CHEMISTRY

The Department of Chemistry, approved by the American Chemical Society (ACS), offers two degree programs leading to the baccalaureate degree with a major in chemistry. There are six options available within the B.S. degree program that allow students to pursue focused study in specific areas of chemistry. The recommended course sequence during the first year is identical for all programs and differs minimally through the junior year, meaning that a change in career emphasis within chemistry need not delay graduation. Completion of specific requirements within their program qualifies a graduate for certification by the department to the American Chemical Society, which offers immediate membership eligibility in the ACS as well as more desirable employment opportunities.

The Bachelor of Science degree (B.S.) offers intensive training in chemistry and mathematics with the greatest flexibility in selecting broad training that covers all areas of chemistry. This degree is designed specifically for students who wish to pursue graduate studies or employment as a chemist.

The biochemistry option provides enhanced study in the chemistry of life processes and macromolecules. This program offers the best preparation for acceptance to medical or dental school as well as graduate programs or lab work that includes biological techniques.

The environmental chemistry option provides focused study in areas that involve the traditional chemistry of the atmosphere, hydrosphere, geosphere, and biosphere. The study of environmental chemistry prepares students for work related to environmental analysis, industrial hygiene, or engineering.

The polymer chemistry option focuses on chemistry that forms the basis of production of plastics, synthetic fibers, paints, coatings, adhesives, and many other chemical products. This program is especially relevant for students planning work in industrial settings or materials development.

The nanotechnology option provides study in the control of materials at very small dimensions to make smaller, cheaper and better materials used in many fields. Students in this program spend a semester at the Penn State University Park campus in their nanofabrication facility. Graduates can pursue graduate studies or employment in materials science.

The engineering instrumentation automation option provides an interdisciplinary program focused on using, controlling, and improving instruments for chemical analysis and interpreting/analyzing data. This degree includes study of industrial electronics, control systems, and robotics that prepares graduates for scientific careers where instrumentation plays a key role, including industry, forensics, or graduate school.

For students wanting a career in teaching chemistry at the high school level, the Bachelor of Science in Education degree (B.S.Ed.) provides a sound background in chemistry as well as the necessary pedagogical methods courses.

An important program option in chemistry is an internship that integrates on-site learning applicable to any of the above degree options. Internships offer students invaluable experience in a job related to their career goal as well as financial remuneration, which helps significantly to defray the expenses of college study. Beginning after the first-year, students choosing this option may alternate periods of on-campus study with off-campus employment until graduation. In addition, up to three credits may be approved to count toward major sequence requirements for each internship experience; up to six credits may be counted toward degree requirements. For more information, see Cooperative Education in the Special Academic Opportunities (https://catalog.millersville.edu/undergraduate/special-academic-opportunities/) section.

The chemistry 3+4 pre-pharmacy option within the B.S. program requires three years of study as a chemistry major in the Millersville liberal arts curriculum along with coursework from the first year in the Lake Erie College of Osteopathic Medicine (LECOM) Pharmacy school program. At the end of the four years, the student receives a B.S. in chemistry degree from Millersville, and after seven years, the student receives a Doctorate in Pharmacy degree from LECOM.

Students majoring in other sciences can readily round out studies in chemistry to complete one of three minors. Additional coursework provides deeper expertise in chemistry, biochemistry, or environmental chemistry that expands professional opportunities.

the programs

- Biochemistry Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/bichemistry-minor/)
- Chemistry Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-minor/)
- Chemistry, B.S. (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bs/)
- Chemistry, B.S. - Biochemistry Option (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bs-biochemistry-option/)
- Chemistry, B.S. - Polymer Chemistry Option (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bs-polymer-chemistry-option/)
- Chemistry, B.S. - 3+4 Pre-Pharmacy Option (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bs-3-4-prepharmacy-option/)
- Chemistry, B.S. - Engineering Instrumentation Automation Option (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bs-engineering-instrumentation-automation-option/)
- Chemistry, B.S. - Environmental Option (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bs-environmental-option/)
- Chemistry, B.S. - Nanotechnology Option (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bs-nanotechnology-option/)
- Chemistry, B.S.Ed. (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/chemistry-bsed/)
- Environmental Chemistry Minor (https://catalog.millersville.edu/undergraduate/college-science-technology/chemistry/environmental-chemistry-minor/)

the faculty

Albert, Daniel; Associate Professor
College of Science and Technology
B.A., Ohio Wesleyan University, 2007; M.S., University of Wisconsin-Madison, 2008; Ph.D., Cornell University, 2013

Baker, Kristen; Assistant Professor
College of Science and Technology

B.S., Gettysburg College, 2016; Ph.D., University of Delaware, 2021

Elioff, Michael; Associate Professor
College of Science and Technology
B.S., University of Texas at Tyler, 1991; M.S., University of Texas at Arlington, 1995; Ph.D., Boston University, 2001

Kennedy, Steven; Associate Professor
College of Science and Technology
B.S., Lewis-Clark State College, 2004; Ph.D., University of California, 2010

Mbindyo, Jeremiah; Professor
College of Science and Technology
B.Ed., Kenyatta University (Kenya), 1987; M.Sc., University of Nairobi (Kenya), 1993; Ph.D., University of Connecticut, 1999

Miller, Aimee; Associate Professor
College of Science and Technology
B.A., Eastern Mennonite University, 1992; Ph.D., University of Virginia, 2000

Mullen Davis, Melissa; Assistant Professor
College of Science and Technology
B.A., Colby College, 2005; Ph.D., The Pennsylvania State University, 2011

Rajaseelan, R; Professor
College of Science and Technology
B.S., University of Peradeniya (Sri Lanka), 1981; Ph.D., University of Arizona, 1989

Rickard, Lyman; Professor
College of Science and Technology
B.S., University of Southern Mississippi, 1973; M.S., Ibid., 1975; Ph.D., Florida Institute of Technology, 1985

Schiza, Maria; Associate Professor
College of Science and Technology
B.S., Roosevelt University, 1995; Ph.D., University of South Carolina, 2001

the courses

CHEM 101: 3 s.h.
Chem!Better Things/Better Lvng (G2)
A brief introduction to chemistry and its uses in modern society: consumer, environmental, and industrial application. Presented in a mostly descriptive fashion. No credit toward chemistry major. 3 hrs. lec. Offered in fall, spring.

CHEM 102: 3 s.h.
Demonstration Chemistry (G2)
Chemical reactions that are encountered in everyday living, present in living systems, the basis of societal issues, the foundation of producing new materials and used to modify materials into finished products. Investigated by observing, describing, explaining and presenting demonstrations. Emphasis on readily understood reactions that begin with and produce nonhazardous materials. No credit toward chemistry major. 2 hrs. lec., 2 hrs. lab. Offered in spring.

CHEM 103: 3 s.h.
Gen Organic and Biochemistry 1 (G2)
An introduction to the basic theories of general and organic chemistry, including nomenclature, reactions and problem solving. Appropriate for nonscience majors and satisfies general education requirements. Proficiency in algebra is essential. High school chemistry is required. 2 hrs. lec., 2 hrs. lab.

CHEM 104: 3 s.h.
Gen Organic and Biochemistry 2 (G2)
Solutions, acids and bases, oxidation reduction and organic chemistry, including nomenclature and basic reactions with relevancy to biochemistry. Appropriate for nonscience majors and satisfies general education requirements. 2 hrs. lec., 2 hrs. lab. Offered in spring. Prereq: CHEM 103 or 111.

CHEM 105: 3 s.h.
Culinary Chemistry (D, G2)
Introduction to foundational chemical principles using examples from food, cooking, and baking. Topics include chemical terminology, reactions, problem solving, the scientific method. Includes specific examples from global cuisines including comparisons of ingredients and cooking methods on the molecular level. There are no pre-requisites for this course which is appropriate for non-science majors and satisfies general education requirements. No credit toward chemistry major. 2 hrs lec, 2 hrs lab. Offered: fall, summer.

CHEM 110: 3 s.h.
Fundamentals of Chemistry
An intensive review of the fundamentals of chemistry, with particular emphasis placed on solving chemistry problems. Topics include: measurements, formulas and nomenclature, equations, stoichiometry, atomic and molecular structure, solution concentrations, acids and bases. This course is designed to prepare students majoring in the sciences for their general chemistry sequence, CHEM 111 and CHEM 112. This course may be counted only as an elective beyond normal graduation requirements. 3 hrs. lec./problem solving. Pre- or Coreq: MATH 101 or MPT of 160 or higher.

CHEM 111: 4 s.h.
Introductory Chemistry 1 (G2)
The properties and theories of the solid, liquid and gaseous states of matter, the stoichiometry and thermochemistry of chemical reactions, and theories and applications of molecular structure and bonding. Proficiency in algebra is essential. High school chemistry is strongly recommended. Intended for science majors: biology, chemistry, Earth sciences, physics. 3 hrs. lec., 1 hr. discussion, 2 hrs. lab. Prereq: Placement in Chem.111 or C- grade or higher in CHEM 110, AND MATH 101 with a grade of C- or higher or MPT of 160 or higher, or permission of instructor. Chemistry majors must earn a C or better.

CHEM 112: 4 s.h.
Introductory Chemistry 2 (G2)
Continuation of CHEM 111. The interactions of matter and energy-thermodynamics, kinetics and electrochemistry. Equlibria in aqueous systemstheory and practice. Coordination chemistry and descriptive chemistry of the elements. 3 hrs. lec., 1 hr. discussion, 2 hrs. lab. Prereq: CHEM 111 with a grade of C- or higher; Chemistry majors must earn a C or better.

CHEM 112H: 4 s.h.
Hnrs:Introductory Chemistry 2 (G2)

CHEM 113H: 1 s.h.
H:Introductory Chem 2 Seminar
The ideas of introductory chemistry are studied in extended depth, using problems, laboratory exercises, readings and discussion. Grades of B-or higher in both CHEM 112 and CHEM 113 will result in honors designation for the pair. The pair of courses counts as one entry in the science component of general education and results in 5 hours of general education credit. 1 hr. discussion. Prereq or Coreq: CHEM 112 is required

CHEM 179: 1-3 s.h.
Experimental
Experimental

CHEM 188: 1 s.h.
Freshman Seminar in Chemistry
An orientation to the opportunities and services available to chemistry students in the university and professional environments. Students will develop a better understanding of the major and career options and will be introduced to the chemistry department faculty and programs. 1 hr. discussion. Required of all freshman chemistry majors. Recommended for transfer students. Offered in fall.

CHEM 231: 4 s.h.
Organic Chemistry 1 (G2)
Organic structural theory, including conformations and configurations of molecules and functional group classification of organic compoundsalkanes, alkenes, alcohols, ethers, alkyl halides, aldehydes and ketones, and aromatic and organometallic compounds. Major emphasis on relationships among molecular structure, chemical reactivity and physical properties. Thorough integration of reaction mechanisms as elucidated using principles of kinetics, thermodynamics, stereochemistry and spectroscopy. Introduction to the instrumentation of organic chemistry: proton and carbon-13 NMR, infrared and mass spectrometry. 3 hrs. lec., 3 hrs. lab. Prereq: CHEM 112 with a grade of C- or higher; Chemistry majors must earn a C or better.

CHEM 232: 4 s.h.
Organic Chemistry 2 (G2)
The structure-property-reactivity-mechanism-synthesis approach from CHEM 231 continues with application to, and/or emphasis on, unsaturated compounds-alkynes, dienes and aromatic compounds. Also, carbonyl compounds, including carboxylic acids and derivatives, along with amines, phenols and complex compounds with multiple functionality. Introduction to natural and synthetic polymers; biomolecules, including fats, oils, amino acids and carbohydrates, along with the basic reactions of metabolism. Thorough integration of structural relationships to spectral properties using UV, IR, C-13 and H-1 NMR, and mass spectral instrumentation and derived data. 3 hrs. lec., 3 hrs. lab. Prereq: CHEM 231 with a grade of C- or higher. Chemistry majors must earn a C or better.

CHEM 235: 4 s.h.
Organic Chemistry
The elementary theory, reactions, and properties of organic compounds in an integrated fashion. No credit toward chemistry major. 3 hrs. lec., 3 hrs. lab. Offered fall. Prereq: CHEM 112 with a grade of C- or higher; C for chemistry majors. CHEM 235 is not an acceptable Prereq for CHEM 232.

CHEM 251: 3 s.h.
Inorganic Chemistry 1
Emphasis on the unification of descriptive chemistry with the basic principles that may be used to explain natural phenomena in inorganic chemistry. The physical and chemical properties of the elements and classes of compounds such as oxides, halides, hydrides, etc., will be described and explained. Acid-base and oxidation-reduction behavior will be emphasized, along with coordination chemistry. Periodic trends are an integral part of the course. 3 hrs. lec. Offered in spring. Prereq: CHEM 112 with a grade of C- or higher; C for chemistry majors; or Coreq: CHEM 112.

CHEM 265: 4 s.h.
Quantitative Analysis (G2)
An integrated study of advanced chemical equilibrium, activity, experimental uncertainty and accepted practice in the analytical laboratory. Titrimetry, potentiometry, extraction theory, introductory spectroscopy and chromatography are discussed. 3 hrs. lec., 3 hrs. lab. Offered spring, summer. Prereq: CHEM 112 with a grade of C- or higher; C for chemistry majors.

CHEM 265H: 4 s.h.
H:Quantitative Analysis (G2)

CHEM 279: 3 s.h.
Experimental
Experimental

CHEM 300: 3-12 s.h.
Co-Op Ed Experience in Chem
Co-Op Ed Experience in Chem

CHEM 312: 3 s.h.
Chemistry in Nanotechnology
A study of principles, methods and applications of chemistry in nanotechnology, with a special emphasis on the chemistry of materials. Topics include synthesis, characterization and manipulation of nanomaterials, sensors, bioinspired nanomaterials, atomic force and scanning electron microscopy. 2 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: NFMT 313 and CHEM 104 or 111; or CHEM 232; or CHEM 235; or permission of instructor.

CHEM 312H: 3 s.h.
Hon: Chem in Nanotechnology

CHEM 324: 4 s.h.
Plant Biochemistry
A study of enzymes and pathways involved in plant intermediary metabolism as related to plant cell structure, function and plant development. Topics include plant bioenergetics, biosynthesis of plant hormones and elicitor molecules, signal perception and transduction, and secondary metabolites (natural products). 3 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: BIOL 221 and 263; CHEM 232 or 235.

CHEM 326: 4 s.h.
Biochemistry 1 (G2)
The structure and physical and chemical properties of carbohydrates, lipids, nucleic acids and other biological compounds, and their importance in life processes. Introduction to metabolic processes. Laboratory studies include the properties of chemicals of biological origin, techniques in isolation, identification, qualitative and quantitative analysis. 3 hrs. lec., 3 hrs. lab. Prereq: C- in CHEM 232 or 235. Chemistry majors must earn a C or better.

CHEM 327: 4 s.h.
Biochemistry 2
Major focus on understanding the chemistry behind the function of biological compounds involved in cellular processes. Specific topics include enzyme mechanisms and energetics, membrane dynamics and transport, replication, transcription, protein translation and signal transduction. Additionally, metabolism of lipids, amino acids and nucleotides is studied in detail. 3 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: CHEM 326 with a grade of C- or higher.

CHEM 327H: 4 s.h.
Hon: Biochemistry 2

CHEM 328: 1 s.h.
Analytical Biochemistry Lab
Laboratory course designed to expand the technical experience of biochemistry students. Experiments completed focus on the analysis of major classes of biological compounds using advanced techniques and instrumentation. Includes opportunities to develop literature research, writing and presentation skills critical for scientific study. 3 hrs. lab. Offered in spring. Prereq or Coreq: CHEM 327 or CHEM 324 or BIOL 324.

CHEM 341: 4 s.h.
Physical Chemistry 1 (W)
A thermodynamic study of chemical systems, including ideal and nonideal solutions, chemical and phase equilibria, and electrochemistry. Investigation of the macroscopic behavior of gases and its theoretical explanations. Summary of the determination and application of additive properties. 3 hrs. lec., 3 hrs. lab. Offered in fall. Prereq: CHEM 265 with a grade of C or higher, PHYS 232, MATH 311 and ENGL 110.

CHEM 342: 4 s.h.
Physical Chemistry 2 (W)
Chemical kinetics, statistical mechanics and the development and present state of quantum theory, including chemical bonding theories, atomic and molecular spectroscopy, and methods of structure determination. 3 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: CHEM 341 with a grade of D or higher and ENGL 110, or permission of instructor.

CHEM 342H: 4 s.h.
H: Physical Chemistry 2 (W)

CHEM 372: 3 s.h.
History of Chem and Society (D, P)
The history of the development of the science of chemistry from its roots in Egyptian and Greek societies through its specialization in the early 20th century. The relationships between chemical developments and society are explored, as well as the influences of chemistry on Western thought. 3 hrs. discussion. Offered in fall. Prereq: COMM 100; ENGL 110; junior status; CHEM 102, 104 or 111; two social science courses, including one history course: HIST 101, 102 or 410 preferred.

CHEM 372H: 3 s.h.
Hnrs:Hist of Chem and Society (D, P)
The history of the development of the science of chemistry from its roots in Egyptian and Greek societies through its specialization in the early twentieth century. The relationships between chemical developments and society are explored, as well as the influences of chemistry on Western thought. 3 hrs. of discussion. Offered in spring.

CHEM 375: 4 s.h.
Environmental Chemistry (D, G2)
The application of modern chemical principles to the chemical and physical interactions among the hydrosphere, lithosphere, atmosphere and biosphere. Also discussed are the more recent topics in the areas of pollution, energy and waste control. (The laboratory covers the current, fundamental instrumental methods and techniques encountered in environmental analysis.) 3 hrs. lec., 3 hrs. lab. Offered in fall. Prereq: CHEM 112 with a grade of C- or higher; C or higher for Chemistry majors.

CHEM 375H: 4 s.h.
Hon: Environmental Chemistry (D, G2)

CHEM 379: 3 s.h.
Experimental
Experimental

CHEM 381: 4 s.h.
Polymer Chemistry 1
An introduction to polymer chemistry. Covered are nomenclature, solutions and solubility, molecular weight determination, morphology, structure determination, polymerization reactions and synthetic methods, physical properties and fabrication methods. The laboratory provides an introduction to the methods of polymer synthesis and characterization. 3 hrs. lec., 3 hrs. lab. Offered in alternate fall semesters. Prereq: C or higher in CHEM 232 or permission of instructor.

CHEM 381H: 4 s.h.
Hon: Polymer Chemistry I

CHEM 391: 1 s.h.
Advanced Laboratory 1
Application of advanced techniques in organic synthesis including chemical and physical methods of separation with major emphasis on advanced spectroscopic methods of characterizing organic compounds. 3 hrs. lab. Prereq: C or higher in CHEM 265, 232.

CHEM 392: 1 s.h.
Advanced Laboratory 2
A continuation of CHEM 391 including advanced techniques in inorganic synthesis and analysis. 3 hrs. lab. Prereq: CHEM 251 with a grade of C or higher.

CHEM 400: 3-12 s.h.
Co-Op Ed Experience in Chem
Co-Op Ed Experience in Chem

CHEM 435: 3 s.h.
Advanced Organic Chemistry
Current theories of organic chemistry, with major emphasis on physical aspects as applied to structure, reactions, spectroscopy and reaction mechanisms. 3 hrs. lec. and reading in current literature. Prereq: C or higher in CHEM 232.

CHEM 452: 3 s.h.
Inorganic Chemistry
Theories of bonding and structure of inorganic elements and compounds, acid-base theories, coordination chemistry, organometallic chemistry, and bioinorganic chemistry. 3 hrs. lec. Offered in fall. Prereq: CHEM 342 and a C or higher in CHEM 251 or permission of instructor.

CHEM 452H: 3 s.h.
H: Inorganic Chemistry

CHEM 465: 4 s.h.
Analytical Chemistry (W)
Theory and practice of modern analytical techniques in chemical separations and instrumental analysis. 3 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: ENGL 110 and Prereq or Coreq: CHEM 342.

CHEM 476: 4 s.h.
Environmental Chemistry 2
Extension of the principle topics covered in CHEM 375, with emphasis on quantitative aspects of topics such as the ozone layer, potential greenhouse effects, tropospheric chemistry, chemical fate and transport in aquatic systems, phase interactions and chemical equilibrium. Includes computer modeling, government regulations, pesticides and pollutants, hazardous waste and disposal methods. All topics will be studied from chemical, political and socioeconomic perspectives. 3 hrs. lec., 3 hrs. lab. Offered alternate spring semesters. Prereq: CHEM 375.

CHEM 482: 3 s.h.
Polymer Chemistry 2
Topics in polymer physical chemistry, including conformation of polymer molecules, polymer solutions, theory of molecular weight determination methods, rheology, orientation, time-temperature dependence of physical properties, thermodynamics and kinetics of polymerization, rubber elasticity and spectroscopic methods of polymer characterization. 3 hrs. lec. Offered alternate spring semesters. Prereq: CHEM 342 and 381 or permission of instructor.

CHEM 486: 4 s.h.
Topics in Chemistry
Detailed investigation of a topic in chemistry of current interest. Topic to be announced each time course is offered. Offered infrequently. Prereq: permission of instructor.

CHEM 487: 0.5 s.h.
Seminar in Chemistry 1
Topics of current chemical interest. 1 hour. Offered in fall. Prereq: senior standing or permission of instructor.

CHEM 488: 0.5 s.h.
Seminar in Chemistry 2
Topics of current chemical interest. 1 hour. Offered in spring. Prereq: CHEM 487; Coreq: GRAD 999 or permission of instructor.

CHEM 489: 1-4 s.h.
Honors Course
For the definition of honors course and eligibility, refer to the Special Academic Opportunities section of this catalog.

CHEM 498: 1-3 s.h.
Independent Study
A course for qualified students to investigate problems in chemistry. Guidance in the methods of chemical research. A minimum of 3 hours of lab required per semester hour. Prereq: permission of instructor. For further information on independent study, see the Special Academic Opportunities section.

CHEM 499: 0.5-4 s.h.
Departmental Honors
For the definition of honors course and eligibility, refer to the Special Academic Opportunities section of this catalog.