# DEPARTMENT OF CHEMISTRY

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## Chemistry Department Mission Statement, Objectives, and Outcomes

The Department of Chemistry is traditional in its approach to the discipline of chemistry and offers a rigorous and well-balanced curriculum. This provides the student with a strong preparation for graduate studies and/or a career in chemistry. The department faculty expertise covers all major areas of chemistry. A variety of research experiences are available to majors through ongoing faculty research programs. In addition, the department attempts to instill in its students an awareness of the beauty and design in nature that reflects the creative hand of God.

There are four separate majors offered within the department:

- **Chemistry:** The traditional chemistry major provides a strong preparation for graduate school or employment in the chemical industry.
- **Biochemistry**: This major provides a strong preparation for graduate or professional schools or for employment in biochemical, molecular biology or genetics industry.
- **Chemistry Secondary Education**: This is a major that prepares the student for teaching chemistry at the secondary school level. It is a program that combines a traditional chemistry curriculum with a number of education courses.
- **Chemistry General Science Secondary Education**: This is essentially the same as Chemistry Secondary Education major. These students, however, in addition to all the chemistry and education courses will take Astronomy and either Geology or Environmental Science. This will qualify them for General Science certification.

Success in the chemical profession requires the ability to search the chemical literature and chemical databases and to effectively communicate that information in written and oral form. Chemists need to be proficient with software designed to operate instruments, analyze data and present results. The Writing Intensive (WI), Speaking Intensive (SI) and Information Literacy (IL) courses in the Chemistry Department are designed to fulfill these academic and professional requirements.

## Chemistry Department Program Objectives

Graduates will be prepared with the knowledge and technical skills to successfully pursue career paths in the chemical industry, secondary education, chemistry graduate studies or other professional programs.

Graduates will be prepared to display critical thinking and problem solving skills to enable them to learn, grow and be effective throughout their professional careers.

Graduates will gain knowledge and develop skills within the context of a Christian worldview, including the Christian foundations of science and the practice of chemistry, both ethical and in conduct, according to Christian principles.

**Chemistry Department Program Outcomes**

Graduates of the Chemistry Department will demonstrate:

1. Knowledge in the areas of general, analytical, organic, physical, inorganic chemistry and biochemistry according to ACS standards.
2. An ability to apply chemical principles and knowledge to solving chemical problems.
3. Knowledge of the mathematical and physical basis of chemical theories.
4. An ability to use laboratory techniques and skills to effectively conduct experiments and interpret results.
5. An ability to accurately maintain a laboratory notebook.
6. Proficiency in the operation of modern instrumentation and the ability to analyze and interpret instrumental data.
7. An ability to search the chemical literature as well as read and comprehend content in professional chemistry journals.
8. An ability to effectively communicate chemical information in written and oral forms according to ACS guidelines.
9. Knowledge of the foundations and the practice of science from a Christian perspective.

***Departmental policy limits students to one major within the Department of Chemistry. Students are expected to confer with their advisors for a detailed schedule of courses recommended to meet requirements for a major.***

**Course Requirements for Bachelor of Science Degree in Chemistry (CHEM)**

**Chemistry Core (49 hours):**

Chemistry 101-102, 227, 241-242, 252, 264, 345-346, 356, 406, 425, and 455- 456.
Chemistry 351 or 352.

**Chemistry Electives (8 hours):**

Eight hours from Chemistry course offerings, with the exception that no more than two hours may be selected from Chemistry 370, 470, 480, or 499 to fulfill the eight hours of Chemistry elective credit. Chemistry 302 will not be applicable for Chemistry elective credit. Any extra hours earned by research courses, internships, or Chemistry 302 will be applied as general elective credit.

**Major-Related requirements (23 hours):**

Computer Science 141.
Mathematics 161, 162 and 261.
Physics 101-102 or 121-122.

**Courses that count in the CHEM major quality point average (MQPA):**
**All courses with "CHEM" prefix. A minimum MQPA of 2.00 is required to graduate.**

**Course Requirements for Chemistry Secondary Education Major leading to (7-12) certification (CSED)**

**Chemistry Core (41 hours):**
Chemistry 101-102, 227, 241-242, 252, 264, 302, 345-346, 351, 356, and 425.
**Major-Related requirements (23 hours):**
Computer Science 141 or 204.
Mathematics 161 and 162.
Physics 101-102 or 121-122.
Science 202.
**Education requirements (33 hours):**
Education 201, 202, 305, 309, 361, 371, 431, 488, and Psychology 102.

**Courses that count in the CSED major quality point average (MQPA):**
**All courses with "CHEM" and "EDUC" prefixes, COMP 141, COMP 204, ENGR 136, and PSYC 102. A minimum MQPA of 2.00 is required to graduate.**

**Course Requirements for Chemistry/General Science Secondary Education Major leading to (7-12) certification (CGSE)**

**Chemistry Core (41 hours):**
Chemistry 101-102, 227, 241-242, 252, 264, 302, 345-346, 351, 356, and 425.
**Major-Related requirements (29-30 hours):**
Computer Science 141 or 204.
Geology 201 or Science 204.
Mathematics 161 and 162.
Physics 101-102 or 121-122.
Physics 206.
Science 202.
**Education requirements (33 hours):**
Education 201, 202, 305, 309, 361, 371, 431, 488, and Psychology 102.

**Courses that count in the CGSE major quality point average (MQPA):**
**All courses with "CHEM" and "EDUC" prefixes; COMP 141, 204; GEOL 201; PHYS 206; PSYC 102; SCIC 202 and 204. A minimum MQPA of 2.00 is required to graduate.**

**Course Requirements for Bachelor of Science Degree in Biochemistry (BIOC)**

**Biochemistry Core (56 hours):**
Biology 101, 234, and 488.*
Chemistry 101-102, 227, 241-242, 252, 264, 345-346, 351-352, 356, 425, and 455.
**Chemistry/Biology Electives (9 hours):**
Nine hours from Chemistry and/or Biology course offerings, with the exception that no more than two hours may be selected from Biology 370, 460, 470, 497, 499; Chemistry 370, 470, or 499. Chemistry 480 or Biology 480 may supply an additional two hours of elective credit. Research and elective hours in excess of the above four hours will be applied as general elective credit.
**Major-Related requirements (16 hours):**
Mathematics 161-162.

Physics 121-122 or 101-102.

**Courses that count in the BIOC major quality point average (MQPA):**
**All courses with "CHEM" and "BIOL" prefixes. A minimum MQPA of 2.00 is required to graduate.**

**Chemistry 456 for three credits may be substituted in place of Biology 488 that is one credit. One credit of Chemistry 456 will count for Biology 488 and the remaining two credits will count toward the nine required hours of Chemistry/Biology electives.*

**Course Requirements for a minor in Chemistry (24 hours)**

Chemistry 101 or 105; 102, 227, and 241 (16 hours)
8 hours from:
Chemistry 242, 252, 264, 345, 346, 351, 352, 356, 425, 455, or 456

Note: Only one course from Chemistry 242, 351 and 352 may be used to fulfill the minor requirement.

## CHEMISTRY (CHEM)

**101. GENERAL CHEMISTRY I.** An introductory survey of the fundamental principles of chemistry including chemical reactions and stoichiometry, chemical formulas, nomenclature of compounds, gas laws, redox reactions, thermochemistry of physical change, crystal structures and the enthalpy of chemical change. Three lectures and one lab per week. *Fall Semester, four hours.*

**102. GENERAL CHEMISTRY II.** An introductory survey of the fundamental principles of chemistry including concepts and theories of rates of reaction, chemical equilibrium, Aqueous equilibria, electrochemistry, coordination chemistry, nuclear chemistry, main group chemistry, and an introduction to organic chemistry. A working knowledge of the following instruments: benchtop GC, IC Metrohm, UV-Vis diode array pH meter, and Spectronic 20 will also be expected by the end of the semester. Three lectures and one lab per week. Prerequisite: Chemistry 101 or 105.
*Spring Semester, four hours.*

**105. CHEMISTRY FOR ENGINEERS.** An introductory survey in the fundamental principles of chemistry, including chemical reactions and equations; behavior of gases; chemical thermodynamics; basics of electrochemistry; crystal structure; and nuclear, organic, and environmental chemical fundamentals. Three lectures and one lab per week.
*Semester course, four hours.*

**227. ANALYTICAL CHEMISTRY.** A study of the theoretical basis and laboratory techniques necessary for the solution of problems in quantitative chemical analysis. Three lectures and one lab per week. Prerequisite: Chemistry 102.
*Fall semester only, four hours.*

**241. ORGANIC CHEMISTRY I.** An introduction to the structure and chemistry of carbon compounds including alkanes, stereochemistry, haloalkanes, alcohols, ethers and alkenes. Structure determination by spectroscopic methods is introduced. Three lectures and one lab per week. Prerequisite: Chemistry 102. *Fall Semester, four hours.*

**242. ORGANIC CHEMISTRY II.** A continued study in the chemistry of organic compounds including conjugated systems, aromatic compounds, aldehydes and ketones, carboxylic acids and their derivatives, amines and biological molecules. Structure determination by spectroscopic methods is emphasized. Three lectures and one lab per week. Prerequisite: Chemistry 241; corequisite for chemistry, biochemistry and chemistry secondary education majors: Chemistry 252. *Spring Semester, four hours.*

**252. INSTRUMENTAL METHODS & SEMINAR.** A course designed to provide instruction in the practical use of instrumentation, chemical informatics, writing scientific papers and the public presentation of scientific information. This course meets the College Information Literacy requirements, and partial components for the Writing Intensive/Speaking Intensive requirements. One laboratory period per week. Prerequisite: Chemistry 241; Corequisite: Chemistry 242. *Spring semester only, one hour.*

**264. CHEMICAL APPLICATIONS OF MATHEMATICAL METHODS.** An introduction, built on the foundation of a two-semester calculus sequence, to mathematical concepts and their application to chemistry. Prerequisite: Mathematics 161-162 and Chemistry 102. *Spring semester only, three hours.*

**302. TECHNIQUES IN CHEMISTRY LABORATORY INSTRUCTION.** A course limited to junior or senior Chemistry Secondary Education and General Science Secondary Education majors involving instruction and experience in setting up and conducting effective educational chemistry demonstrations and laboratories. This course fulfills the Writing Intensive (WI), Speaking Intensive (SI), and Information Literacy (IL) requirements for Chemistry Education majors. Prerequisite: Chemistry 227 and 241. *Spring semester only, one hour.*

**345. PHYSICAL CHEMISTRY I.** An introduction to the principles of quantum mechanics and their application in describing molecular properties. An emphasis is placed on developing a solid understanding of the principles of spectroscopy. Three lectures and one lab per week. Prerequisites: Chemistry 102 or 105 and Chemistry 264. *Fall Semester, four hours.*

**346. PHYSICAL CHEMISTRY II.** Thermodynamics, Statistical Mechanics, and Kinetics. The relationships between the properties of macroscopic systems are developed to gain an understanding of chemical equilibrium. The principles of statistical mechanics are introduced to show how thermodynamic properties can be predicted from molecular properties described by quantum mechanics. Connections are developed between chemical kinetics and reaction mechanisms. Three lectures and one lab per week. Students may not receive credit for both Chemistry 346 and Physics 340. Prerequisites: Chemistry 102 or 105 and Chemistry 264. *Spring Semester, four hours.*

**351. BIOCHEMISTRY I.** A study of the structure-function relationships of biochemical compounds of living systems. This course concentrates on the major pathways of human metabolism. Three lectures and one lab per week. Prerequisite: Chemistry 242. *Fall Semester, four hours.*

**352. BIOCHEMISTRY II.** A study of biochemical compounds and their interactions. This course will center specifically on the structure and functional relationships of DNA, RNA and proteins. Three lectures and one lab per week. Prerequisite: Chemistry 242. *Spring Semester, four hours.*

**356. MOLECULAR SYMMETRY AND GROUP THEORY.** An introduction to the chemical applications of group theory. The relationship between the symmetry of molecules and their physical and chemical properties will be emphasized. One lecture per week. Prerequisite: Chemistry 241. *Spring semester only, one hour.*

**370. INDEPENDENT CHEMISTRY RESEARCH.** Juniors who have displayed aptitude in chemistry perform assigned research problems. This course may not be taken concurrently with Chemistry 499. Three hours of laboratory work per week per credit hour. Prerequisite: an application must be submitted and approved by department. *Semester course, one or two hours.*

**390. STUDIES IN CHEMISTRY.** This course is used to present various advanced topics in chemistry. *Semester course, one to three hours.*

**406. INSTRUMENTAL ANALYSIS.** A course focused on instrumental theory and design, and the application of instruments in the analytical process and analysis of complex samples. Prerequisite: Chemistry 227, 252, and 346. *Spring semester only, three hours*.

**425. INORGANIC CHEMISTRY.** This course emphasizes the role that symmetry plays in chemical structure and bonding theory with descriptive chemistry interwoven to illustrate theoretical concepts. The periodic table is studied in sufficient detail for the student to become aware of the many important trends that form the basis of its organization. Three lectures per week. Prerequisite: Chemistry 242, 252, and 356. *Fall semester only, three hours.*

**428. ORGANOMETALLIC CHEMISTRY.** A study of the synthesis and properties of organometallic compounds and their role in modern catalytic processes. The rapidly growing areas of bioinorganic and bioorganometallic chemistry is discussed. Three lectures per week. Prerequisite: Chemistry 425. *Spring semester only, three hours.*

**455. CHEMICAL SYNTHESIS AND SPECTROSCOPY I.** An introduction to advanced laboratory synthesis coupled with modern spectral analysis for the determination of molecular structure. Organic, inorganic and organometallic sytheses will be interspersed in order to give the student a broad range of laboratory experiences. One lecture and two labs per week. Chemistry 455 fulfills the writing intensive (WI) requirement for Chemistry and Biochemistry majors. Prerequisites: Chemistry 242, 252.

*Fall Semester, three hours.*

**456. CHEMICAL SYNTHESIS AND SPECTROSCOPY II.** An advanced laboratory course and introduction to 2-dimensional NMR techniques for the determination of molecular structure. Organic, inorganic and organometallic syntheses will be interspersed in order to give the student a broad range of laboratory experiences. One lecture and two labs per week. Chemistry 456 fulfills the speaking intensive (SI) requirement for Chemistry majors. Prerequisite: Chemistry 455.*Spring Semester, three hours.*

**463. POLYMER CHEMISTRY.** An introduction to the structure, synthesis, and physical properties of the major organic polymers. Two lectures per week. Prerequisite: Chemistry 242. *Fall semester only, two hours.*

**466. ADVANCED ORGANIC CHEMISTRY.** A detailed study of organic reactive intermediates and organic reaction mechanisms. Two lectures per week. Prerequisite: Chemistry 242. *Spring semester only, two hours.*

**470. INDEPENDENT CHEMISTRY RESEARCH.** Seniors who have displayed aptitude in chemistry perform assigned research problems. This course may not be taken concurrently with Chemistry 499. Three hours of laboratory work per week per credit hour. Prerequisite: Chemistry 370 and an application must be submitted and approved by department. *Semester course, one or two hours.*

**480. INTERNSHIP IN CHEMISTRY.** Selected students participate in an individual field experiences in a research laboratory under the supervision of professional staff. Minimum two weeks work required per intern credit hour. The grade is determined on the basis of a written evaluation by the cooperating institution mentor and a written report by the student submitted to the Chemistry Department. Prerequisites: Minimum 24 hours chemistry and permission of the department. *Semester course, one to six hours.*

**499. HONORS IN CHEMICAL RESEARCH.** Seniors who have shown special aptitude in chemistry may, with consent of the Department of Chemistry, undertake supervised chemistry research. Not to exceed two hours each semester.
*Semester course, one or two hours.*