CHEMISTRY (PhD, MS, BS/MS)

CHEMISTRY (MS, BS/MS), ENVIRONMENTAL SCIENCES (PhD)/GREEN CHEMISTRY TRACK

Faculty

Joseph S Alper, PhD, *Yale University* • Physical Chemistry • Theoretical Chemistry

Jean-Pierre Anselme, PhD, *Polytechnic Institute of Brooklyn* • Organic Chemistry • Synthesis and Mechanisms of Organic Polynitrogen Compounds

Robert L Carter, PhD, *University of Kansas* • Inorganic Chemistry • Structural Studies of Ionic Inorganic Solids by Infrared and Raman Spectroscopy

Timothy Dransfield, PhD, *Harvard University* • Physical Chemistry • Gas-Phase Chemistry of the Middle and Lower Atmosphere

Jason Evans, PhD, *University of Delaware* • Analytical Chemistry • Biological Mass Spectrometry

Michelle Foster, PhD, *University of Texas at Austin* • Physical Chemistry • Heterogeneous Atmospheric Reactions of the Troposphere

Stuart Licht, PhD, *Weizman Institute* • Physical/Analytical Chemistry • Renewable Energy Chemistry • Chemistry • Electrochemistry

Thomas N Margulis, PhD, *University of California, Berkeley* • Physical Chemistry • X-Ray Crystallography of Drugs and Natural Products

Wayne H Pitcher, PhD, *Stanford University* • Biochemistry • Catalytic Properties of Enzymes

Deyang Qu, PhD, *University of Ottawa* • Physical/Analytical Chemistry • Electrochemical Sensors • Fuel Cells, Battery Materials, and Super-capacitors

John F Reardon, PhD, *Boston University* • Analytical Chemistry • Aqueous and Non-aqueous Thermochemistry and Electrochemistry

Marietta E Schwartz, PhD, *University of Wisconsin* • Charge-transfer Complexation • Synthesis and Study of Strained Hydrocarbons

Hannah Sevian (Department of Curriculum and Instruction), PhD, *University of Wisconsin* • Science Education • Chemistry Education • Physical Chemistry • Chemical Physics

Hans van Willigen (emeritus), PhD, *University of Amsterdam* • Physical Chemistry • Application of Spin Resonance in the Study of Structure and Dynamics

Leverett J Zompa, PhD, *Boston College* • Inorganic Chemistry • Chemistry of Transition Metal Complexes

Facilities and Resources

The Department of Chemistry is housed in the University's modern and well-equipped Science Building. A variety of modern, specialized laboratory equipment (FTIR, STM, NMR, HPLC, TGA, DSC, UV-Vis, X-Ray diffractometer, Raman spectrometer, AA/AES, AFM, ESR, GCMS, LCMS-MS) is available for use by students pursuing MS theses and Green Chemistry dissertations. Facilities include laboratory space for faculty and graduate student research; glass blowing, machine and electronics shops; and access to the Healey Library's science collections. The department's library and equipment resources are augmented through cooperative arrangements with other area educational and industrial institutions.

The PhD Track in Environmental Sciences/Green Chemistry

Green chemistry involves an ecologically sustainable view of chemical research, development, and manufacture. Toxicological consequences and environmental fate are important factors in understanding the entire life cycle of any product or process. Issues related to energy, the environment and human health provide some of the most exciting and important research topics facing chemists today.

This Green Chemistry PhD Track within the Environmental Sciences PhD Program was the first such program in the world. It focuses specifically on providing chemistry doctoral students with the skills and tools necessary to design and carry out chemistry that reduces or eliminates impact on human health or the environment. The program aims to provide chemistry doctoral students with the tools and experiences needed to understand and modify the impact of chemicals and chemical processes on the world around us and to conduct research in new, fundamental, and applied physical, analytical, organic, and inorganic chemistries. Examples of research topics include renewable energies, environmental sensors, atmospheric reaction pathways, minimizing the negative impact of manufacturing processes from "cradle to grave," understanding the hazards associated with pollution, and reducing toxicological impacts on the biosphere. Fundamental processes that can be investigated include new synthetic and analytical methodologies, photon/matter interactions, reaction theory, fate and transport of chemicals, surface chemistry, charge transfer, and biochemical interactions.

The strength of the Green Chemistry curriculum lies in its overlapping, interdisciplinary themes of research. Students completing the Green Chemistry program will be prepared for conventional chemistry jobs in industry, government, and academia. In addition, required and elective courses from the Environmental, Earth, and Ocean Sciences Department (EEOS) and the Biology Department will provide graduates with a broad scientific base not usually provided in traditional chemistry PhD programs.

The Green Chemistry PhD track is administered by the Chemistry Department and leads to a PhD in Environmental Sciences. The multidisciplinary complement of Chemistry, EEOS, and Biology Department faculty has enabled the University of Massachusetts Boston to create this unique, interdisciplinary Green Chemistry doctoral program.

PhD Requirements

Please see the general statement of degree requirements for doctoral programs in the "Regulations, Procedures, and Degree Requirements" section of this publication.

Requirements for this degree include

1. Six courses in the core course area and an additional course selected from a list of science policy and economics offerings of EEOS. All students must take Green Chemistry (CHEM 671), Chemical Dynamics (CHEM 601), Chemical Structures (CHEM 611), Chemical Synthesis (CHEM 621), Chemistry of Natural Waters (ECOS 640), and Environmental Toxicology (ECOS 635).
2. A minimum of three additional graduate courses must be taken, subject to the approval of the student's academic advisor or dissertation committee. Elective courses are normally selected from the graduate offerings in Chemistry, Biology, or EEOS.
3. Five credits of an appropriate seminar (CHEM 691-692) or journal readings class in Chemistry, EEOS, or Biology.
4. Students are required to serve as teaching assistants for at least two semesters to enhance their teaching experience and skills.
5. Students must pass two examinations before being advanced to candidacy:
   (a) A written comprehensive examination, and
   (b) A subsequent oral qualifying examination based on

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- The oral description and defense of the student's dissertation proposal, and
- Comprehensive questioning focused on questions covered in the written exam.

6. An original contribution (dissertation) in Green Chemistry based on individual research (24 credits minimum), which the student submits and defends.

A minimum of 60 graduate credits is required. Up to six credits in courses in which the student received a grade of "B" or better may be transferred from other institutions subject to the approval of the program director.

The Master's Program

The requirements for the MS Program in Chemistry have been designed with a flexibility that accommodates not only students interested in the usual areas of concentration in chemistry, but also those with interests in other, interdisciplinary, chemistry-related fields. As many as nine of the required thirty-three graduate credits may be earned in a related area of study. In addition to the traditional subdivisions within the field of chemistry, candidates may work in such areas as chemical physics and chemical biology, or in such divergent fields as chemical economics, and chemical writing or editing.

All candidates for the master of science degree take required courses in each of three areas: synthesis, structure, and dynamics. These courses, which cut across the traditional boundaries of organic, inorganic, analytical, and physical chemistry, are designed to give students of diverse backgrounds and with diverse aims a broad overview of the recent advances in chemistry. A group of elective courses allows the student to specialize in a field of his or her choice. For students hoping to continue their studies in a research-oriented PhD program, the curriculum offers the opportunity for both extensive course work and a research project. This flexible program is designed for recent graduates as well as for people who hold positions in high schools, community colleges, and industry and who are seeking advancement through further professional training. Attempts will be made to arrange schedules for those who must study part-time.

MS Degree Requirements

Requirements for this degree include

1. The following three Level I courses:
   - CHEM 601 (Chemical Dynamics I)
   - CHEM 611 (Chemical Structure I)
   - CHEM 621 (Chemical Synthesis I)

The student must complete each of these courses with a grade of B or better in order to become a degree candidate.

2. Three elective courses. These may be chosen from a list including CHEM 602 (Chemical Dynamics II), CHEM 612 (Chemical Structure II), and CHEM 622 (Chemical Syntheses II), as well as a number of courses offered through the Graduate Program in Chemistry or other UMass Boston graduate programs. Students wishing to take electives offered through other programs should seek prior approval of the Chemistry Graduate Program Director.
3. CHEM 691-692 (Seminars I and II). Students participate in a seminar each semester through enrolling in these courses, and each student makes a total of two oral presentations during the time he/she is enrolled in the program.
4. An original contribution (thesis) in chemistry or in a chemistry-related field based on individual research (10 credits maximum), which the student submits and defends.

A minimum of 33 graduate credits is required. Up to six credits in courses in which the student received a grade of B or better may be transferred from other institutions subject to the approval of the program director.

The BS/MS Degree in Chemistry

The Chemistry Department offers a combined BS/MS, designed to offer talented and motivated students the opportunity to attain a master's degree in five years. Students who plan to enter this program should have a solid high school record, particularly in chemistry, mathematics, physics, and English.

BS/MS Degree Requirements

Requirements for this degree include

1. All the chemistry courses required for the BA.
2. The requirements for the MS degree in chemistry.
3. A minimum of 11 credits of elective chemistry courses, chosen from departmental offerings.

The student completing these requirements will receive both the BS in chemistry and the MS in chemistry. No degree is awarded until the requirements are complete. To be retained in the program, students must maintain a GPA of 2.0 in undergraduate chemistry and biochemistry courses and grades of B or better in graduate chemistry courses. Admission to this program is by application only. Complete information is available at the department office.

Admission Requirements

Please see the general statement of admission requirements for all graduate studies programs in the "Admissions" section of this publication. The Chemistry Program will recommend admission to either the Green Chemistry track of the PhD or the MS program for those applicants who present evidence of their ability to do graduate work with distinction. Applicants should present:

1. Graduate Record Examination (GRE) scores (aptitude and advanced tests). Applicants to the MS programs who have graduated from American or Canadian colleges or universities are not required to present these scores but are strongly urged to do so. The GRE is required of all PhD applicants and all master's applicants with undergraduate degrees from foreign institutions.
2. Three letters of recommendation.
3. A personal statement of purpose in pursuing a graduate degree in chemistry at UMass Boston.
4. Applicants to the PhD program must present a cumulative undergraduate grade point average of at least 3.0 in all science and mathematics courses.

Students intending to pursue the BS/MS must satisfy the University's undergraduate admissions requirements.

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Teaching and Research Assistant Awards

The Chemistry Department offers a limited number of teaching assistantships to highly qualified new and continuing students in its MS program and in the Green Chemistry track in the Environmental Sciences PhD program. Students in the BS/MS program who have achieved at least 120 credits may also be eligible for teaching assistantships. These awards, which include a stipend and waiver of tuition, require recipients to serve as laboratory instructors in certain of the Chemistry Department's undergraduate courses. Subject to availability, continuing students may be appointed as research assistants with the support of external grant funding provided through their research directors.

Course Prerequisites

Please consult UMass Boston's undergraduate catalog for complete information about the undergraduate courses listed here as prerequisites for individual graduate-level courses.

Courses

CHEM 601
Chemical Dynamics I
Discussions and outside readings in the areas of chemical and physical equilibria and rate processes. Emphasis on thermodynamics from classical and statistical points of view and on chemical reaction mechanisms.
Prerequisite: Enrollment in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 Credits

CHEM 602
Chemical Dynamics II
Selected topics of interest to students and staff involved. Typical subjects: molecular transport processes and kinetic theory, photochemistry and excitation transfer processes, surface and electrode rate processes, particle collision dynamics and reactivity, irreversible thermodynamics, interaction of radiation and matter, and molecular state transitions.
Prerequisite: Enrollment in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 Credits

CHEM 611
Chemical Structure I
Structure determination and theory. Molecules of interest are chosen. Based on these molecules, discussions and readings attempt to show how a chemist determines each structure and how the structure is understood in terms of modern chemical theory.
Prerequisite: Enrollment in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 Credits

CHEM 612
Chemical Structure II
Study of the determination of chemical structures by various methods such as UV-Vis, infrared and nuclear magnetic resonance spectroscopy, and X-ray diffraction.
Prerequisite: Enrollment in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 Credits

CHEM 621
Chemical Synthesis I
The tactics, strategy, and methods of accomplishing the synthesis of chemical substances.
Prerequisite: Enrollment in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 Credits

CHEM 622
Chemical Synthesis II
Approaches to the synthesis of a number of representative organic compounds.
Prerequisite: Enrollment in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 Credits

CHEM 653
Polymer Chemistry
An introductory survey of polymer chemistry including polymer structure and stereochemistry, characterization of polymers, categories of polymers, synthesis of monomers, and polymerization reactions and their mechanisms. Why and how polymers are tailor-made is exemplified. Emphasis is given to polymer chemistry as an interdisciplinary field and as a unique area of chemical science.
Prerequisite: CHEM 254 or equivalent, or permission of instructor.
Hrs by arrangement, 3 Credits

CHEM 658
Medicinal Chemistry
This graduate and upper-level professional course presents the principles of medicinal chemistry. Organized along pharmacological lines, the course considers the development and design of drugs, those a) acting on the central and peripheral nervous system; b) acting on the cardiovascular, hematopoietic and renal systems; and c) acting as chemotherapeutic agents, vitamins, and hormones. Special emphasis is given to drugs used in emergencies and to drugs described in the United States Pharmacopoeia and the National Formulary. Syntheses of important compounds in the various categories are presented.
Prerequisite: CHEM 254 or equivalent.
Hrs by arrangement, 3 Credits

CHEM 666
Electrochemistry
This course provides an advanced study in the field of electrochemistry. Electrochemistry will include an overview of the theories of ionics, electrodiscs, and charge transfer. These theories will then be applied to the understanding of a variety of electroanalytical techniques and electrochemical applications such as contemporary batteries and fuel cells. Electroanalytical techniques to be discussed include static and dynamic methods for application of controlled voltage (potentiometric) and controlled current (coulometric) as well as ion detection, electro-separation, and conductometric methods. Specific topics emphasized will include electrochemical instrumentation, reference electrodes, cyclic voltametry, microelectrochemistry, and contemporary ion selective electrode analysis.
Prerequisite: Matriculation in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 credits

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CHEM 671
Introduction to Green Chemistry
The goal of this course is to provide a global perspective on Green Chemistry. The first of three sections will identify an environmental problem such as global warming, ozone depletion, or water pollution. The second section will look at real-world implications of Green Chemistry—for example, from a manufacturing, toxicological, or economic perspective. The third section will present an array of representative topics: renewable energy, atmospheric chemistry, chemical reactions in water and soil, or benign chemical syntheses, for example. Combined, the three sections provide an understanding of chemistry designed to benefit society and provide pathways to minimize environmental impact.
Prerequisite: Matriculation in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 4 Credits

CHEM 687
Topics in Chemistry
Graduate-level readings in various areas of chemistry under the supervision of a faculty member.
Prerequisite: Permission of instructor.
Hrs by arrangement, 1-10 Credits

CHEM 688
Topics in Physical Chemistry
Topical discussions, each based on elementary principles of physical chemistry and progressing toward recent developments in the field. Open to graduates and advanced undergraduates.
Prerequisites: CHEM 312 and 369, or equivalents.
Hrs by arrangement, 3 Credits

CHEM 689
Topics in Organic Chemistry
Discussions of selected topics of current interest in organic chemistry. Open to graduates and advanced undergraduates.
Prerequisite: CHEM 254 or equivalent.
Hrs by arrangement, 3 Credits

CHEM 690
Topics in Inorganic Chemistry
Discussions of selected topics of current interest in inorganic chemistry. Open to graduates and advanced undergraduates.
Prerequisite: CHEM 370 or equivalent.
Hrs by arrangement, 3 Credits

CHEM 691
Seminar I
Students take CHEM 691 or 692 during every semester they are enrolled in the program.
Prerequisite: Enrollment in a graduate chemistry program or permission of instructor.
Hrs by arrangement, 1 Credit

CHEM 692
Seminar II
Students take CHEM 691 or 692 during every semester they are enrolled in the program.
Prerequisite: Enrollment in the Graduate Chemistry Program or permission of instructor.
Hrs by arrangement, 1 Credit

CHEM 696
Independent Study
Study of a particular area of chemistry under the supervision of a faculty member.
Prerequisite: Permission of instructor.
Hrs by arrangement, 1-10 Credits

CHEM 699
Master's Thesis
Open to degree candidates.
Hrs by arrangement, 1-10 Credits

CHEM 899 (Subject to final University approval)
Dissertation Research
Research, conducted under faculty supervision, which leads to the presentation of a doctoral dissertation.
Hrs by arrangement, 1-10 Credits