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Committee on Professional Training

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# CPT Updates Guidelines for Undergraduate Chemistry Programs

The Committee on Professional Training (CPT) regularly updates the ACS document, *Undergraduate Professional Education in Chemistry: Guidelines and Evaluation Procedures*, which is used to evaluate and approve undergraduate chemistry programs. The last update of the ACS Guidelines was in 1999 and included the major change of requiring that all certified chemistry majors take at least three semester hours of biochemistry as part of their undergraduate curriculum. The next update of the Guidelines is scheduled for release in 2003.

The 2003 ACS Guidelines do not require any major new changes to undergraduate chemistry programs. Rather, this revision is intended as a "minor upgrade" focused on updating and clarifying the Guidelines. This article provides a synopsis of the most important changes to the Guidelines that will be in the 2003 update.

One area in which a substantive change is being made is chemistry education. The Committee recognizes that there is a critical need for well-trained high school chemistry teachers. Two programs for addressing this need have been developed.

- The chemistry education option has been streamlined. The reduced chemistry requirements recognize that substantial additional course work is necessary for students to become state-certified to teach chemistry in secondary schools.
- A new chemistry education minor has been added. This minor is designed for students majoring in another natural science who also may teach chemistry in secondary schools.

ACS-approved programs may offer these new programs after applying for and receiving approval from CPT.

The updated Guidelines have been expanded in areas addressing the manner in which students are taught and advised.

- Teamwork skills and multidisciplinary work are important parts of a chemist's training, and they should be incorporated into classroom and laboratory components of the chemistry curriculum.
- Mentoring of undergraduate students is encouraged because it leads to improved confidence, opens educational and career opportunities, and results in higher achievement.

The updated Guidelines have also been expanded to address concerns related to faculty composition and faculty development.

- The chemistry profession benefits from the broader inclusion of underrepresented groups, including women and minorities. It is essential that chemistry faculties reflect the diversity of modern society and the chemistry profession. The Committee expects institutions to demonstrate a strong commitment to these principles in their faculty hiring and professional development practices.
- The trend of replacing permanent tenure-track faculty members with temporary, adjunct, or part-time faculty is strongly discouraged so that students have access to regular faculty and all teaching faculty receive professional development opportunities and appropriate compensation. As stated in the current version of the Guidelines, courses required for a certified degree should be taught by regular, full-time faculty.
- Professional development opportunities are essential for all faculty, including temporary, adjunct, and part-time faculty and instructors. Financial support and adequate time must be provided for professional development.
- Mentoring of junior faculty reduces isolation, provides networking opportunities, and helps to develop successful careers. Mentoring can be especially important for underrepresented groups including women and minorities.

The Committee continues to recognize the value of undergraduate research as part of a chemist's education. The updated Guidelines acknowledge that conducting research with undergraduate students takes substantial time and effort.

- If an institution expects faculty members to direct undergraduate research, then it should give substantial teaching credit for time spent guiding independent student research.

The updated Guidelines recognize the increasing importance of computers in chemistry, both in the curriculum and in literature searching and retrieval.

- Computational chemistry courses may be counted toward the laboratory-hour requirement.
- Online searching of databases is an essential experience for chemistry graduates.

- Included with this newsletter are the *ACS Directory of Graduate Research 2001 Errata*. All of the additions and corrections are reflected in *DGRweb 2001* as well.
- The CPT publication *Graduate Education in Chemistry, The ACS Committee on Professional Training: Surveys of Programs and Participants* is now available as a PDF on the CPT website at chemistry.org/education/cpt.

## In This Issue . . .

Although the topics covered in a typical chemistry curriculum continue to expand, the minimum number of faculty members for an approved program remains at four. However, the updated Guidelines address the advantage of having at least five faculty members.

- Having at least five faculty members is highly desirable in order to provide expertise in all chemistry subdisciplines, permit the regular teaching of all courses required for certification by full-time faculty, maintain reasonable faculty contact hour teaching loads, and allow for regular faculty sabbatical leaves. A minimum of five faculty members will typically be needed for approval of an option degree.

To further clarify the existing Guidelines, the new version offers additional explanation in the following areas.

- The 500 laboratory-hour requirement applies to the chemistry degree and to all option degrees (except the new streamlined chemistry education option degree).
- Comprehensive written research reports are required when undergraduate research is used to fulfill advanced course requirements. Oral, poster, and computer presentations do not meet this requirement, nor do published journal articles, even if an undergraduate student is a coauthor.

The updated Guidelines are intended to strengthen the faculty and curricula of ACS-approved chemistry programs and thereby improve the quality of chemistry training received by undergraduate students. The 2003 ACS Guidelines will be distributed to every chemistry faculty member of each ACS-approved institution and be posted to the CPT website. Additional print copies may be requested from the Office of Professional Training.

# *Revised Requirements for Chemistry Education Option and New Chemistry Education Minor*

The revised requirements for the chemistry education option and a new chemistry education minor for ACS-approved programs are under final review and are expected to be in operation in 2003. The Committee believes that the modified requirements and new minor will encourage more departments to offer this option, increase the number of students entering secondary school chemistry teaching, and ensure that future chemistry teachers at this level have an adequate background in chemistry. The review process, the revised requirements for the option, and the proposed new minor were published in the Spring 2002 CPT Newsletter. Committee members are most grateful for the oral and written comments on the proposals that were received at the ACS meeting in Orlando in April and the Biennial Conference on Chemical Education in July.

The total number of chemistry courses and laboratory contact hours has been reduced for the chemistry education option to provide the requisite time in an undergraduate curriculum for students to complete course work in education needed for state certification to teach in secondary schools. The Committee recognizes the importance of laboratory work for preservice teachers as preparation for their future chemistry teaching through inquiry-based exercises and, consequently, strongly encourages laboratory experience—beyond the minimum—through course work or research. The chemistry teaching methods requirement for this option (and the chemistry education minor) will ensure that students develop the skills required for teaching secondary school chemistry. This requirement may be satisfied by completion of a specific course or other experience(s) that includes laboratory experiment design and preparation, acquisition and storage of chemicals and laboratory apparatus, safety, disposal of chemical waste, teaching assistant experience, and the literature of chemical education. This requirement may be met through various means, including independent study, teaching assistantships, specific methods courses, and interdisciplinary activities. Chemistry faculty are expected to be directly involved in the design and teaching of the chemistry teaching methods experience.

At its August 2002 meeting, the Committee incorporated some of the suggestions into the version below, which will undergo a final review at the January 2003 meeting.

**Chemistry Education Option.** This option, for which an approved department may apply to offer, is designed for students preparing for precollege teaching careers. Minimum requirements for this degree option are a total of 33 semester credit hours of core and/or advanced chemistry courses, which include no fewer than 270 total laboratory contact hours. In addition, the equivalent of a three-semester credit hour course in chemistry teaching methods is required. The required chemistry curriculum must include the following: the same first two years that certified chemistry majors take in introductory and organic chemistry course work, but requiring only one semester of organic chemistry laboratory; exposure to biochemistry, analytical, inorganic, and physical chemistry equivalent to a one-semester course in each area; and one additional course that builds upon this foundation. Students are also expected to complete the courses in education needed for certification as defined by state requirements.

**Minor in Chemistry.** A chemistry minor should include a minimum of 20 semester credit hours (or the equivalent). Two or more areas of chemistry should be chosen beyond the first-year courses in chemistry from the following: analytical, biochemistry, inorganic, organic, and physical. A minor should include 200 total contact hours of laboratory experiences in at least 2 different areas beyond first-year chemistry.

Although the Committee provides advice for a minor in chemistry, the only minor for which an approved department may apply is the chemistry education minor. This minor has been designed for students majoring in another natural science who plan to teach science courses in secondary schools. The background in chemistry obtained by students completing the chemistry education minor would enhance their teaching in their major field and ensure that they have adequate background for teaching chemistry at the secondary level.

**Chemistry Education Minor.** Students must complete the requirements described above for a chemistry minor: one semester of physics with laboratory and the equivalent of a three-semester credit hour course in chemistry teaching methods. Students receiving a chemistry education minor are also expected to complete a major in another natural science.

# *Environmental Chemistry Option*

**The statement of the option requirements in the ACS document, *Undergraduate Professional Education in Chemistry: Guidelines and Evaluation Procedures*, is as follows:**

**Environmental Chemistry:** Six semester hours of biology, geology, or other environmentally related science and at least two semesters of advanced work in chemistry of the environment, including some aspects of aquatic chemistry, atmospheric chemistry, and geochemistry. Fieldwork and studies of modeling in environmental systems are encouraged in the advanced work. These advanced courses may include research culminating in a comprehensive written report.

There are wide differences in environmental courses offered in educationally sound programs. Therefore, the requirements of six semester hours of introductory work outside the core and two semesters of advanced work were intentionally left open. Some guidance is given below.

## What additional introductory-level natural science or engineering courses should be required?

(*Chemistry, calculus, and physics are in the core.*)

The answer clearly depends on the institution. Courses in environmental science designed for nonscience students should be avoided. Good introductory environmental science courses, where they exist, may be appropriate. Ecology gives an excellent broad introduction to environmental issues in some institutions, while at others it may lack the appropriate level of scientific rigor. Basic biology and geology or earth science courses may be appropriate; however, some coverage in such courses may have little content directly related to the environment. On some campuses, geography departments offer natural science courses that play a central role in this area. Engineering schools often offer sound, broadly based environmental courses.

Conclusion: Departments must assess carefully what is best at their institution to provide appropriate rigor and breadth in the required introductory science courses.

## What should be in the advanced courses?

The focus of advanced study must be on the chemistry of environmental systems and must build on the core chemistry background. Courses without explicit chemistry prerequisites must be carefully justified. Fieldwork, working with real data, and the modeling of environmental systems are encouraged. A good program has a balance among the three major systems: earth, air, and water. Carefully guided independent research is always an excellent option for advanced work. While policy-oriented courses such as environmental law or economics may be of great interest and importance to these students, they may not be used as advanced environmental chemistry courses. Many advanced courses will be found in departments other than chemistry.

Conclusion: Departments must examine carefully all advanced courses, looking for a strong chemical component and making every effort to avoid duplication of course content. Coordination with and participation by other departments may be essential to this process.

Some possible advanced course topics:

- Advanced Analytical Chemistry including Chemometrics and Trace Analysis
- Advanced Environmental Chemistry
- Aquatic Chemistry/Marine Chemistry
- Atmospheric Chemistry
- Biochemistry of Toxins and Pollutants
- Chemistry and Climate Change
- Environmental Engineering
- Environmental Toxicology
- Geochemistry
- Hydrology on all Scales
- Microbiology
- Multimedia Transport of Substances of Environmental Concern
- Oceanography
- Radiochemistry and the Environment
- Soil Chemistry
- Sources and Effects of Environmental Pollutants

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