Chemistry Department
Curricular Objectives with Student Learning Goals
Revised and Abridged

Overarching disciplinary and course specific learning objectives have been formulated to serve six student cohorts; 1) those intending to fulfill requirements of the American Chemical Society for degree certification, 2) chemistry majors who do not opt for ACS certification, 3) biochemistry majors, 4) environmental studies-chemistry combined majors, 5) minors and 6) non-science students. We construct the curriculum in accordance with guidelines promulgated by our professional accrediting body, the American Chemical Society’s Committee on Professional Training. These establish a curricular framework which, in turn, informs specific learning goals. CPT emphasizes and requires attention to the following points which provide the basis for comprehensive 5-year recertification reviews we must submit to CPT for accreditation:

- Problem solving and laboratory experience reinforce the study of essential content.
- Chemistry should be made accessible to all students seeking a liberal education.
- Problem solving also lends itself to teamwork.
- Effective communication through writing and speaking.
- Core curriculum taken by certifiable chemistry graduates includes a minimum of 28 semester credit hours of basic instruction with comparable emphasis on the areas of analytical chemistry, inorganic chemistry, organic chemistry, and calculus-based physical chemistry. At least three semester credit hours of biochemistry must also be part of the undergraduate curriculum for all certified graduates. The 28 semester credit hours of study shall include a minimum of 7 semester credit hours (300–350 contact hours) of laboratory instruction.
- Six semester hours of advanced courses that include sufficient laboratory work to bring the total number of laboratory contact hours to 500 are dictated for certified degrees.
- Principles of chemical safety, current health and safety issues must be integral.
- Historical perspective as well as references to current developments in chemistry.
- Real-world problems, early introduction to instrumental and computational techniques.
- Laboratory instruction should include practical experience with instrumentation for spectroscopy, chemical separations, and electrochemical methods. It should give students hands-on experience with chemistry and the self-confidence and competence to-
  - keep legible and complete experimental records;
  - synthesize and characterize inorganic and organic compounds;
  - perform accurate and precise quantitative measurements;
  - use and understand modern instruments, particularly NMR, FT-IR, and UV-vis spectrometers; GC, GC-MS, and HPLC instruments for chemical separations; and electrochemical instruments;
  - interpret experimental results and draw reasonable conclusions;
  - analyze data statistically and assess reliability of results;
  - anticipate, recognize, and respond properly to hazards of chemical manipulations;
  - design experiments;
• plan and execute experiments based on searching and using the literature;
• communicate effectively through oral and written reports; and
• work effectively in small groups and teams.

• Biochemistry must be part of the curriculum for all certified majors.
• Undergraduate research can integrate the components of the core curriculum

Students must learn how to retrieve specific information from the enormous and rapidly expanding chemical literature.

**Common and Overarching Departmental Learning Goals For Majors**

Students of serious purpose upon completing a major in chemistry, biochemistry, or environmental studies-chemistry should be expected to:

1) Understand atomic and molecular level structure (including bonding), how structure is determined experimentally, and how it is depicted using a variety of symbolic representations.

2) Understand how structure determines both physical properties and chemical reactivity.

3) Understand the organization of the periodic table and periodic trends of atoms.

4) Appreciate the nature of intermolecular bonds and their impact on properties; solubility, boiling point, non-covalent interactions between molecules etc.

5) Appreciate how chemists devise and test theories which seek to explain the how and why, rather than just the what, of chemical reactivity and chemical structure.

6) Have both a qualitative and quantitative understanding of acid/base concepts and their utility in explaining chemical reactions of many types.

7) Have both a qualitative and quantitative understanding of redox concepts and their utility in understanding a large family of chemical transformations.

8) Understand the factors which impact on rates of reaction (kinetics).

9) Understand the factors which impact on relative stabilities of chemical species and the position of various chemical and physical equilibria (thermodynamics).

10) Appreciate how chemical and physical properties can be measured and quantified; to include error analysis and statistical treatment of data.

11) Understand the quantum mechanical description of the atom.

12) Appreciate why certain molecules should be synthesized and how this can be done; to include familiarity with synthesis planning strategies and methodology.
13) Have familiarity with some of the important tools for separating mixtures of compounds with an emphasis on modern chromatographic methods.

14) Have a solid understanding of the theory and practice of spectroscopic methods based upon the interactions of electromagnetic radiation with matter and how to utilize the resulting data for structural elucidation.

15) Be able to assimilate large amounts of data, present it clearly and make well reasoned and supported conclusions based upon it in formal laboratory reports in a variety of formats.

16) Feel confident in the laboratory environs based in part of significant hands on experience with a wide range of sophisticated instrumentation.

17) Appreciate the imperatives of chemical safety and environmental stewardship including proper handling and disposal of chemicals and wastes and safe laboratory practices.

18) Be familiar with the scope, structure and content of the primary and secondary literature and possess a facility with some of the tools utilized to access it.

19) Have completed a faculty-mentored research project and effectively communicated the nature of their investigation, its context and significance, and progress towards its completion in two oral seminars and a final written research report. Students receiving honors designation will have presented the final written report in the form of an undergraduate thesis and successfully defended in front of a committee of three faculty.

20) Appreciate the applicability and relevance of chemical concepts, tools, and investigative methods to the solution of a wide variety of social and scientific problems.

For Minors

A minor in chemistry requires the student to complete six courses including general chemistry (2.5 units) and organic chemistry (2.5) with two additional courses at the 200, 300 or 400 level according to their interests. These students will have a modest degree of facility with all of the objectives with the exception of the research project although with greater competence in those areas specifically focused upon in the upper-level electives.

Common and Overarching Departmental Learning Goals For Non-Majors Liberal Education Courses

Students of serious purpose upon completing a natural science distribution course in chemistry should:

1) Have a rudimentary understanding of atomic and molecular level structure and how structure is depicted using a variety of symbolic representations. Understand the nature of and different types of chemical bonds.
2) Appreciate the types of questions that chemists address and some of the approaches taken to answer these questions.

3) Have the ability to communicate using the vernacular of the discipline at a level which would allow them comprehend chemically related issues appearing in newspapers and popular science journals. Be able to effectively write about chemical issues at a similar level.

4) Understand the organization of the periodic table and periodic trends of atoms.

5) Appreciate how the tools of the chemistry can be used to solve contemporary problems in at least one area (environmental science, pharmaceuticals, forensics etc. depending on focus of course.)

6) Appreciate the nature and limits of the scientific method as it unfolds in the development of new knowledge in chemistry.

Those completing a natural science with laboratory distribution course should additionally:

7) Feel a degree of confidence in the laboratory based in part on significant hands on experience with powerful and sophisticated instrumentation.

8) Appreciate the imperatives of chemical safety and environmental stewardship including proper handling and disposal of chemicals and chemical wastes.

9) Be able to communicate the results of their experimental work to a variety of audiences by way of written reports of various types.