

# MASTER OF SCIENCE IN CHEMISTRY

## Program Director

Dr. Sherri R. Lovelace-Cameron  
5016 Ward Beecher Science Hall  
(330) 941-1997  
srlovelacecameron@ysu.edu

## 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.

## Admission Requirements

In addition to the minimum admission requirements of the College of Graduate Studies, an applicant for admission to the M.S. degree program in the Department of Chemistry must present an undergraduate major in chemistry or the equivalent. Ordinarily, this entails the completion of at least a year's study in both organic and physical chemistry. 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 the Graduate Dean. Students must achieve an acceptable score on the Graduate Record Examination general test (GRE) for admission to the program. The Chemistry or Biochemistry subject GRE test is also required of all students who do not have a B.S. or B.A. in chemistry or biochemistry.

Students must submit three recommendation letters 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

**Larry S. Curtin**, Ph.D., Associate Professor  
Electroanalytical chemistry; synthetic inorganic chemistry; self-assembled monolayers; buckminsterfullerene; conducting polymers and charge transfer salts

**Douglas T. Genna**, Ph.D., Associate Professor  
Merging organic chemistry with metal organic frame-works; stabilization of reactive intermediates

**Allen D. Hunter**, Ph.D., Professor  
Materials chemistry; crystallography; instrumental Methods; chemistry education

**John A. Jackson**, Ph.D., Professor  
Synthetic organic chemistry; organophosphorus chemistry; synthetic methodology; biologically active compounds; asymmetric synthesis

**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

**Sherri R. Lovelace-Cameron**, Ph.D., Professor  
Synthesis and electrochemistry of novel organometallic polymers; synthesis of metal organic frameworks

**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., Associate 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

**Timothy R. Wagner**, Ph.D., Professor, Chair

Synthesis of inorganic oxide and mixed-anion materials; structure characterizations using single crystal and powder X-ray diffraction; electron microscopy techniques

A minimum of 35 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>		
Select 15 semester hours		15
<b>Electives</b>		
Select 6 semester hours in consultation with advisor		6
<b>Thesis</b>		
CHEM 6990	Thesis	9-12
Total Semester Hours		35-38

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>		
Select 15 semester hours		15
<b>Electives</b>		
Select 6 semester hours in consultation with advisor		6
<b>Thesis</b>		
CHEM 6990	Thesis	9-12
Total Semester Hours		36-39

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.

## 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, CHEM 3740 (may be concurrent).

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

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

**Prereq. or concurrent:** 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 5836 Quantum Chemistry 3 s.h.

Basic principles of quantum chemistry, with applications to problems in molecular structure, spectroscopy and thermodynamics.

**Prereq.:** CHEM 3740.

### 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 5861L Polymer Science 1: Polymer Chemistry and Plastics Laboratory 0 s.h.

Polymer Science 1: Polymer Chemistry and Plastics Laboratory.

**CHEM 5862 Polymer Science 2: Polymer Rheology, Processing, and Composites 3 s.h.**

Polymer rheology, processing methods, and materials characterization. The effects of additives and the major classes of thermoplastic, thermoset, elastomeric, and composite materials. Two hours lecture, three hours lab.  
**Prereq.:** CHEM 5861 or consent of the chairperson.

**CHEM 5862L Polymer Science 2: Polymer Rheology, Processing, and Composites Laboratory 0 s.h.**

Polymer Science 2: Polymer Rheology, Processing, and Composites Laboratory.

**CHEM 5876 Enzyme Analysis 2 s.h.**

Advanced biochemistry laboratory focusing on the methods of enzyme purification and characterization. One hour lecture, two hours lab.  
**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 6933 Physical Methods in Structure Determination 3 s.h.**

The determination of molecular-level structures of biological, organic, and inorganic compounds in the gas phase, solution, and solid state by diffraction and spectroscopic methods, especially X-ray crystallography and NMR spectroscopy. Three hours lecture.

**Prereq.:** CHEM 5822, CHEM 5832, 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.

**Prereq.:** CHEM 3721 Genetics and CHEM 3740 Physical Chemistry 2.

**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 6963 Advanced Polymer Science 3 s.h.**

Advanced methods of polymer synthesis and characterization, high performance polymers, polymerization kinetics and mechanisms, polymer processing, materials optimization, and high performance applications. Three hours lecture.

**Prereq.:** CHEM 3740 and CHEM 5861, or permission of the instructor.

**CHEM 6969 Laboratory Problems 2 s.h.**

A laboratory course that stresses individual effort in solving chemical problems. Recommended for high school chemistry teachers. Not applicable to the M.S. degree in chemistry. May be repeated up to six semester hours.

**Prereq.:** An undergraduate minor in chemistry.

**CHEM 6971 The Teaching and Learning of Chemistry 3 s.h.**

An introduction to the current literature and research problems in the teaching and learning of chemistry. Topics include theories of teaching, learning styles, assessment, problem solving, misconceptions, and the role of laboratories, recitations, and demonstrations in learning chemistry. Also includes examination of these issues as related to teaching biology.

**CHEM 6972 Methods of Chemistry Education Research 3 s.h.**

Principles of chemistry education research. Issues of problem design, data collection, and data analysis are considered from both quantitative and qualitative frameworks. Methodologies include surveys and questionnaires, think-along protocols, interviews, observations, and action research. Also includes examination of these issues as related to biology.

**CHEM 6973 Chemistry and National Science Education Standards 3 s.h.**

Implications of national standards for modifying high school chemistry instruction in a variety of classroom situations. Topics include inquiry learning, science and technology literacy, the history and nature of science, preservice science teacher education, assessment, and the impact of standards on advanced placement chemistry.

**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 concurrent:** 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 concurrent:** 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 concurrent:** 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.

**Prereq.:** CHEM 6981 and permission of the thesis advisor, or concurrently with six semester hours of CHEM 6990.

**CHEM 6985 Fundamental Chemistry for Educators 3 s.h.**

Fundamentals of general, organic, and biological chemistry including application to the teaching of science. Two hours lecture, three hours laboratory/discussion. Not applicable to the M.S. degree in chemistry.

**Prereq.:** Admission to the graduate program or permission of instructor.

**CHEM 6989 Special Topics in Chemistry Practicum 1-3 s.h.**

Topics selected by the faculty from fields of current research, pedagogical interest, or special emphasis. S/U grading option. May be repeated with different topics.

**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 6991Q Special Topics Quantum Chemistry 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.