Options

Criteria for Admission into the Departmental Honors Option

1. Major in Chemistry or Forensic Chemistry.
2. Completion of at least 60 units of courses.
3. Overall cumulative GPA of 3.25 or above and a 3.50 or above cumulative average in major course requirements. Students below this threshold may appeal to the Departmental Honors Committee.

Interested students should contact the department honors coordinator to find out the procedure for applying to this program.

ACS Certification

Certification of a student's chemistry degree from the American Chemical Society (ACS) is widely recognized throughout industry, government and education as a standard of excellence. Students with a good academic record are encouraged to pursue this option. Students electing the Professional Track may obtain ACS certification of their degrees provided they submit a comprehensive written report on their research (CHEM 491). Students who have taken PHYS 211-PHYS 212 may count these courses for ACS certification provided that an additional advanced physics lecture course is taken, subject to prior approval by the Department of Chemistry.

Environmental Chemistry Track in Environmental Science and Studies Program

Students may pursue the Environmental Chemistry Track of the Environmental Science and Studies Program that is described in a later section in the College of Science and Mathematics.

Transfer Credit Policy

Students who transfer to TU from a regionally accredited two-year college with an A.A. degree should have completed two terms of general chemistry with lab, two terms of organic chemistry with lab, one term of calculus and two terms of general physics. Students who transfer from a two-year college without an A.A. degree should complete as many of the above-mentioned chemistry, physics and mathematics courses as possible. Transfer students should consult the Department of Chemistry concerning the transferability of chemistry courses and this catalog for TU transfer policies.

Transfer students must complete at least 12 upper-level units in chemistry at TU to graduate with a degree in Chemistry.

Advanced Placement and Credit for Prior Learning

The Department of Chemistry awards credit for General Chemistry through the Advanced Placement Examinations given by the Educational Testing Service.

Students may also receive credit for General Chemistry by taking the Credit for Prior Learning Examination, which is administered through the Registrar's Office. Students may also receive credit for other chemistry courses by passing the appropriate examinations. Further information may be obtained from the department.

Advanced Composition Course

The Department of Chemistry offers CHEM 301 Professional Ethics for Scientists, which is a course that deals with professional ethics in the physical sciences and fulfills the requirements for the advanced writing course.
Core Curriculum Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
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<tr>
<td>CHEM 301</td>
<td>PROFESSIONAL ETHICS FOR SCIENTISTS</td>
<td>3</td>
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Core 9: Advanced Writing Seminar

CHEM 100  CHEMISTRY AND CURRENT PROBLEMS  3
CHEM 104  INTRODUCTION TO ENVIRONMENTAL CHEMISTRY  4
CHEM 115  HONORS CHEMISTRY FOR ALLIED HEALTH PROFESSIONS I  4
CHEM 131  GENERAL CHEMISTRY I LECTURE  3
CHEM 121  ALLIED HEALTH CHEMISTRY I LECTURE  3
CHEM 121L ALLIED HEALTH CHEMISTRY I LABORATORY  1
CHEM 131L GENERAL CHEMISTRY I LABORATORY  1
CHEM 132  GENERAL CHEMISTRY II LECTURE  3
CHEM 132L GENERAL CHEMISTRY II LABORATORY  1

1 These two-term lecture-laboratory sequences meet the Core 8 requirement.

Research in Chemistry

Students interested in participating in research may enroll in CHEM 491 and should consult the undergraduate research coordinator, who will assist them in finding a research project of interest. Students must complete CHEM 491 before their final term at TU. In addition, undergraduate research participation grants are awarded by TU on a competitive basis to provide support for student research. The department offers competitive summer research stipends.

Internships

Chemistry majors are encouraged to participate in the Internship program and receive academic credit. Internships may be undertaken in either the public or private sector. Internships must have a significant chemistry component. At the completion of the internship, the student submits for evaluation a portfolio describing the work undertaken. This portfolio will be evaluated by Chemistry Department faculty in conjunction with the student's work supervisor during the internship.

Academic credit can be acquired by taking CHEM 395, Internship in Chemistry, which may be repeated as CHEM 396. Enrollment in CHEM 395 or CHEM 396 requires prior approval of the Department Internship Coordinator. Students interested in participating in the Internship program should contact the Department Internship Coordinator at least one term prior to when they wish to begin an internship. For further information, contact the Department of Chemistry main office and ask to be directed to the Department Internship Coordinator. Further information on available internships can be obtained from the University Career Center.

Graduate Programs

The Master of Science in Forensic Science program is a molecular biochemistry based program focusing on forensic DNA analysis rich with laboratory experience, capped with a research program, internship in a forensic laboratory or thesis. The program is intended for students who are interested in working as forensic scientists in the discipline of forensic body fluid analysis. Detailed information regarding the program is given in the Graduate Catalog.

The Department of Chemistry participates in the Master of Science (M.S.) program in Environmental Science. Detailed information regarding these programs is also found in the Graduate Catalog.

Departmental Activities and Awards

Many Chemistry majors actively participate in the Student Affiliates of the American Chemical Society (ACS), a student group supported by the department under the auspices of the ACS. This organization permits students to join the national organization and to obtain certain chemistry publications and services at reduced rates.

Student awards are given annually for outstanding work in chemistry courses. These include:

- CRC Press Freshman Chemistry Achievement Award
- Achievement Award in Organic Chemistry
- ACS Achievement in Organic Chemistry Award (joint Polymer-Education Committee)
- Analytical Division (ACS) Award in Analytical Chemistry
- Floyd A. Blankenship Award in Physical Chemistry
- American Institute of Chemists Outstanding Senior Award
- ACS Outstanding Student Award
- Dr. Frank R. Milio Book Endowment
- Linda Sweeting Endowment for Undergraduate Research in Science
- Alan and Eileen Wingrove Endowment for Chemistry Scholars
- Raspet Summer Research Fellowship.

Chemistry Courses

CHEM 100  CHEMISTRY AND CURRENT PROBLEMS (3)
Chemistry concepts and their application to current topics such as environment, energy, food, and health-related chemistry. Three lecture demonstration hours. Gen Ed II.A or Core: Biological & Physical Sciences.

CHEM 103  FOUNDATIONS OF CHEMISTRY (3)
Development of reasoning and quantitative skills for problem solving. Introduction to atomic structure, chemical reactions, chemical nomenclature, formulas, symbols and equations, basic skills of laboratory work. Three lecture hours. Not for credit toward Chemistry major or minor. Does not satisfy University Core requirement. S/U grading.
CHEM 104 INTRODUCTION TO ENVIRONMENTAL CHEMISTRY (4)
Principles of chemistry that are relevant to environmental issues, including water quality, nutrient pollution, air pollution, and specific classes of environmental contaminants. Three lecture hours and three laboratory hours. Prerequisite: three years of high school mathematics. Gen Ed II.A or Core: Biological & Physical Sciences. Lab/class fee will be assessed.

CHEM 112 HONORS CHEMISTRY AND CURRENT PROBLEMS (3)
Discussion of a selected aspect of chemistry and its applications to technology, environment and society. Topics will vary. Three lecture-demonstration hours. Prerequisites: high school chemistry recommended. Honors College. Gen Ed II.A.

CHEM 115 HONORS CHEMISTRY FOR ALLIED HEALTH PROFESSIONS I (4)
An introduction to the concepts of general chemistry, including states of matter, atomic structure and periodic table, molecular structure, chemical reactions, intermolecular forces, solutions, buffers and pH and radio activity. Laboratory includes data handling and chemical and instrumental techniques. May not be used as a prerequisite for the Chemistry major program. Three lecture hours and one three hour laboratory. Prerequisite: MATH 115 or MATH 119 (either may be taken concurrently). Must be admitted to the Honors College. Gen Ed II.A or Core: Biological & Physical Sciences. Lab/class fee will be assessed.

CHEM 121 ALLIED HEALTH CHEMISTRY I LECTURE (3)
Atomic and molecular structure, stoichiometry, chemical reactions, states of matter, solutions, intermolecular forces, acids, bases and buffers, chemical equilibrium, reaction energies and rates. Not open to those who successfully completed CHEM 105/ CHEM 115. CHEM 121 is a quantitative course and students are expected to be proficient in algebraic manipulations, exponentials, logarithms and graphical interpretation. Corequisite: CHEM 121L. Core: Biological and Physical Sciences or GenEd II.A.

CHEM 121L ALLIED HEALTH CHEMISTRY I LABORATORY (1)
Laboratory experiments to support concepts of Allied Health Chemistry I Lecture. Not open to those who successfully completed CHEM 105/ CHEM 115. Corequisite: CHEM 121. Core: Biological and Physical Sciences or GenEd II.A. Lab/class fee will be assessed.

CHEM 131 GENERAL CHEMISTRY I LECTURE (3)
Atomic and molecular structure; theories of bonding, stoichiometry; chemical reactions; gases; solutions. Open to science/math majors/minors only. Not open to those who successfully completed CHEM 110. CHEM 131 is a quantitative course and students are expected to be proficient in algebraic manipulations and graphical interpretation. Corequisite: CHEM 131L. Core: Biological & Physical Sciences or GenEd II.A. Lab/class fee will be assessed.

CHEM 131L GENERAL CHEMISTRY I LABORATORY (1)
Laboratory experiments to support concepts of General Chemistry I Lecture. Not open to those who successfully completed CHEM 110. Corequisite: CHEM 131. GenEd II.A or Core: Biological & Physical Sciences. Lab/class fee will be assessed.

CHEM 132 GENERAL CHEMISTRY II LECTURE (3)
Physical properties of liquids, solids and solutions, kinetics, equilibrium, acids and bases, chemical thermodynamics and electrochemistry. Not open to those who successfully completed CHEM 111. CHEM 132 is a quantitative course and students are expected to be proficient in algebraic manipulations, exponentials, logarithms and graphical interpretation. Corequisite: CHEM 132L. Prerequisites: CHEM 131 & CHEM 131L. Core: Biological & Physical Sciences or GenEd II.A.

CHEM 132L GENERAL CHEMISTRY II LABORATORY (1)
Laboratory experiments to support concepts of General Chemistry II Lecture. Not open to those who successfully completed CHEM 111. Corequisite: CHEM 132. GenEd II.A or Core: Biological & Physical Sciences. Lab/class fee will be assessed.

CHEM 210 ANALYTICAL CHEMISTRY (5)
Theory and practice of chemometrics, gravimetry, titrimetry, chromatography, electrochemistry, and spectrophotometry. Three lecture hours, one laboratory-lecture hour, and three hours of laboratory. Prerequisites: CHEM 132 and CHEM 132L. Lab/class fee will be assessed.

CHEM 301 PROFESSIONAL ETHICS FOR SCIENTISTS (3)
Integrity of scientific literature and the responsibilities of scientists to associates and the public. Discussion of principles and case studies emphasizing the physical sciences. Not open to those who have successfully completed WRIT 335, CHEM 335 or IDNM 305. Does not count toward Chemistry major or minor. Requires grade of C or better to fulfill Core or GenEd requirement. Prerequisites: three courses in ASTR, BIOL, CHEM, ENVS, GEOL, PHYS, or PHSC and at least two courses with laboratory; ENGL 102. Core: Advanced Writing Seminar or GenEd I.D.

CHEM 310 INSTRUMENTAL ANALYSIS (4)
Theory and practice of spectroscopic, chromatographic, and electrochemical instruments, their design and modification to solve practical problems. Three lecture hours and four laboratory hours. Prerequisites: CHEM 210, and CHEM 330 or CHEM 331. Lab/class fee will be assessed.

CHEM 323 INORGANIC CHEMISTRY (4)
Atomic Structure; Valence-bond, Molecular orbital, and crystal-field theories of bonding; structure and bonding in ionic and metallic solids; chemistry of main-group and transition-metal compounds; acid-base theories; organometallic compounds; syntheses and characterizations of main-group and transition-metal compounds. Three lecture hours and three laboratory hours. Not open to students who successfully completed CHEM 321. Prerequisites: CHEM210 and CHEM331 or CHEM330. Lab/ Class fee will be assessed.

CHEM 330 ESSENTIALS OF ORGANIC CHEMISTRY (5)
A one-term survey course in organic chemistry for non-chemistry majors taught on a conceptual basis. Not part of a traditional two-term organic chemistry sequence. Emphasis will be on principles, mechanisms, and modern techniques. Laboratory will include synthesis and identification of organic compounds. Three lecture hours, one recitation hour, and one three hour lab. Prerequisites: CHEM 132 and CHEM 132L. Lab/Class fee will be assessed.

CHEM 331 ORGANIC CHEMISTRY I (5)
Structure, stereochemistry, reactions and their mechanisms, preparation and properties of alkanes, alkenes, alkynes, alkyl halides and alcohols. Laboratory techniques include purification, spectroscopic (IR, NMR) and chromatographic (GLPC) methods of identification, and synthesis. Three lecture hours, one hour of laboratory lecture, and one three-hour lab. CHEM 331 and CHEM 332 comprise a traditional two-term organic chemistry sequence. Prerequisites: CHEM 132 and CHEM 132L. Lab/Class fee will be assessed.
CHEM 332 ORGANIC CHEMISTRY II (5)
Structure, reactions and their mechanisms, preparation and properties of alcohols, ethers, aldehydes, ketones, carboxylic acids and their derivatives, amines, carbohydrates, etc. Laboratory emphasizes synthetic techniques and modern qualitative organic analysis using chemical reactions and IR, UV, and NMR. Three lecture hours, one hour of laboratory lecture and one three-hour lab. CHEM 331 and CHEM 332 comprise a traditional two-term organic chemistry sequence. Prerequisite: CHEM 331. Lab/Class fee will be assessed.

CHEM 345 PRINCIPLES PHYSICAL CHEM (3)
Empirical derivations of the unifying physical principles of chemistry. Emphasis on applications including environmental chemistry and biochemistry. Not open to students who successfully completed CHEM 340 or CHEM 341. Prerequisites: CHEM 132 and CHEM 132L and (MATH 211 or MATH 273) and (PHYS 211 or PHYS 241).

CHEM 346 THEORETICAL FOUNDATIONS OF PHYSICAL CHEMISTRY (3)
Theoretical principles unifying the vast body of chemical observations. Extensive use of differential and integral calculus in developing mathematical models describing the behavior of chemical systems. Prerequisites: CHEM 345, MATH 274, PHYS 212 or PHYS 242.

CHEM 351 BIOCHEMISTRY I (3)
An overview of the chemistry of proteins, nucleic acids, carbohydrates, and lipids. Basic enzyme catalysis and kinetics, biochemical genetics, membrane structure, bioenergetics, and analytical methods. General principles of metabolism applied to several major pathways. Three lecture hours. Prerequisite: CHEM 330 or CHEM 332.

CHEM 356 BIOCHEMISTRY LAB (2)
Physical methods in biochemistry including spectrophotometry, centrifugation and ultra-centrifugation, electrophoresis, and chromatography. Isolation and purification of proteins and nucleic acids. Enzyme kinetics and the binding of small molecules to macromolecules. One lecture hour and three laboratory hours. Prerequisite: CHEM 351 (may be taken concurrently). Lab/Class fee will be assessed.

CHEM 357 BIOCHEMISTRY II (3)
Carbohydrate and lipid metabolism and their regulation, overview of amino acid and nucleotide metabolism, membrane structure and function, DNA-protein interactions and regulation of gene expression, and other topics in biochemistry. Prerequisite: CHEM 351.

CHEM 372 PHYSICAL CHEMISTRY LABORATORY (2)
Introductory experiments in physical chemistry involving thermodynamics, kinetics and spectroscopy to characterize properties of materials and chemical systems. Four laboratory-lecture hours. Prerequisites: CHEM 210 and CHEM 345 (CHEM 345 may be taken concurrently). Lab/Class fee will be assessed.

CHEM 391 SPECIAL PROBLEMS IN CHEMISTRY I (1-3)
A laboratory or library problem in chemistry to be selected by the student in consultation with the instructor. Students are required to submit a written report. May be repeated for a maximum of 6 units provided a different topic is taken. Prerequisite: consent of the instructor.

CHEM 392 SPECIAL PROBLEMS IN CHEMISTRY II (1-3)
A laboratory or library problem in chemistry to be selected by the student in consultation with the instructor. Students are required to submit a written report. May be repeated for a maximum of 6 units. Prerequisite: consent of the instructor.

CHEM 393 SPECIAL PROBLEMS IN CHEMISTRY III (1-3)
A laboratory or library problem in chemistry to be selected by the student in consultation with the instructor. Students are required to submit a written report. May be repeated for a maximum of 6 units. Prerequisite: consent of the instructor.

CHEM 394 SPECIAL PROBLEMS IN CHEMISTRY IV (1-3)
A laboratory or library problem in chemistry to be selected by the student in consultation with the instructor. Students are required to submit a written report. May be repeated for a maximum of 6 units. Prerequisite: consent of the instructor.

CHEM 395 INTERNSHIP IN CHEMISTRY (3)
Students will be given credit in this cooperative education program for approved experience in chemistry in the private or public sector. A portfolio of their work will be submitted by students and evaluated by the Chemistry Faculty. May be repeated once as CHEM 396 for a maximum of 6 units. Graded S/U. Prerequisites: CHEM 332 and CHEM 210, 3.0 GPA overall and junior class standing.

CHEM 396 INTERNSHIP IN CHEMISTRY (3)
Students will be given credit in this cooperative education program for approved experience in chemistry. A written final report will be submitted by students. May be repeated for credit as CHEM 396 for a maximum of 6 units. Graded S/U. Prerequisite: CHEM 395.

CHEM 401 COMMUNICATION SKILLS IN CHEMISTRY (1)
Effective scientific communication skills will be developed, culminating in student presentations to the Chemistry Department. Topics will be selected from chemical literature. Attendance at departmental seminars is required. Prerequisites: CHEM 210, CHEM 332.

CHEM 450 ECOLOGICAL BIOCHEMISTRY (3)
Examining diversity of natural products involved in biochemical interactions between plants, animals (including insects, humans, and other herbivores) and microbial flora. Effects that changes in the chemistry of these compounds have on function in ecological systems. Not open to students who have taken BIOL 450. Prerequisites: CHEM 330 or CHEM 331, and BIOL 200/BIOL 200L (BIOL 201) or BIOL 202.

CHEM 461 ADVANCED LECTURE TOPICS (1-3)
Advanced studies in one of the major topics in chemistry. Content will depend on instructor. This course may be repeated for a maximum of 9 units with a different topic. Prerequisites: CHEM 345, CHEM 332 and consent of instructor.

CHEM 462 ADVANCED LABORATORY TECHNIQUES (1-2)
An advanced, focused laboratory in chemistry. Content will depend on the instructor. This course may be repeated for a maximum of 6 units as a laboratory experience with a different focus. Prerequisites: CHEM 332, CHEM 372 and consent of instructor. Lab/Class fee will be assessed.

CHEM 472 APPLICATIONS OF ENVIRONMENTAL CHEMISTRY (3)
Fate and transport of chemical contaminants; physico-chemical processes controlling pollutant partitioning and distribution; implications of chemical speciation on toxicity to biota. Prerequisites: CHEM 210; CHEM 330 or CHEM 332; or consent of instructor.

CHEM 480 CHEMICAL TOXICOLOGY (3)
Study of the fate, effects, and mechanisms of action of toxicants; physical and biological factors affecting transport, transformation and toxicity of chemical stressors; emphasis on forensic and environmental applications. Prerequisites: CHEM 351, BIOL 200/BIOL 200L (BIOL 201), or consent of instructor.
CHEM 491 RESEARCH IN CHEMISTRY (1-3)
An original experimental or theoretical investigation to be conducted under the supervision of a chemistry faculty member. Projects may span multiple semesters, and students may repeat the course for credit provided a different topic description is specified for each semester. A student should expect to complete a formal written report and/or presentation. Prerequisite: consent of instructor.

CHEM 499 HONORS THESIS IN CHEMISTRY (2)
Writing of an honors thesis based on independent research done under the direction of a faculty member. Oral presentation of the work in a public seminar. Prerequisites: consent of instructor, and open only to students who have been approved as departmental honors candidates.

Forensic Science Courses

FRSC 363 CHEMISTRY OF DANGEROUS DRUGS (3)
A study of the chemistry, methods of detection and analysis of narcotics, depressants, stimulants and hallucinogens. Also, the influence of physiochemical properties upon the pharmacological effects of drug receptor interactions. Historical, forensic, and socio-economic implications associated with drug abuse will also be reviewed. Three lecture hours. Prerequisites: CHEM 210, CHEM 330 or CHEM 332.

FRSC 367 FORENSIC CHEMISTRY (3)
Introduction to chemical and physical analyses used by a modern crime laboratory in the evaluation of physical evidence encountered in criminal acts. Areas of concentration will include drug analysis, toxicology, forensic serology, explosives analysis, arson examination, firearms and tool marks, latent prints and trace evidence. Emphasis will be placed on the value of such examinations as presented by the expert witness in a criminal trial. Three lecture hours. Prerequisites: CHEM 210 and (CHEM 330 or CHEM 332).

FRSC 368 PROFESSIONAL PRACTICES IN FORENSIC SCIENCE (3)
Introduction to the various professional practices encountered in forensic science including Laboratory Safety, Quality Assurance and Quality Control, Documentation, Ethics, Chain of Custody, and Expert Witness Testimony. Prerequisites: CHEM 210, CHEM 332.

FRSC 420 BODY FLUID ANALYSIS (4)
Current methods and concepts in forensic biology with laboratory practice in identification and individualization of biological forensic samples by several different methods, including biochemical testing, antigen-antibody reactions, and DNA typing, representing best practice in forensic science. Prerequisite: BIOL 409 (may be taken concurrently). Lab/Class fee will be assessed.

FRSC 440 FORENSIC SCIENCE, EMERGENCY MEDICINE, AND DEATH ANALYSIS (3)
Overview of the principles of Forensic Science as it applies to emergency medicine in physical and sexual assaults, environmental contamination, natural mass disasters, terrorist attacks, and natural and suspicious deaths. Prerequisite: CHEM 367.

FRSC 467 FORENSIC ANALYTICAL CHEMISTRY (3)
Instruction and laboratory practice of analytical procedures used for analysis of arson, explosives and trace evidence. Laboratory work includes sample preparation and use of microscopes, FTIR, and GC/MS as well as analysis and interpretation of data. Use of conformity to standard protocols, calibration, and discriminant function analysis. Prerequisites: CHEM 210; FRSC 367 (may be taken concurrently). Lab/Class fee will be assessed.