis and purification of organic molecules using modern techniques, structure elucidation using spectroscopic techniques. Lecture discussion includes use of instrumentation, planning of practical syntheses, use of the primary chemical literature and safety in the laboratory. Two hours lecture, six hours lab.

**Prereq.:** CHEM 3720.

### CHEM 5822L Advanced Organic Laboratory 0 s.h.

Advanced Organic Laboratory.

### CHEM 5830 Intermediate Inorganic Chemistry 2 s.h.

Reactions and descriptive chemistry of transition metal, organometallic, and main-group compounds.

**Prereq.:** CHEM 3729.

**Prereq. or Coreq.:** CHEM 3740.

### CHEM 5831L Inorganic Chemistry Laboratory 2 s.h.

Preparation of typical inorganic compounds and their characterization. Six hours lab-discussion.

**Prereq. or Coreq.:** CHEM 3729 and CHEM 3739.

### CHEM 5832 Solid State Structural Methods 3 s.h.

The determination of structures of biological, organic, and inorganic materials in the solid state. Introduction to the crystalline state, defects, diffraction of waves, powder and single crystal diffraction methods of neutron and x-ray analysis, electron microscopy, and solid state NMR. Two hours lecture, three hours lab.

**Prereq.:** CHEM 3729.

### CHEM 5832L Solid State Structural Methods Laboratory 0 s.h.

Solid State Structural Methods Laboratory.

**CHEM 5861 Polymer Science 1: Polymer Chemistry and Plastics 3 s.h.**  
Preparation, characterization, structure-property relationships, morphology, and uses of the major commercial polymers. Two hours lecture, three hours lab.

**Prereq.:** CHEM 3739.

**CHEM 5876 Enzyme Analysis 3 s.h.**

Lecture discussions highlight protein chemistry, covering both the theoretical foundations and the practical applications of protein purification and analysis methods. The course places a strong emphasis on developing scientific writing skills essential for clearly communicating research findings.

**Prereq.:** CHEM 3785 or equivalent and CHEM 3785L or equivalent.

**CHEM 6911 Advanced Analytical Chemistry 1 3 s.h.**

Theory and applications of spectroscopy and theory of chemical separation methods.

**Prereq.:** CHEM 3739 Physical Chemistry I.

**CHEM 6912 Advanced Analytical Chemistry 2 3 s.h.**

Applications of chemical separation methods and theory and applications of electrochemistry and electrochemical techniques.

**Prereq.:** CHEM 3739 Physical Chemistry.

**CHEM 6921 Advanced Biochemistry 1 3 s.h.**

Protein structure and intermediary metabolism.

**Prereq.:** CHEM 3720, or concurrently with CHEM 3737 or CHEM 3739.

**CHEM 6922 Advanced Biochemistry 2 3 s.h.**

A study of metabolic pathways and other biochemical systems at the molecular level.

**Prereq.:** CHEM 6921.

**CHEM 6931 Advanced Inorganic Chemistry 1 3 s.h.**

Current theories and types of bonding. Modern structural principles with applications in main-group molecular compounds, coordination compounds, and inorganic solids.

**Prereq.:** CHEM 3729 Inorganic Chemistry.

**CHEM 6932 Advanced Inorganic Chemistry 2 3 s.h.**

Transition metal organometallic chemistry emphasizing molecular structure, bonding methods, characterization, and functional group reactivity. The properties, chemical reactivity, and trends of the elements.

**Prereq.:** CHEM 5830, CHEM 6931, or permission of instructor.

**CHEM 6941 Advanced Organic Chemistry 1 3 s.h.**

Principles of chemical bonding and structure in organic molecules, physical organic chemistry, structure of reactive intermediates, stereochemistry, and detailed descriptions of reaction mechanisms.

**CHEM 6942 Advanced Organic Chemistry 2 3 s.h.**

Detailed study of functional group transformations in organic synthesis as applied to the preparation of complex molecules. Carbon-carbon bond forming reactions, organometallic reagents in organic synthesis, oxidation-reduction chemistry, and multi-step synthesis.

**Prereq.:** CHEM 6941.

**CHEM 6951 Advanced Physical Chemistry 1 3 s.h.**

Principles of quantum chemistry and spectroscopy with applications.

**CHEM 6952 Advanced Physical Chemistry 2 3 s.h.**

Molecular basis of thermodynamics and kinetics.

**CHEM 6975 An Introduction to Teaching Chemistry 1 s.h.**

A course to prepare graduate students to serve as teaching assistants in both chemistry laboratories and recitations. Topics include laboratory safety (governmental regulations, ACS guidelines, hazardous materials, waste disposal) and practical matters of teaching (active learning, leading discussions, grading, cheating, etc.). Required of all graduate students serving as first-year teaching assistants.

**CHEM 6976 Teaching Practicum in General Chemistry 2 s.h.**

Teaching strategies in the General Chemistry laboratory. Students will meet with General Chemistry course instructors and must demonstrate proficiency in the material to be presented in CHEM 1515 General Chemistry 1 and CHEM 1516 General Chemistry 2 laboratories. Grading for CHEM 6976 is S/U. May be repeated for a total of six semester hours for CHEM 6976, CHEM 6977, CHEM 6978, and CHEM 6979.

**Prereq. or Coreq.:** CHEM 6975.

**CHEM 6977 Teaching Practicum in Chemistry for Allied Health Sciences Lab 2 s.h.**

Teaching strategies in CHEM 1510. Students will meet with the course instructor and must demonstrate proficiency in the material to be presented in CHEM 1510. Grading for CHEM 6977 is S/U. May be repeated for a total of six semester hours for CHEM 6977.

**Prereq.:** or concurrent: CHEM 6975.

**CHEM 6978 Teaching Practicum in Organic Chemistry 2 s.h.**

Teaching strategies in the organic chemistry laboratory. Students will meet with organic chemistry course instructors and must demonstrate proficiency in the material to be presented in CHEM 3719 Organic Chemistry 1 and CHEM 3720 Organic Chemistry 2 laboratories. Grading for CHEM 6978 is S/U. May be repeated for a total of six semester hours for CHEM 6976, CHEM 6977, CHEM 6978, and CHEM 6979.

**Prereq. or Coreq.:** CHEM 6975.

**CHEM 6979 Teaching Practicum for Chemistry in Modern Living Lab 1 s.h.**

Teaching strategies in the Chemistry in Modern Living Laboratory. Students will meet with course coordinator and must demonstrate proficiency in the material to be presented in CHEM 1500L. Grading for CHEM 6979 is S/U. May be repeated for a total of six semester hours for CHEM 6979.

**Prereq. or Coreq.:** CHEM 6975.

**CHEM 6980 Introduction to Chemical Research 3 s.h.**

Principles of chemical research planning, design, execution, and reporting. Includes research proposals, record keeping, written reports, oral presentations, the reviewing process, and professional standards. The application of the principles of chemical research to the student's M.S. research project. Required of all first-year students in the M.S. program in chemistry.

**CHEM 6981 Seminar 1 1 s.h.**

Preparation of a formal written research proposal and oral presentation of the proposal. Under the guidance of a research supervisor, the student will investigate the background literature and rationale for a project. Required of all first-year students in the M.S. program in chemistry. Hours arranged.

**Prereq.:** CHEM 6980 and permission of the Chemistry chair.

**CHEM 6982 Seminar 2 1 s.h.**

Oral presentation and defense of thesis. Hours arranged. Restrictions: permission of the thesis advisor.

**Prereq.:** CHEM 6981.

**Prereq. or Coreq.:** six semester hours of CHEM 6990.

**CHEM 6983 Non-thesis Research 3 s.h.**

Preparation of a written and oral report on a relevant chemical topic. The written and oral report will be evaluated by a three-membered committee chosen by the student and instructor. This course is mandatory for all non-thesis Chemistry Masters students and should be taken in their final semester.

**CHEM 6990 Thesis 1-9 s.h.**

Hours arranged. May be repeated.

**CHEM 6991 Special Topics 1-3 s.h.**

Topics selected by the faculty from fields of current research interest or of special emphasis. May be repeated with different topics.

**CHEM 6991Y ST Concepts in Biol Sciences 1-3 s.h.**