

CHEMISTRY

Department of Chemistry

The chemistry program provides education and training to students who wish to pursue careers in chemistry, biotechnology, medicine, dentistry, allied health fields, science teaching, environmental science, materials science, and engineering. Chemistry is considered the central science because it is required for a full understanding of many other sciences as well as medicine. The Chemistry Department offers courses for general education and for majors in chemistry, biology, biotechnology, and nursing. Besides the chemistry major and minor programs, the department also has concentrations in biochemistry, green chemistry and environmental chemistry, materials science and inorganic chemistry, and bioinformatics. The department offers opportunities for undergraduate research in organic chemistry, bioanalytical chemistry, nanoscience, and molecular modeling. The Chemistry Department promotes green chemistry in its curriculum and research. Majors in chemistry may be eligible for the Accelerated Pharmacy Program with the Massachusetts College of Pharmacy and Health Sciences. In addition, students may opt to major in Chemistry with a concentration in Pre-Medicine.

Certification by the American Chemical Society: The Chemistry Department at Worcester State University is among the programs approved by the American Chemical Society (ACS). The chemistry curriculum is reviewed by the ACS Committee on Professional Training on a five-year cycle and reports are made to the ACS annually.

Undergraduate chemistry majors who have demonstrated academic excellence and interest in research may participate in the Chemistry Honors Program. The department has a chapter of the Gamma Sigma Epsilon National Honor Society in chemistry for those who qualify.

- Chemistry
- Chemistry Honors Program
- Major in Chemistry and prerequisites for the Accelerated Pharmacy Program
- Major in Chemistry, Concentration in Biochemistry
- Major in Chemistry, Concentration in Bioinformatics
- Major in Chemistry, Concentration in Green Chemistry and Environmental Chemistry
- Major in Chemistry, Concentration in Materials Science and Inorganic Chemistry
- Major in Chemistry, Concentration in Pre-Medicine
- Minor in Chemistry

Faculty

Jeremy R. Andreatta, Associate Professor (2012), B.S., Tarleton University; Ph.D., Texas A&M University

Meghna Dilip, Department Chair, Professor (2008), B.S., University of Madras, India; M.S., Anna University India; M.S., Ph.D., University of Alabama

Eihab Jaber, Professor (2006), B.A., Hunter College; M.S., Ph.D., State University of New York Stony Brook

Margaret E. Kerr, Professor (2000), B.S., University of Maine; Ph.D., Wesleyan University

Susan Mitroka-Batsford, Co-Coordinator of the Biotechnology Program, Associate Professor (2013), B.A., Rutgers University; Ph.D., Virginia Polytechnic Institute and State University

Kathleen Murphy, Associate Professor (2014), B.S., College of William and Mary; M.S., Ph.D., University Of Massachusetts, Amherst

Jeffry C. Nichols, Associate Professor (2006), B.A., Texas Tech University; Ph.D., Rice University

Joseph G. Quattrucci, Associate Professor (2011), B.A., University of Southern Maine; Ph.D., University of Massachusetts Amherst

Sara Shafiei Haghighi, Visiting Assistant Professor (2021), B.S., M.S., Shiraz University, Iran; Ph.D., Texas Tech University

Sara Shafiei-Haghighi, Visiting Assistant Professor (2021), B.S., M.S., Shiraz University, Iran; Ph.D., Texas Tech University

Weichu Xu, Associate Professor (2016), B.S., Suzhou University Suzhou China; M.S., Ph.D., Chinese Academy of Sciences

Courses

CH-106 Paper Or Plastics?

LASC Categories: NSP

Students will study modern issues related to chemistry. These will include sustainability, green chemistry, climate change and the ozone layer.

Every year. 3 Credits

CH-112 Survey of Chemistry

LASC Categories: LAB, NSP

Chemical and physical properties of inorganic, organic and biochemical compounds with implications for human health and environment.

Ancillary course - Nursing program. Three lecture hours and three laboratory hours per week.

Fall and Spring and every year. 4 Credits

CH-120 General Chemistry I

LASC Categories: NLL, QR

Prerequisites: Math placement exam score of 5 or above required.

Modern survey of chemistry. Topics include chemical equations, properties of gases, atomic structure, periodic table, chemical bonding, chemistry of carbon. Three lecture hours and three laboratory hours per week. CH-120 and CH-121 provide the foundation for further courses in chemistry.

Every year. 4 Credits

CH-121 General Chemistry II

LASC Categories: NLL

Prerequisites: CH-120 with a minimum grade of C-

Continuation of CH120. Topics include elements of thermodynamics, acids and bases, reaction rates, oxidation-reduction reactions, and electrochemistry. Three hours of lecture and a three-hour laboratory per week.

Spring only and every year. 4 Credits

CH-193 Special Topics in Chemistry for First Year Students

LASC Categories: FYS

Introductory level course covering topics of special interest to first-year students.

Every year. 3 Credits

CH-201 Organic Chemistry I (lecture)**Prerequisites:** CH-120 and CH-121 with a C- or above.

Structure, reactions, mechanisms, and stereochemistry of the alkanes, alkenes, alkynes, dienes, alkyl halides. Introduction to aromatic chemistry. Every year. 3 Credits

CH-202 Organic Chemistry II (lecture)**Prerequisites:** CH-201 with a C- or above.

Continuation of CH-201. Reactions and mechanisms of aromatic chemistry; structures and reactions of alcohols, ethers, carboxylic acids, aldehydes, ketones. Every year. 3 Credits

CH-203 Organic Chemistry Laboratory I**LASC Categories:** NLL**Prerequisites or Corequisite:** CH-201 with a C- or above.

Techniques of preparation, purification, and identification of aliphatic compounds. One four-hour laboratory per week. Every year. 2 Credits

CH-204 Organic Chemistry Laboratory II**LASC Categories:** NLL**Prerequisites:** CH-203 with a C- or above.**Prerequisites or Corequisite:** Corequisite: CH-202 (C- or better)

Application of basic and more advanced techniques to increasingly complicated synthetic problems. One four-hour laboratory per week. Every year. 2 Credits

CH-210 Chemical Analysis: an Introduction to Modern Methods**LASC Categories:** NLL, WAC**Prerequisites:** CH-120, CH-121 (minimum grade C-), and EN-102.

Introduction to modern methods of chemical analysis including gravimetry, acid-base and redox titrations, potentiometry, UV-visible and atomic absorption spectrophotometry, and gas and HPLC chromatography. Three lecture hours and four laboratory hours per week. Every year. 5 Credits

CH-250 Instrumental Technology for Forensic Analysis**LASC Categories:** NSP, QAC, NLL**Prerequisites:** CH-120 and CH-121, minimum grade C- or take CH-112, minimum grade C-.

Introduction to instrumental techniques used to analyze crime scene evidence. Includes HPLC, IR spectrometry, Atomic spectroscopy, and GC-MS. Three lecture hours and three lab hours per week. Other or on demand. 4 Credits

CH-260 Chemistry Literature Seminar**Prerequisites:** CH-201 and CH-203

This course will serve to provide a foundation for chemistry majors in searching, evaluating, and using up-to-date chemical literature resources. Additionally, students will gain first-hand experience in scientific word processing, production of presentations (posters and slide shows), presentation (written and oral) scientific data, and chemical drawing software. This course will also introduce students to the wide variety of career and post-bachelor degree opportunities for chemists in addition to the different fields of chemistry (organic, inorganic, biochemistry, physical, analytical, etc.).

Spring only and every year. 1 Credit

CH-290 Ind Study: Chemistry

Students will be introduced to the concepts of laboratory research through involvement in an original research project.

Fall and Spring and every year. 1-6 Credits

CH-301 Physical Chemistry I (Lecture Only)**Prerequisites:** CH-120, CH-121, MA-200, MA-201, PY-241, and PY-242 with a C- or above.

Study of quantum theory, chemical bonding, spectroscopy, molecular structure, and computational molecular modeling. Three lecture hours per week.

Every year. 3 Credits

CH-302 Physical Chemistry II (Lecture Only)**Prerequisites:** CH-301 with a grade of C- or better.

Continuation of CH-301. Study of first, second, and third laws of thermodynamics, and of chemical solution, and phase equilibria. Three lecture hours per week.

Every year. 3 Credits

CH-303 Physical Chemistry Laboratory I**LASC Categories:** NLL**Prerequisites or Corequisite:** CH-301 with a C- or above.

Laboratory deals with methods of physical measurement of chemical systems and their application to the determination of molecular structure, spectroscopy and thermodynamic data. One four-hour laboratory per week, lecture is CH301.

Other or on demand. 2 Credits

CH-320 Environmental Chemistry**LASC Categories:** NLL**Prerequisites:** CH-120 and CH-121 with a C- or above.

Chemistry of the atmosphere, soil, and natural water systems, air and water pollution, water treatment, hazardous wastes and pollution control. Lab techniques including sampling and analysis of environmental media. Lecture 3 hours per week and Lab will meet once a week for 3 hours. Fall only and every year. 4 Credits

CH-330 Environmental Toxicology**Prerequisites:** CH-201 or CH-320 with a C- or above.

Topics include the pharmacological and biochemical properties of toxins and the effects of toxins on human health, including the assessment of risk(s).

Every 2-3 years. 3 Credits

CH-335 Green Chemistry**Prerequisites:** CH-201 or CH-320 with a C- or above.

This course will provide an understanding of the fundamentals of green chemical design that either eliminates or reduces the use or generation of hazardous substances. Three hours of lecture/lab per week.

Every 2-3 years. 3 Credits

CH-340 Advanced Inorganic Chemistry**Prerequisites:** CH-120, CH-121, CH-201, or CH-202, with a C- or above.

CH-301 recommended.

This course is a survey of the chemistry of the inorganic elements, focusing on the relationship between electronic structure, physical properties, and reactivity across the periodic table.

Every 2-3 years. 3 Credits

CH-350 Medicinal Chemistry**Prerequisites:** CH-201 and CH-202 with a C- or above.

A study of how drugs work and the science and technology of modern drug discovery illustrated with case histories. Three lecture hours per week.

Every 2-3 years. 3 Credits

CH-355 Molecular Pharmacology

Prerequisites: CH-201, CH-202, BI-141, with a C- or above.

Prerequisites or Corequisite: CH-410, with a C- or above.

Course examines the interdisciplinary science of pharmacology from a chemical perspective. Topics include pharmacotherapeutics, pharmacokinetics, pharmacodynamics, pharmacognosy, pharmacy and toxicology. Three lecture hours per week.

Every 2-3 years. 3 Credits

CH-360 Introduction to Materials Science

Prerequisites: CH-120, CH-121 and either PY-221 and PY-222 or PY-241 and PY-242 with a C- or above.

Physical structure of solids. Electrical, magnetics, thermal, and optical properties of solids, liquids, and soft matter. Structure-property relationships in materials.

Every year. 3 Credits

CH-370 Introduction to Nuclear Science

Prerequisites: CH-120, CH-121, MA-200, and either PY-221 and PY-222 or PY-241 and PY-242 with a C- or above.

Fundamentals of nuclear science. Topics include nuclear structure and forces, radioactive decays, nuclear reactions, and modern applications.

Every 2-3 years. 3 Credits

CH-402 Advanced Organic Chemistry

Prerequisites: CH-202 and CH-204 with a C- or above.

This advanced organic chemistry course will continue the study of synthetic organic reactions and mechanisms: stereochemical features including conformation and stereoelectronic effects; reaction dynamics and special reactive intermediates. It is a course built on the foundation of Organic Chemistry I & II and is appropriate for upper-level undergraduates. This course will also be an immersive overview of organic reactivity, the use and synthetic manipulations of functional groups, and total synthesis tactics.

Alternating and other or on demand. 3 Credits

CH-408 Directed Study: Chemistry

Directed study offers students, who because of unusual circumstances may be unable to register for a course when offered, the opportunity to complete an existing course with an established syllabus under the direction and with agreement from a faculty member.

3-4 Credits

CH-410 Biochemistry I

LASC Categories: NLL

Prerequisites: CH-201 with a C- or above.

The chemistry of proteins, nucleic acids, carbohydrates, and lipids; enzymes, biological oxidations; and correlations in intermediary metabolism. Three hours of lecture and a three- hour laboratory per week.

Every year. 4 Credits

CH-411 Biochemistry II

Prerequisites: CH-410 or BI-410 with a C- or above.

The generation and storage of metabolic energy; biosynthesis of macromolecular precursors, DNA, RNA, and protein; and biochemical regulation. Three hours of lecture per week.

Every 2-3 years. 3 Credits

CH-435 Advanced Laboratory Experience

LASC Categories: LAB

Prerequisites: CH-204 and CH-210 and CH-303 CH-303 with a C- or above.

Problem based laboratory class that incorporates topics from the various disciplines within chemistry. This course requires laboratory skills learned in previous lab courses. Students will devise and execute their own experiments associated with the topics being covered. This course is intended to provide a more realistic approach to solving research type problems. With guidance from the instructors, students will bring their project to completion and present their findings.

Spring only and every 2-3 years. 2 Credits

CH-440 Organometallics for Organic Synthesis

Prerequisites: CH-201 CH-201 with a C- or above.

Have you ever wondered about the elements below carbon on the periodic table that we never talk about in organic chemistry? Now is your chance to learn about the transition metals and the role they play in organic synthesis. We will learn about organometallic complexes and how they are used in modern industrial processes. Knowledge of 18-electron complexes, ligand types, and organometallic mechanisms will allow us to study catalysis and its role in the manufacture of modern commodity products such as polymers, pharmaceuticals, and fine chemical precursors.

Fall only and every 2-3 years. 3 Credits

CH-450 Computational Chemistry

Prerequisites: CH-301 with a C- or above.

Modern theoretical methods used in studying molecular structure, bonding, and reactivity. Application of these theories to various chemical systems.

Every 2-3 years. 3 Credits

CH-455 Special Topics in Chemistry

Exploration of frontier areas of chemistry, including chemical kinetics, quantum chemistry, polymers, spectroscopy, materials science, environmental bioinorganic and medicinal bioinorganic and medicinal chemistry. Prerequisites: 18 credits in Chemistry and consent of Department.

Every 2-3 years. 3-4 Credits

CH-470 Instrumental Analysis

LASC Categories: NLL

Prerequisites: CH-120, CH-121, and CH-210 or CH-301 with a C- or above.

Advanced level survey of instrumental methods of separation and analysis including spectrophotometry, potentiometry, polarography, and chromatography. Laboratories are project-oriented. Two lecture hours and six laboratory hours per week.

Every 2-3 years. 4 Credits

CH-475 Chemistry Seminar

LASC Categories: CAP

Prerequisites: CH-260 and 25 credits in Chemistry.

Contemporary developments in chemistry, review of technical literature in both print and electronic format, preparation and presentation of technical paper. [Prerequisite: Successful completion of 25 Chemistry credits or special permission of instructor.]

Every year. 1 Credit

CH-480 Internship: Chemistry

Project completed at an institution other than Worcester State by a student with a non-Worcester State sponsor and Worcester State liaison.

Every year. 1-6 Credits

CH-492 Advanced Chemistry Research Methods

Students develop and execute a research project in a field of chemistry under the direction of a faculty member. This may include the development of a formal research proposal in collaboration with the faculty mentor, conducting needed background literature search, data collection through appropriate lab experiments and, analysis of data and production of a research paper summarizing the findings. Permission of instructor.

Every year. 1-6 Credits

Program Learning Outcomes

- Describe properties of matter, explain the changes it undergoes and calculate the energy associated with these changes
- Identify appropriate equipment to perform analyses and safely execute a previously published procedure with minimal input from the instructor
- Read and communicate accurate scientific information to different audiences using a variety of media (lab reports, scientific reviews, oral presentations)
- Define green chemistry and critically assess greenness of a process
- Apply critical thinking and logical reasoning skills to chemical systems