Chemistry (CHEM)

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The Department of Chemistry offers two degree programs in the field of chemistry: a Bachelor of Science (B.S.) degree and a Bachelor of Arts (B.A.) degree. The department is on the list of schools approved by the American Chemical Society (ACS) for the professional training of chemists, and the B.S. degree is certified by the American Chemical Society. The B.S. has either a chemistry or a biochemistry concentration option. This degree is recommended for students who plan to pursue graduate study in chemistry in preparation for college teaching, or advanced research in academic, industrial or government laboratories.

The B.A. degree requires fewer chemistry courses and offers the possibility of completing a double major if students have a strong interest in another field. Both degrees offer some latitude in the selection of upper level courses, thus allowing the student some flexibility to pursue an interest in a particular area of chemistry. Students graduating with either the B.S. or the B.A. may also qualify for departmental honors.

Chemistry is an excellent major for students interested in biochemistry, food science, forensic science, medicine, medicinal chemistry, dentistry, pharmaceutical chemistry, pharmacology, patent law, polymer science, chemical engineering, environmental science, materials science and other interdisciplinary fields. The major is also suited to students with a complementary interest in other sciences, or in computers, education, economics or business.

Students graduating with a major in chemistry will have the necessary knowledge to prepare them for a career in chemistry or for graduate school, and the confidence and skill to succeed. They will have the ability to read, understand, write and speak with clarity and understanding in technical areas. They will constantly be applying critical thinking to their readings in the technical literature. They will have developed good laboratory skills and be familiar with modern instrumentation and with the use of computers in technical fields. They will have developed the skills necessary to analyze their data and to draw conclusions from it.

For students interested in teacher licensure, see the various combinations of science education in the Department of Teacher Education in this catalog.

All graduating senior majors are required to take an achievement test for purposes of assessment of the major and College accreditation.

In order to receive a degree in chemistry from the University of St. Thomas, transfer students must complete a minimum of sixteen credits in chemistry at the university in addition to the two-credit seminar sequence.

The department offers a number of courses for non-majors to fulfill the laboratory science component of the core curriculum.

Graduation with Honors in Chemistry

Students graduating with a B.A. or B.S. degree in chemistry may also qualify for departmental honors. Students interested in this designation must consult with the department chair one year (or more) prior to their graduation date. Requirements include:

1) a minimum cumulative GPA of 3.25 and a major field GPA of 3.50;
2) completion of CHEM 493 or four credits (CHEM 491-492) in research; (participation in one summer of research in chemistry at St. Thomas may be applied in place of two credits; research must be completed at least one semester before graduation);
3) preparation of a written thesis in the format of the primary literature;
4) successful defense of the thesis before a panel composed of:
   - thesis director (chair of committee)
   - two additional UST chemistry faculty
   - one UST faculty member outside the chemistry department
   - one faculty member from another institution selected in consultation with the thesis adviser (while off-campus examiners are typically chemists, committee members from other disciplines such as biochemistry and physics may be employed when appropriate).
5) presentation of research at an off-campus meeting such as the Minnesota Section Undergraduate Research Symposium, Minnesota Academy of Sciences, NCUR, regional ACS meeting, or national ACS meeting.
6) All requirements must be completed by April 20 for spring commencement, or similarly early enough to allow for notification of the registrar and academic dean.

Major in Chemistry (B.S.) (ACS-certified)

111 General Chemistry I
112 General Chemistry II
201 Organic Chemistry I
202 Organic Chemistry II
300 Quantitative Analysis

320 Instrumental Analysis
331 Chemical Thermodynamics and Reaction Dynamics
332 Quantum Chemistry and Molecular Spectroscopy
340 Organic Spectroscopy (2 credits)
400 Advanced Inorganic Chemistry
440 Biochemistry I
481-484 Seminar Sequence (2 credits)
491 Research (2 credits) (or a summer research project sponsored by the department)

Plus four credits from:
295 Topics (2-credit course offered in J-term)
420 Bioanalytical and Forensic Chemistry (2 credits)
430 Advanced Organic Chemistry (2 credits)
442 Biochemistry II*
488 Topics (2-credit course offered in J-term)
494 Research

*required for a B.S. in Chemistry with a biochemistry concentration, plus a research project in biochemistry

Allied requirements
MATH 113 Calculus I
MATH 114 Calculus II
PHYS 111 Introduction to Classical Physics I
PHYS 112 Introduction to Classical Physics II

Strongly recommended:
MATH an additional course numbered 200 or above
QMCS 230 Software Design Using the JAVA Language

Course Sequence
All chemistry majors are advised to take 111-112 and MATH 113-114 (Calculus) during the freshman year if at all possible. Then 201-202 and PHYS 111-112 (Introductory Physics) should be taken during the sophomore year. (Note that PHYS 109-110 is not acceptable for the chemistry major). Other sequences of math and physics are much less desirable. If necessary, MATH 113 can be started in the second semester of freshman year; then MATH 114 can be taken concurrently with PHYS 111 during first semester sophomore year.

Major in Biochemistry (B.S.)

See Interdisciplinary Programs

Major in Chemistry (B.A.)

The minimum requirement for a major is 38 credits as specified below; 30 credits (including seminar) comprise the core.
111 General Chemistry I
112 General Chemistry II
201 Organic Chemistry I
202 Organic Chemistry II
300 Quantitative Analysis
320 Instrumental Analysis
331 Chemical Thermodynamics and Reaction Dynamics
481-484 Seminar (2 credits total)

Plus at least eight credits in courses chosen from the following list:

Prior to registration for the second semester courses of junior year, each chemistry major should schedule a conference with the departmental adviser in order to plan and discuss course selection for the final three semesters of college. Discussion of post-college plans and goals will be an important factor in course selection.

332 Quantum Chemistry and Molecular Spectroscopy (strongly recommended)
340 Organic Spectroscopy (2 credits)
400 Advanced Inorganic Chemistry*
420 Bioanalytical and Forensic Chemistry (2 credits)
430 Advanced Organic Chemistry (2 credits)
440 Biochemistry I
442 Biochemistry II
491 Research (1 credit)**
492 Research (0 credit)**

493 Research (0 credit)**
494 Research (1 credit)**

*Students should note that 332 is a prerequisite.

**Many options are available to students interested in pursuing research. A full unit of research may be taken in one semester as 493 (a second full unit would be 494). A full unit also could be taken in two sep arate semesters as 491 followed by 492. It is even possible for a student to take one half-course of research through two one-quarter courses (391 followed by 392).

Allied requirements

MATH 113-114 Calculus I and II*
PHYS 111-112 Introductory Physics I-II

*Students not placing into MATH 113 must take MATH 108, 109 and 114 in order to satisfy the overall calculus requirement.

Note: Math and physics requirements are as specified above plus MATH 200 and/or 201 are highly recommended. The ACS also requires familiarity with computer programming; although many chemistry courses make use of computers, the interested student is well-advised to take an additional course in quantitative methods and computer science.

Teacher Licensure

Elementary Education with a Co-major in Science and Mathematics for Elementary Education
Elementary Education with a Specialty in Science (5-8)
Co-major in Science (5-8) – Chemistry (9-12) and a Co-major in Secondary Education
See Department of Teacher Education

Minor in Chemistry

111 General Chemistry I
112 General Chemistry II
201 Organic Chemistry I

Plus twelve credits from the following:

202 Organic Chemistry II
298 Topics (2 credits)
300 Quantitative Analysis
320 Instrumental Analysis*
331 Chemical Thermodynamics and Reaction Dynamics
332 Quantum Chemistry and Molecular Spectroscopy
340 Organic Spectroscopy* (2 credits)
420 Bioanalytical and Forensic Chemistry* (2 credits)
430 Advanced Organic Chemistry* (2 credits)
440 Biochemistry I*
442 Biochemistry II*
491 Research (2 credits)
494 Research **

*These courses have prerequisites beyond the 12-credit core, or require permission of the instructor.

**A student may take four credits of research for the minor with the approval of the department chair. No special approval is needed for 491 (2 credits).

100 Chemistry in Our World (111)

An introduction to chemistry and its applications to modern society and personal life. The course is intended for non-majors and satisfies a general requirement for one semester of a laboratory science course. The chemistry studied includes the structure of matter, elements and compounds, chemical bonding, reactions, energy changes and an introduction to organic chemistry. The emphasis in the course is the relevance of chemistry in everyday life, and the applications studied will include various topics such as environmental problems, energy resources, chemistry and health, and consumer chemistry. Lecture plus three laboratory hours per week.

101 Environmental Chemistry

An introduction to chemistry with particular emphasis on environmental science. Basic chemistry topics covered include the structure of matter, elements, compounds, reactions, energy and energy changes. These topics lead to studies of topical environmental problems and their proposed solutions, including the depletion of ozone in the stratosphere, the Greenhouse Effect and global warming, acid rain, smog, waste disposal, water pollution and the search for non-polluting energy resources. Lectures and laboratory. This course satisfies the lab science requirement for non-majors.

111 General Chemistry I (100)
This course and its sequence 112 provide a two-semester introduction to chemistry. Topics include atomic structure, molecular structure, chemical bonding, the periodic table, states of matter, reactions (types, energy changes, equilibrium and rates), properties of the common elements and their ions in aqueous solution, electrochemistry and nuclear chemistry. Lecture plus four laboratory hours per week.
Prerequisite: Math placement at 108 or above; if placement is lower than 108, registration must be for section 31 (extended)

112 General Chemistry II
This course continues the study of chemistry begun in 111. See 111 for topics. Lecture plus four laboratory hours per week.
Prerequisite: A minimum grade of C- in 111

201 Organic Chemistry I
Study of the various families of organic compounds. Emphasis is placed on structure determination, reaction mechanisms, stereochemistry and spectroscopy in addition to a survey of various reaction types. An introduction to biochemical topics is included. Lecture plus four laboratory hours per week.
Prerequisite: A minimum grade of C- in 112

202 Organic Chemistry II
Continuation of 201.
Prerequisite: A minimum grade of C- in 201

295, 296, 297, 298 Topics
The subject matter of these courses, announced in the annual *Class Schedule*, will vary from year to year, but will not duplicate existing courses. See the description of these courses at the beginning of the "Departments and Curricula" section of this catalog.

300 Quantitative Analysis
An introduction to quantitative chemical analysis. Topics include sample treatment, the statistical handling of data, equilibria governing acid/base relationships, complexation and redox reactions and the fundamentals underlying titrimetry, spectrophotometry, luminescence and potentiometric methods of analysis. Lecture plus four laboratory hours per week. This course fulfills the second-level Computer Competency requirement in the core curriculum.
Prerequisite: A minimum grade of C- in 112

320 Instrumental Analysis
Principles and techniques of operation of modern chemical instrumentation. Topics include the capabilities, limitations and data interpretation of HPLC, GC, capillary electrophoresis, voltammetry, and mass spectrometry. Fundamentals of signal processing, basic circuitry and optical components is also included. The laboratory consists of both structured exercises and a student designed project and report based on an analysis problem of interest to the student. Lecture plus four hours of lab each week.
Prerequisites: 202, 300

331 Chemical Thermodynamics and Reaction Dynamics
Physical chemical introduction to the fundamentals of kinetic-molecular theory, statistical thermodynamics, classical thermodynamics, and chemical reaction dynamics. Emphasis on the in-depth study of chemical reaction equilibria, phase equilibria, and chemical reaction kinetics in gaseous, liquid and solid systems. Laboratory work involves modern computational methods in physical chemistry, as well as physicochemical measurements related to thermodynamics and reaction dynamics. Lecture plus six laboratory hours per week. This course fulfills the second level Computer Competency requirement in the core curriculum.
Prerequisites: 202, MATH 114 and PHYS 111

332 Quantum Chemistry and Molecular Spectroscopy
Study of chemical systems from the point of view of molecular theory. Introduction to the fundamentals of quantum chemistry and atomic/molecular spectroscopy. Laboratory work involves computational methods in molecular quantum mechanics and spectroscopic measurements of atomic/molecular systems. Lecture plus six laboratory hours per week. This course fulfills the second level Computer Competency requirement in the core curriculum.
Prerequisites: 202, MATH 114 and PHYS 112

340 Organic Spectroscopy **2 credits**
A more detailed study of various spectroscopic methods, especially as they are employed to determine structures of organic molecules. Coverage includes H-1, F-19, and C-13 NMR, mass spectrometry, ultraviolet and visible and infrared spectroscopies.
Prerequisite: A minimum grade of C- in 202

391 Research **1 credit**
Work on a problem under the direction of the staff. Primarily literature work.
Prerequisite: Permission of the department chair

392 Research **1 credit**
Work on a problem under the direction of the staff. Primarily laboratory work.
Prerequisite: 391

400 Advanced Inorganic Chemistry
A study of the preparation, structure, bonding and reactions of inorganic compounds. Selected topics include group theory, periodicity, catalysis, bonding theories; main group, coordination, solid state and organometallic chemistry. Lecture plus four laboratory hours per week.
Prerequisites: 202 and 332 or permission of the instructor

420 Bioanalytical and Forensic Chemistry **2 credits**
The chemistry behind criminal investigations as well as some developments in analysis of biologically important molecules. Topics to be covered include enzyme and DNA analysis, the detection and identification of explosives and fire accelerants, methods of connecting the suspect to the scene of a crime (analysis of fingerprints, fibers, glass fragments, soil and gunshot residue), the analysis of drugs and poisons, and the detection of forgeries using ink, paint and materials analysis. The course is designed to have a lab component that uses both instrumental and "wet chemical" methods of analysis. The culminating examination is a mystery that the students will work in teams to solve. It requires some lab work as well as a written report that interprets the information for the "district attorney's office." Offered in January term in even years.
Prerequisite: 202

430 Advanced Organic Chemistry **2 credits**
A study of modern topics selected from physical organic chemistry, polymers, spectroscopic applications, orbital symmetry and pericyclic reactions plus other topics of the instructor's choice.
Prerequisite: 202

440 Biochemistry I
The chemistry of biological molecules. Emphasis on the structure, energetics, kinetics and mechanisms of biologically important molecules. Topics include: protein structure; enzyme kinetics, mechanisms and regulation; anabolic and catabolic pathways; structure, organization and regulation of nucleic acids; bioenergetics; protein synthesis; and student-chosen special topics. Laboratory integrated with lecture topics: protein isolation; enzyme kinetics and mechanisms; DNA isolation, plasmid mapping, sequencing, protein synthesis and sequencing; lipids and vessicles; student chosen special projects. Lecture plus four laboratory hours per week.
Prerequisite: 202

442 Biochemistry II
Continuation of Biochemistry I (440). Lecture plus four laboratory hours per week.
Prerequisite: 440

475, 476, 477, 478 Experiential Learning
See the description of these courses at the beginning of the "Departments and Curricula" section of this catalog.

481, 482, 483, 484 Student Seminar
This sequence of courses is begun first semester of the junior year and progresses for a total of four semesters. The first (481) and last (484) courses are each one credit and are graded on the usual letter grade scale. The interior two courses (482, 483) are no credit and are graded on a pass-fail basis (S/R). Throughout all four courses meetings are held with seminars given by guest speakers. UST faculty also present seminars on their own research. In 481, juniors are introduced to the chemical literature and search techniques including use of computer databases and write a short paper based on literature research. In 483, seniors meet in small groups with faculty and discuss articles from the chemical literature. In 484, seniors research a topic from the chemical literature and present it in both written and oral formats. Required of all chemistry majors.

487, 488, 489, 490 Topics
The subject matter of these courses, announced in the annual *Class Schedule*, will vary from year to year, but will not duplicate existing courses. See the description of these courses at the beginning of the "Departments and Curricula" section of this catalog.

491, 492, 493, 494 Research
See the description of these courses at the beginning of the "Departments and Curricula" section of this catalog.

495, 496, 497, 498 Individual Study
See the description of these courses at the beginning of the "Departments and Curricula" section of this catalog.