Course Catalog

Chemistry

Faculty

Bert D. Chandler, Ph.D., Professor
Christina B. Cooley, Ph.D., Assistant Professor
Laura M. Hunsicker-Wang, Ph.D., Associate Professor
Corina Maeder, Ph.D., Assistant Professor
Christopher J. Pursell, Ph.D., Professor; Chair
Adam R. Urbach, Ph.D., Professor
Marilyn D. Wooten, Ph.D., Instructor

Overview

Six degree programs are offered to students interested in a major in chemistry:

- Bachelor of Science degree in Chemistry
- Bachelor of Science degree in Biochemistry
- Bachelor of Science degree in Applied Chemistry
- Bachelor of Science degree in Biochemistry and Molecular Biology
- Bachelor of Arts degree in Chemistry
- Bachelor of Arts degree in Chemistry with High School Teaching Certification

The Bachelor of Science degrees in Chemistry and Biochemistry are four-year courses of study designed for those students who plan to be professional chemists and biochemists. Both of these programs meet the standards set by the American Chemical Society to train chemists for industry and graduate programs in chemistry and biochemistry.

The Bachelor of Science degree in Biochemistry and Molecular Biology is offered jointly with the Department of Biology, and meets the needs of students preparing for graduate studies at the interface of chemistry and biology. Course offerings in this program are balanced between Chemistry and Biology, whereas the B.S. in Biochemistry coursework is primarily in Chemistry.

The Bachelor of Arts program is suitable for students who desire a core degree in Chemistry and provides the flexibility to couple that desire with other interests and opportunities. Students earning the B.A. in Chemistry can go on to graduate study, and this degree is appropriate for students interested in art conservation, premedical
training, secondary school teaching, and interdisciplinary studies such as biophysics, environmental sciences, oceanography, and toxicology. The B.A. in Chemistry with High School Teaching Certification provides the necessary coursework to enter into secondary school teaching or to enter professional training programs like Trinity's MAT program.

All students interested in a major are encouraged to begin research involvements during their first and sophomore years. The course offering “Research Techniques and Applications” (CHEM 1190) provides students with the opportunity to be engaged in the ongoing research programs of chemistry faculty, and a significant component of this experience will involve the use of sophisticated instrumentation for specific research applications. The junior-senior course “Independent Research in Chemistry and Biochemistry” (CHEM 3-90) then allows experienced students to undertake suitably challenging projects with faculty.

Requirements

- Bachelor of Arts Degree
- Bachelor of Arts Degree with High School Teaching Certification
- Bachelor of Science Degree in Chemistry
- Bachelor of Science Degree in Biochemistry
- Bachelor of Science Degree in Applied Chemistry
- Guidelines for the Acceptance of Majors
- The Minor
- Honors in Chemistry
- Bachelor of Science Degree in Biochemistry and Molecular Biology
- Honors in Biochemistry and Molecular Biology

Bachelor of Arts Degree

The requirements for the degree of Bachelor of Arts with a major in chemistry are as follows:

I. Departmental requirements:

   A. 31-32 credits in chemistry: CHEM 1318, 1118, 2319, 2119, 2320, 2220, 3330, 2130, 3001, 3432, 3334, 3135, 3321, 3121, and one upper division course selected from CHEM 3335, 4242, 4340, 4346, or 4347.
   B. MATH 1311, 1312.
   C. PHYS 1111, 1112, 1309 or 1311, 1310 or 1312.

II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.
Bachelor of Arts Degree with High School Teaching Certification

The requirements for the degree of Bachelor of Arts with a major in chemistry with 8-12 teacher certification are as follows:

I. Departmental requirements:

A. 32 credits in chemistry including CHEM 1318, 1118, 2319, 2119, 2320, 2220, 3330, 2130, 3001, 3432, 3334, 3335, 3135, 3321, 3121.
B. MATH 1311, 1312.
C. PHYS 1111, 1112, 1309 or 1311, 1310 or 1312.
D. EDUC 2203, 3320, 3331.

The recommended full Education Course of Study to teach high school chemistry is: (a) EDUC 1105 and 1106 for first year students; (b) EDUC 2202, 2203 or 3303, 3320, 3331, 3342; (c) EDUC 4100.

II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.

Bachelor of Science Degree in Chemistry

The requirements for the degree of Bachelor of Science with a major in chemistry are as follows:

I. Departmental requirements:

A. 44 credits in chemistry: CHEM 1318, 1118, 2319, 2119, 2320, 2220, 3330, 2130, 3001, 3101, 3190, 3432, 3334, 3135, 3321, 3121, 3335, 4242, 4250 and two courses selected from 4340, 4346 and 4347. Students may substitute an advanced course in molecular biology, engineering science, or physics for one of the two advanced electives in chemistry. This substitution must be approved by the department chair.
B. MATH 1311, 1312, plus one additional course from MATH 2321 or 3316.
C. PHYS 1111, 1112, 1309 or 1311, 1310 or 1312.

II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.
Bachelor of Science Degree in Biochemistry

The requirements for the degree of Bachelor of Science with a major in biochemistry are as follows:

I. Departmental requirements:

A. 39 credits in chemistry: CHEM 1318, 1118, 2319, 2119, 2320, 2220, 3330, 2130, 3001, 3101, 3131, 3432, 3334, 3135, 3321, 3121, 4242, 4340, and one course chosen from 3335, 4346, and 4347.
B. BIOL 1311, 1111, 2312, 2112, 2413.
C. CHEM 3190 or BIOL 3190.
D. PHYS 1111, 1112, 1309 or 1311, 1310 or 1312.
E. MATH 1311, 1312.

II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.

Bachelor of Science Degree in Applied Chemistry

The requirements for the degree of Bachelor of Science with a major in applied chemistry are as follows:

I. Departmental requirements:

A. 34 credits in chemistry, including CHEM 1318, 1118, 2319, 2119, 2320, 2220, 3330, 2130, 3190, 3001, 3101, 3432, 3334, 3135, 3321, 3121, 3335.
B. ENGR 2311, 4366, 4357 or 4358, one additional course selected from ENGR 2359, 3323, 4357, 4358, 4341.
C. One additional advanced elective course selected from CHEM 4340, 4242, 4250 or an upper division engineering science course.
D. MATH 1311, 1312, 2321, 3316.
E. PHYS 1311, 1111, 1312, 1112.
F. ECON 1311.

II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.
Guidelines for the Acceptance of Majors

Full acceptance is granted if the following requirements are met at the time of application:

I. Completion of CHEM 1318, 1118, 2319, 2119, 2320, 2220 with grades of C or better.
II. Completion of MATH 1311 with a grade of C or better.
III. A grade point average of at least 2.0 on all other university work.

Provisional acceptance may be granted if it is apparent that the applicant can meet the requirements for full acceptance by the end of the semester in which application is made.

Transfer students will be accepted provisionally pending completion at Trinity of at least one upper division chemistry course, which includes lab, with a grade of C or better.

The Minor

A minor in chemistry may be obtained by successful completion of a minimum of 20 hours in chemistry, to include CHEM 1318, 1118, 2319, 2119, 2320, 2220, 2130, and at least 6 additional hours in upper division courses. CHEM 3001 and 3101 cannot be used towards satisfying the upper division course requirement.

Honors in Chemistry

In addition to the minimum requirements for an honors thesis described earlier, the Department of Chemistry has the following requirements:

**Application and Procedures**

Students planning to write an Honors Thesis in Chemistry should discuss research opportunities with at least three faculty members. Normally the choice of research director will be made in the first semester of the Junior year, although students with extraordinary research experience, including research during a summer, may defer the choice of research director for one or two semesters.

**Requirements**

The Honors Program in Chemistry requires a minimum of nine credit hours of research normally arranged over three semesters. At least six of these hours must be taken in the senior year and devoted to the thesis research. If a student has worked full-time on research related to the thesis for a minimum of ten weeks during one summer, the department may waive the requirement for three of the nine credit hours.
Submission of the final research report for the summer is required for this waiver.

Bachelor of Science Degree in Biochemistry and Molecular Biology

The requirements for the degree Bachelor of Science with a major in Biochemistry and Molecular Biology are as follows:

I. Department requirements

   A. At least 47 credits in chemistry and biology, distributed as follows:

      1. Core Courses. BIOL 1311, 1111, 2312, 2112, 2413, 3474, CHEM 1318, 1118, 2319, 2119, 2320, 2220, 3330, 2130, 3131, 3334, and 4340; BIOL 3000 or CHEM 3000 (1 semester).

      2. Advanced Electives. Two courses chosen from the following list (one from each department):
         BIOL 3450, 3458, 3466, CHEM 3432, 4346, 4347, or the combination of 3321 and 3121.

   B. MATH 1311, 1312

   C. PHYS 1309, 1111, 1310, 1112

II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.

Guidelines for Acceptance of Majors

Full acceptance is granted if the following requirements are met at the time of application:

I. Completion of CHEM 1318, 1118, 2319, 2119, 2320, 2220 and BIOL 1311, 1111, 2312, 2112, and 2413 with grades of C or better.

II. Completion of MATH 1311 with a grade of C or better.

Provisional acceptance may be granted if it is apparent that an applicant can meet the requirements for full acceptance by the end of the semester in which application is made.
Honors in Biochemistry and Molecular Biology

Students may undertake honors under the direction of faculty in either the Biology or Chemistry Departments. The procedures and requirements will be determined by the department affiliation of the research mentor. These are described in the Biology and Chemistry sections of this bulletin.

Courses

CHEM-1118 General Chemistry Laboratory
Emphasis is placed on the development of laboratory skills that are fundamental to experimental chemistry. Laboratory operations include the use of modern potentiometric and spectrophotometric methods of analysis as well as traditional gravimetric and volumetric procedures. Corequisite: CHEM 1318.

CHEM-1190 Research Techniques and Applications
Involvement in ongoing research programs with individual faculty. Information retrieval, chemical and instrumental methods, and experimental design for the solution of specific problems are emphasized. 6 laboratory hours a week for 1 semester. Prerequisite: Consent of instructor.

CHEM-1300 Introduction to Chemistry
Introduction to the fundamental concepts of chemistry including the mole, stoichiometry, balanced reactions, electronics structure, chemical bonding, and intermolecular interactions with modern examples. An emphasis will be placed on problem solving involving mathematics. CHEM 1300 provides a thorough preparation for CHEM 1318. Lecture, 3 hours per week.

CHEM-1301 The Chemistry of Crime
The study of forensic chemistry, with an emphasis on the scientific basis for the various techniques used in solving crimes. The course is designed as studio course which includes both lectures and laboratory experiments during the class period. The course will contain a minimum of 25 hours of laboratory activities. Two field trips on Friday afternoon/Saturday morning may be required. This course is intended for students who major in a non-science discipline. No student who has already fulfilled (or who is currently enrolled in a course fulfilling) the Using Scientific Methods section of the Understanding Natural Science and Technology portion of the Common Curriculum.

CHEM-1305 The Chemistry of Art
The study of the chemical foundation of the art world. Topics range from a study of the historical development of technical innovations and discoveries which impacted the evolution of art, to the chemical and physical properties of artists’ materials, to an introduction to conservation and the analysis of works of art. The course is designed as
a studio course which includes both lectures and laboratory experiments during the class period. A minimum of one half of the course meeting times will be laboratory activities. This course is intended for students who major in a non-science discipline. Credit for CHEM 1305 will not be given to those students who have already fulfilled (or who are currently enrolled in a course fulfilling) the Using Scientific Methods section of the Understanding Natural Science and Technology portion of the Common Curriculum.

CHEM-1318 General Chemistry
Fundamental concepts in chemical science, taught from perspectives of chemistry in the modern world, with emphasis placed on quantitative problem solving. Course content will include stoichiometry and mass relationships, properties of solutions, atomic structure, molecular structure and bonding, intermolecular forces, chemical equilibrium, thermodynamics and kinetics. Lecture, 3 hours per week. Credit for the Common Curriculum will not be granted for both CHEM 1300 and CHEM 1318. Prerequisite: Passing the Chemistry Placement exam or CHEM 1300. Co requisite: CHEM 1118.

CHEM-2119 Laboratory Methods in Organic Chemistry
The laboratory stresses modern techniques for the preparation and analysis of organic compounds. Infrared spectral analyses and chromatographic separations are introduced. Laboratory, 3 hours per week. Corequisite: CHEM 2319. Prerequisite: CHEM 1118 or equivalent.

CHEM-2130 Advanced Chemical Principles Laboratory
Emphasis is placed on the development of foundational laboratory techniques and skills, including attention to details and precision. Utilizing quantitative instrumental techniques, students build a deeper level of experimentation and problem solving skills while becoming increasingly independent. Laboratory, 3 hours per week. Prerequisite: CHEM 2320

CHEM-2220 Chemical Synthesis Laboratory
Continued development of student laboratory experience with emphasis on organic and inorganic syntheses. Nuclear magnetic resonance spectroscopy, use of Chemical Abstracts, and technical writing are emphasized. Laboratory, 5 hours per week, alternate weeks; discussion session 1 hour each week. Pre- or Corequisite: CHEM 2320. Prerequisite: CHEM 2119.

CHEM-2305 Chemistry for the Visual Artist
The study of the chemical foundations of the visual arts. Topics range from a study of the historical development of technical innovations and discoveries that impacted the evolution of art, to the chemical and physical properties of artists’ materials, to an introduction to conservation, and the analysis of works of art. The course is designed to include both lectures and laboratory experiments during the class period. A minimum of one half of the course meeting times will be laboratory activities. A field trip may be included. The laboratory activities will be expanded and built upon in the co requisite course, ART 2305. This course is intended for students who major in non-science discipline. No student who has already fulfilled (or who is currently in a course fulfilling) the Using Scientific Methods section of the Understanding Natural Science and Technology portion of the Common Curriculum may register for CHEM 2305. Students may register for one of CHEM 1305 or CHEM 2305. Co requisite: ART 2305: Studio Art for Chemists.
CHEM-2319 Organic Chemistry I
Introduction to the basic principles of organic chemistry through studies of the structures, properties, and reactions of carbon-based compounds. Lecture, 3 hours per week. Corequisite: CHEM 2119. Prerequisite: CHEM 1318 or equivalent.

CHEM-2320 Organic Chemistry II
The continuation of Chemistry 2319 with emphasis on structure-activity relationships, mechanisms, and synthesis of complex organic compounds. Lecture, 3 hours per week. Prerequisite: CHEM 2319

CHEM-2340 Application of Chemical Principles
Application of chemical structure, thermodynamics, and kinetics to a broad range of problems, including acid-based reactions, redox reactions, and energy production. Lecture, 3 hours per week. Prerequisite: CHEM 2319

CHEM-3000 BCMB Seminar
Students must attend a minimum of 10 scientific seminars. Appropriate seminars are those offered by the Department of Biology, the Department of Chemistry, the Department of Physics and Astronomy, the Neuroscience Program, and/or seminars presented as part of the Distinguished Scientist Lecture Series. Pass/Fail.

CHEM-3001 Chemistry Seminar I
Exposure to the breadth of chemistry through attendance at the department seminar. Students will have the opportunity to interact with the speaker and discuss the work in greater detail. Short essays based on the lectures and reading from the chemical literature will be assigned for the student to assess the significance of the work and place it into the larger scientific context. Pass/Fail only.

CHEM-3101 Chemistry Seminar II
Exposure to the breadth of chemistry through attendance at the department seminar. Students will have the opportunity to interact with the speaker and discuss the work in greater detail. Short essays based on the lectures and readings from the chemical literature will be assigned for the student to assess the significance of the work and place it into the larger scientific context. Course may be repeated up to three times. Pass/Fail only. Prerequisite: CHEM 3001

CHEM-3121 Inorganic Chemistry Laboratory
Synthesis, spectroscopic characterization, and reactivity studies of inorganic compounds. Students will develop advanced synthesis and characterization techniques, and will become familiar with the Inorganic Chemistry literature. In the second half of the semester, students may be able to develop individual projects relating to the broader fields of interest. Laboratory 3 hours per week. Prerequisite CHEM 2220, 3334. Pre-or Corequisite: CHEM 3135, 3321, or consent of instructor.

CHEM-3131 Biochemistry Laboratory
An introduction to modern experimental biochemistry. The course emphasizes analytical and physical methods used in isolating and determining the properties of proteins, and nucleic acids. Laboratory, 3 hours per week.
Prerequisites: CHEM 3330, 2220.

CHEM-3135 Physical Chemistry Laboratory
Experimentation in physical and biophysical chemistry using modern laboratory techniques and instrumentation. The emphases of the course are to illustrate physical chemistry principles and to develop careful and critical experimental expertise. Topics covered include chemical kinetics, thermodynamics and equilibrium. Laboratory, 3 hours per week. Prerequisites: CHEM 3334, 3432

CHEM-3321 Inorganic Chemistry
Chemistry of the main group and transition metal elements, with emphasis on the application of fundamental chemical principles to trends in stability and reactivity. Topics include atomic theories, bonding, molecular structure, symmetry and group theory, acid-base theories, thermodynamic properties, kinetics and reactivity, redox properties, coordination compounds, organometallic chemistry, solid state chemistry, catalysis and bioinorganic chemistry. Lecture 3 hours per week. Prerequisite: CHEM 2320, 3334. Co-requisite: CHEM 3121.

CHEM-3330 Biochemistry I
The structure and function of biological molecules. The course emphasizes protein and nucleic acid structure and metabolism, mechanisms of enzyme action, membrane structure and dynamics, and energy production, storage, and utilization. Lecture, 3 hours per week. Prerequisite: CHEM 2320

CHEM-3334 Physical Chemistry I
Emphasis is placed on the effect of temperature, pressure, volume and chemical composition on chemical equilibrium and reaction rates through the development of fundamental principles of chemical thermodynamics and reaction kinetics. Lecture, 3 hours per week. Pre- or Corequisite: PHYS 1309 or 1311. Prerequisites: CHEM 1318; MATH 1308 or 1312.

CHEM-3335 Physical Chemistry II
A continuation of Chemistry 3334 with emphasis on quantum mechanical approaches to chemical structure and dynamics, statistical mechanics, and theoretical developments in chemistry. Lecture, 3 hours per week. Pre- or Corequisite: PHYS 1310 or 1312. Prerequisite: CHEM 3334.

CHEM-3-90 Independent Research Chemistry & Biochemistry
Analyses directed to the solution of a problem having mutual student and faculty interest. All available instrumental and technical resources appropriate to this research are employed. Oral and written communication of results are required. 6 laboratory hours a week per credit hour. An end of semester written report is required. Attendance at departmental seminars is expected. Prerequisite: Junior standing.

CHEM-3398 Honors Reading
Independent study in selected areas in preparation for Honors Thesis. May be taken for up to three hours of credit. Prerequisite: Consent of instructor.
CHEM-3432 Analytical Chemistry
Principles of quantitative chemical analysis. Discussions will include topics such as sampling, statistical analysis, experimental design and optimization, chemical equilibrium, volumetric and gravimetric techniques, electrochemistry, and elementary instrumental analysis. Typical laboratory experience includes volumetric analysis and elementary instrumental analysis. 3 lecture hours and 3 lab hours per week. Prerequisite: CHEM-2319

CHEM-4242 Advanced Analytical Methods
Principles of modern instrumental analysis, with emphasis on separation methods and mass spectrometry. Both theory and practical experience are addressed. Appropriate laboratory experience emphasizes use of sophisticated chemical instrumentation. Equivalent of 1 lecture hour and 3 laboratory hours per week. Prerequisite: CHEM 3432. CHEM 3334 is recommended.

CHEM-4250 Senior Integrated Laboratory
Advanced experimentation in chemistry and biochemistry. A team-taught course designed to bring the perspectives of multiple disciplines to bear on advanced laboratory problems. The emphasis in the course will be on the use of emission and absorption spectroscopy, magnetic resonance, electrochemistry, and computational chemistry to study complex chemical and biochemical problems. Equivalent of 1 lecture hour and 6 laboratory hours per week. (offered every Fall). Prerequisites: CHEM 3334, 3335, 3135.

CHEM-4340 Biochemistry II
The continuation of CHEM 3330 with emphasis on metabolism, biosynthesis, and gene expression. Lecture, 3 hours per week. Prerequisites: CHEM 3330, 3334.

CHEM-4346 Advanced Interdisciplinary Topics-Fall
Advanced topics in chemistry, with an emphasis on modern approaches in interdisciplinary areas. Topics will vary from semester to semester and may include physical inorganic, physical organic, bioinorganic, bioorganic, organometallic chemistry or the chemistry of materials. Lecture, 3 hours per week. Pre- or Corequisite: CHEM 3334.

CHEM-4347 Advanced Interdisciplinary Topics-Spring
Advanced topics in chemistry, with an emphasis on modern approaches in interdisciplinary areas. Topics will vary from semester to semester and may include physical inorganic, physical organic, bioinorganic bioorganic, bioanalytical, organometallic chemistry, or the chemistry of materials. Lecture, 3 hours per week, Spring. Prerequisite: CHEM 3334.

CHEM-4395 Thesis Research in Chemistry and Biochemistry
Written communication of research performed at Trinity University in thesis form. Course enrollment requires a minimum of two semesters of research involvement in a research project and the permission of the department chair.

CHEM-4399 Honors Thesis
Individual research and scholarly investigation under faculty supervision leading to the preparation of an Honors
Thesis. To be taken only by Senior Honors students in both terms of their Senior year. Includes participation in Senior Colloquium where students present reports on their Thesis work.