DEPARTMENT OF CHEMISTRY
COLLEGE OF ARTS AND SCIENCES

Faculty
Michael Hayes (2009). Professor of Chemistry and Department Chair. B.S., Union University; Ph.D., University of Texas at Austin.

Tamara (Betsy) Caceres (2019). Assistant Professor of Chemistry. B.Pharm., Universidad Central del Este, Dominican Republic; Ph.D., Utah State University

Jimmy H. Davis (1978). O. P. Hammons Chair and Professor of Chemistry. B.S., Union University; Ph.D., University of Illinois; Additional study, University of Florida, Oak Ridge Associated Universities, Argonne National Laboratory, Harvard University, and Oxford University (England).

Sally A. Henrie (1998). University Professor of Chemistry. B.S., University of Arizona; Ph.D., South Dakota State University.

Randy F. Johnston (1994). University Professor of Chemistry. B.S., University of Missouri, St. Louis; Ph.D., Texas Tech University.

Michael R. Salazar (2001). Professor of Chemistry. B.S., New Mexico State University; Ph.D., University of Utah; Additional study, Los Alamos National Laboratory.

Staff
Laura Hailey (2020). Academic Secretary—Biology and Chemistry, and Biology Program Coordinator. B.S., Union University.


Curriculum
The chemistry program at Union University seeks to serve effectively all students, recognizing different needs, interests, and career goals. The faculty seeks to help students understand the physical world, the methods by which it may be studied, and its relationship to other aspects of the human experience. It is the intention of the faculty to create an environment in which students are challenged to acquire skills in problem solving utilizing the modern methods of science and to study in-depth the chemical processes which characterize life systems while developing an inquiring attitude toward scientific exploration. The curriculum is intended to provide liberal arts students with a working knowledge of science and to meet the needs of students who wish to:

- continue study in chemistry at the graduate level;
- teach science at the elementary or secondary school level;
- prepare to enter a health science profession such as medicine, dentistry, medical technology, pharmacy, nursing, physical therapy, or other allied health fields; or
- become a professional/industrial chemist.

Students who complete the chemistry or biochemistry degree as described below or upon their coursework being approved by the chair of the department, will receive degrees that are certified by the American Chemical Society. Our certified programs offer students a broad-based and rigorous chemistry education that provides them the intellectual, experimental, and communication skills necessary to become successful scientific professionals.

Students pursuing a major in Chemistry or Biochemistry must complete Math 211, 212; Physics 231, 232, and meet one of the following sets of requirements:

I. Major in Chemistry—46 hours
   A. CHE 111, 112, 211, 221, 314, 315, 317, 318, 319, 324, 326, 327, 335, 498
   B. Research, 3 hours from: 424 or 425
   C. One of: 405, 430, 435

II. Major in Biochemistry—70 hours
   A. CHE 111, 112, 211, and 221—13 hours
   B. CHE 314, 315, 324, 326—10 hours
   C. CHE 317, 318, 329, 327, 335—19 hours
   D. CHE 424/425—3 hours
   E. CHE 498—1 hour
   F. BIO 112, 211, 315, 325—16 hours
   G. BIO—one 200-level Elective—4 hours
   H. BIO—one 300-level Elective—4 hours
   I. No minor is required.

III. Major in Medical Laboratory Science—102–105 hours
   A. Chemistry 111, 112, 211-21, 314-15, 319, 324, 326
   B. Biology 112, 211, 221, 222, 315, 316, 320
   C. Physics 213-214 or 231-232
   D. Computer Science (3 hours) and MAT 111 or preferably MAT 211
   E. A minimum of 33 hours of Medical Technology at an affiliated hospital as the fourth year of study.

IV. Major in Chemical Physics—119 hours
   Designed for those seeking a broad background in the physical sciences to pursue graduate work in chemistry or physics or secondary teacher licensure, the major permits students with previous experiences to shorten the time spent in formal education without reducing the quality of the degree obtained.

   Students with an advanced preparation in secondary school or as college sophomores may be selected for this program. Entrance as a freshman requires an ACT Composite of 26 or higher with a Math ACT of 25 or higher, 4 units of high school math with a B average or higher, high school chemistry and physics with a B average or better, and a successful personal interview with a faculty admissions committee. Entrance as a sophomore requires readiness to enter MAT 211, CHE 111 and PHY 231 with a cumulative and science GPA of 2.5 or higher, and a successful interview with admissions committee.

   A. CHE 111, 112, 211, 221, 314, 315, 324, 326, 317, 318, 327, 319, 335–38 hours
B. PHY 231, 232, 311, 313, 314; 325 or 420; 430–26 hours
C. PHY or CHE 424; PHY or CHE 498; Upperlevel PHY or CHE—4 hours
D. MAT 211, 212, 213, 314–15 hours
E. ENG 111, 112; 201 or 202–9 hours
F. ART 210; CHR 111, 112; BIO 112; HIS 101; and 9 hours of social science—27 hours
G. No minor is required.

V. Teacher Licensure with Endorsement in Chemistry 6–12
A. Complete the requirements for the Chemistry major as shown above including CHE 405.
B. Additional Requirements: CSC 105, PHY 112 (in B.S. core), PHY 231 and 232, MAT 212 (in B.S. Core), and membership in SMACS.
C. Professional Education:
   2. Fall of Internship Year—EDU 306, 340, 418, 440
   3. Spring of Internship Year—EDU 441 and 451
   4. CSC 105 is required in the BA core
D. Completion of applicable portions of the Praxis II.
E. For additional information, see the Director of Educator Preparation.

VI. Minor in Chemistry
A. CHE 111, 112, 211, 221, 314, 315, 324 326—23 hours
B. Elective, one of: 317, 319, 335, 405, 430—3 or 4 hours

Major in Chemistry with Discipline-Specific Honors
In addition to the requirements listed in I., students must complete
A. Honors contracts in two of the following courses: CHE 211, 315, 318, 319, or 335
B. An honors contract in one of the following courses:
   CHE 405, 430, or 435
C. An honors contract in CHE 424/425 and 498

Major in Biochemistry with Discipline-Specific Honors
In addition to the requirements listed in II., students must complete
A. Honors contracts in two of the following courses:
   CHE 211, 315, 318, 319, or 335.
B. An honors contract in CHE 329.
C. An honors contract in CHE 424/425 and 498.

Admission Requirements for Majors with Discipline-Specific Honors
- Completion of at least 15 hours at Union University or in transfer

Progression in Majors with Discipline-Specific Honors
To remain in the program a student must earn at least a B in each honors contract course in the major. A student who earns a B in two honors contract courses in the major may continue in the program only with permission of the department committee. This committee of three or four faculty (including the course instructor or research mentor) will be created for each course. The committee will approve the honors contract with the student and will evaluate the honors project on a satisfactory/unsatisfactory basis. The course instructor will determine the overall course grade.

Honors Contract Courses
1. Honors Contract Course Projects
   In addition to the normal coursework, the discipline-specific honors student must complete one project in each honors contract course as noted here:
   a. In the first honors contract course, prepare a review article on a topic studied within the course.
   b. In the second honors contract course, prepare and deliver two 30-minute lectures on topics studied within the course.
   c. In the third honors contract course, prepare a societal impact study of an important chemically related topic.
2. Research Course Project
   The student must complete the first honors lecture course before starting the research course. The research course includes preparation of a formal written proposal for the work to be completed (written before work starts) and a defense of the proposal before the department committee.
3. Seminar Course Project
   The student must prepare a research proposal (similar to the one for the research course) on a different topic and make an oral presentation of the proposal to the class and committee.

Assessment of Majors
The Department utilizes standardized tests of the American Chemical Society as final examinations for the first and/or second semester of all one-year courses. These courses include General (CHE 111-2), Organic (CHE 314-5 and CHE 435), and Physical (CHE 317-8). Standardized examinations are also used as the final examination in Fundamentals (CHE 105), Analytical (CHE 211), and Biochemistry (CHE 319-29), and Inorganic (CHE 335 and CHE 430). Examination results are used to monitor progress of students as a group through their course of study at Union. Strengths and weaknesses of courses are also assessed by comparing class averages with national norms. Students are required to complete a research project (CHE 424) and give a seminar to faculty and colleagues (CHE 498).

Student Organizations
Student Members of the American Chemical Society is organized to better acquaint students interested in chemical science with professional opportunities in the field and the mechanics of preparing and presenting technical material. The organization instills professional pride in the chemical sciences, while stimulating awareness of the responsibilities and challenges of the modern chemist. Membership is open
to any student pursuing an undergraduate degree in chemistry or physics.

Sigma Zeta is a national honorary science society for those who have completed 15 hours in natural science and mathematics and with a minimum 3.0 GPA in these courses. Membership advantages include recognition for academic achievements by the Sigma Zeta Honor Award, participation in nationally recognized research projects, and a means of cooperation in similar areas of interest by students of different colleges.

Student Awards

The Chemistry Research Award is given by the faculty of the Department of Chemistry and Physics to the student who presents the best research paper of the year. The research must have been an original piece of work and must have been presented at a state, regional, or national professional chemistry meeting prior to graduation.

The C.R.C. Freshman Chemistry Award, given to encourage and sustain interest in the sciences, is awarded in recognition of outstanding scholastic achievement in Freshman Chemistry.

Whiteaker Freshman Chemistry Award. The Chemistry Department selects a freshman chemistry major or minor to receive this award based on outstanding scholastic achievement, financial need, Christian service, and school spirit.

Course Offerings in Chemistry (CHE)

( ) Hours Credit; F–Fall; W–Winter; S–Spring; Su–Summer

102. Chemistry of Common Consumer Products (4) F, S, Su
A study of several of the many chemical compositions found in the everyday lives of American consumers. Students will learn how highly specialized mixtures of diverse substances enable the safety, comfort and convenience of early 21st century life. From this students will be equipped to make better product purchase and use decisions throughout their lives. Course includes a lab. Both lecture and lab are taught through internet delivery. This course is for adult students only.

105. Fundamentals of Chemistry I (4) F, S, Su
An introductory general chemistry course that includes study of both physical and chemical properties, structure and reaction of matter. Not applicable to pre-health professions except Nursing. Science credit will not be given to a student who has completed a course in either CHE or PHY. Three 1-hour lectures and one 2-hour laboratory period/week.

106. Fundamentals of Chemistry II (4) As Needed
Prerequisite: CHE 105 or 111.
A beginning course in organic and biochemistry with emphasis on topics specifically related to the health sciences: carbohydrates, fats, proteins, vitamins, hormones, normal and abnormal metabolic processes, and the role of ATP. Not open to science majors other than physical science and nursing. Three 1-hour lectures and one 3-hour laboratory period/week.

111. General Chemistry (4) F, W
Prerequisite: ACT math subscore 21 or higher or instructor consent.
A comprehensive study of the fundamental experiments, principles, and theories of chemistry with emphasis on quantitative relationships. The structure and properties of matter with their energy relationships are stressed. Three (four for enhanced sections) 1-hour lectures and one 3-hour laboratory/week.

112. Chemical Equilibrium (4) W, S
Prerequisite: CHE 111.
Quantitative study of chemical principles, including detailed study of the principles of equilibrium in chemical systems. Three 1-hour lectures and one 3-hour laboratory period/week.

113. Survey of Chemical Instrumentation (2) W—Even Years, S—Odd Years
Prerequisite: CHE 111.
An introduction to chemical instrumentation used in industry, including titrations, spectroscopy, and chromatography. One lecture and one 3-hour lab/week.

211. Analytical Chemistry (3) S
Prerequisite: CHE 112; Corequisite: CHE 221.
A continuation of the study of fundamental principles including topics in statistics, gravimetric analysis, titrimetric analysis (neutralization, precipitation, complex formation, oxidation-reduction), and spectrophotometric and electrochemistry analysis. Three 1-hour lectures/week.

221. Analytical Chemistry Laboratory (2) S
Prerequisite: CHE 112; Corequisite: CHE 211.
The application of gravimetric, titrimetric, spectrophotometric quantitative analysis, and chromatographic separations to the study of chemistry. Two 3-hour laboratory periods/week.

300. Chemical Safety and Health (1) S—Even Years
Safety policies and procedures for the use of hazardous chemicals. Topics include awareness, routes of chemicals into the body, safety apparatus and use; identification, types of chemical hazards; proper ways to handle, store, and dispose of hazardous chemicals.

314. Organic Chemistry I (3) F
Prerequisite: CHE 112; Corequisite: CHE 324.
An introduction to the compounds of carbon, with emphasis on the relationship between structure and properties. Applications of bonding theory, reaction mechanisms, and stereochemistry are included. Some functional groups containing halogen and oxygen are examined in detail.
315. Organic Chemistry II (3) S  
Prerequisite: CHE 314; Corequisite: CHE 326.  
An in-depth examination of the common oxygen and nitrogen functional groups with respect to structure and chemistry. Continued application of basic theory is included. Heterocyclic and biomolecules are examined. Three 1-hour lectures/week.

317. Physical Chemistry I (3) F  
Prerequisites: CHE 211, MAT 212, and PHY 232.  
Application of physical techniques to chemical systems with emphasis on thermodynamics. The laws of thermodynamics are derived and applied to phase and chemical equilibria, electrochemical cells, and surface phenomena.

318. Physical Chemistry II (3) S  
Prerequisite: CHE 317.  
A continuation of CHE 317 with emphasis on dynamics and quantum chemistry: kinetics, mechanisms, and photochemistry; atomic and molecular electronic structure and application to spectroscopy.

319. Biochemistry (4) F  
Prerequisite: CHE 315, CHE 326, and BIO 112.  
Introduction to the organic chemistry of living systems. Topics include the structure and function of proteins, enzymatic control of chemical reactions, catabolism, anabolism, bioenergetics, biosynthesis, and molecular biology. Three 1-hour lectures and one 3-hour lab/week.

324. Organic Chemistry Laboratory (2) F  
Corequisite: CHE 314.  
Introduction to the basic techniques for the physical characterization and isolation of organic compounds. Use of spectrometric methods as applied to the determination of structure is included, as are some synthetic methods. Two 3-hour labs/week.

326. Organic/Inorganic Synthesis Laboratory (2) S  
Prerequisite: CHE 314 and CHE 324; Corequisite: CHE 315.  
Application of laboratory techniques in synthesis and characterization of organic and inorganic compounds. Two 3-hour labs/week.

327. Physical Chemistry Laboratory (2) S  
Corequisite: CHE 318.  
The application of physical methods in the study of chemical compounds. Two 3-hour labs/week.

329. Biochemistry II (4) S  
Prerequisite: CHE 319.  
A continuation of 319 with emphasis on bioenergetics and metabolism. Topics include the function and molecular control of catabolic pathways for proteins, lipids, and carbohydrates as well as anabolic pathways for biological synthesis of these molecules. Three 1-hour lectures and one 3-hour lab/week.

335. Intermediate Inorganic Chemistry (3) S  
Pre- or Corequisite: CHE 315.  
Introduction to inorganic compounds with an emphasis on coordination, bioinorganic, nuclear, and organometallic chemistry. The relationships between structure, physical properties, and reactivity will be examined in detail.

405. Environmental Chemistry (4) W—Odd Years  
Prerequisite: CHE 211 and 315.  
Study of rapid changes in earth’s atmosphere, water, and soil caused by the activities of humankind with attention to the ozone layer, air quality, and water cycles. The vectors, fate, and treatment/removal strategies for organic and heavy metal pollutants are discussed. Three 1-hour lectures and one 3-hour lab/week.

424-5. Introduction to Research (1-3) 424–F; 425–S  
Prerequisite: 20 hours of chemistry and junior/senior standing. The student’s knowledge is integrated by application of a simple piece of original work. Each course is three hours per week per credit hour.

430. Advanced Inorganic Chemistry (4) F—Even Years  
Prerequisite: CHE 211. Pre- or Corequisite: CHE 318 and 335.  
A theoretical treatment of fundamental inorganic topics such as chemical bonding, periodic relationships, stereochemistry of inorganic complexes, acids and bases, and physical properties of inorganic compounds. Three 1-hour lectures and one 3-hour lab/week.

435. Advanced Organic Chemistry (4) F—Odd Years  
Prerequisite: CHE 315.  
Extensive treatment of topics including reaction mechanisms, stereochemistry, heterocyclic chemistry, and molecular rearrangements. Three 1-hour lectures and one 3-hour lab/week.

498. Seminar (1-3) S  
Prerequisite: 20 hours of chemistry and junior/senior standing. Skills in scientific and technical presentations, written and oral, are polished. To be used at the discretion of the department for majors and minors only.
Medical Technology Hospital-in-Residence Curriculum

411. Clinical Chemistry (6)
Chemical analysis of various body fluids and the study of their relationship to disease states.

412. Instrumentation (1)
The principles, use, and care of instruments found in up-to-date laboratories.

421. Hematology and Coagulation (7)
Application of theory to technical performance in hematological procedures which aid in classification of anemias, leukemias, and other blood cell abnormalities.

422. Advanced Microbiology (7)
A lecture and lab course covering the role of microorganisms as they cause disease in humans. Methods employed in the identification of bacteria, fungi, viruses, and rickettsiae.

423. Serology (2)
A lecture and lab course in immunology, including demonstrating reactions between antigens and antibodies. Use of these reactions as a serodiagnostic tool is presented.

424. Immunohematology (5)
Includes selection, testing and bleeding of donors, identification of blood group antigens and antibodies, procedures employed in providing compatible blood for patients, and principles and procedures used in blood component therapy.

425. Parasitology (2)
A study of parasites of medical significance, both indigenous and foreign, with particular emphasis on life cycles and identification.

431. Urinalysis (2)
Gross, physical, microscopic, and chemical analysis of urine.

432. Clinical Correlations (1)
Basic understanding of altered physiology in disease; correlation between laboratory test results and anatomical/physiological changes.

440. Principles of Management and Ethics (0)
Preparation for the medical graduate for positions of leadership as supervisors and instructors.

179-279-379-479. External Domestic Study Programs (1-3) As Needed
All courses and their applications must be defined and approved prior to registering.

179PF-279PF-379PF-479PF. External Domestic Study Programs (Pass/Fail) As Needed
All courses and their applications must be defined and approved prior to registering.

180-280-380-480. Study Abroad Programs (1-4)
All courses and their application must be defined and approved prior to travel.

180PF-280PF-380PF-480PF. Study Abroad Programs (Pass/Fail) As Needed
All courses and their applications must be defined and approved prior to travel.

195-6-7. Special Studies (1-4)

295-6-7. Special Studies (1-4)
Lower-level group studies which do not appear in the regular departmental offerings.

395-6-7. Special Studies (1-4)
Upper-level group studies which do not appear in the regular departmental offerings.

495-6-7. Independent Study (1-4)
Individual study under the guidance of a faculty member(s).

489-9. Seminar (1-3)
To be used at the discretion of the department.