

exposure to multiple foundation areas of chemistry or a group of topics organized by overarching themes (for example, synthesis, characterization, and reactivity) rather than by the traditional organization of chemistry subdisciplines.

**5.4 In-Depth Course Work.** The curriculum required for certification must also include a minimum of the equivalent of four one-semester or six one-quarter in-depth courses and correspond to at least 12 semester or 18 quarter credit hours.

Because in-depth courses build on prerequisite foundation course work, the goals of in-depth courses are both to integrate topics introduced in the foundation courses and to investigate these topics more thoroughly. Exams and other assignments associated with in-depth courses should require critical thinking and problem-solving skills. The second semester in a two-semester course sequence such as organic or physical chemistry can be considered an in-depth course.

In-depth course work could focus on content that increases a student's understanding of one or more of the foundation areas. It could also include courses that support a specialized degree track (see Section 5.8). One or more of the in-depth courses may be taught in another department, but they must contain significant chemistry or chemistry-related content at a level beyond the foundation. The Committee encourages programs to integrate modern topics in chemistry such as catalysis, environmental chemistry, green/sustainable chemistry, materials science, and toxicology into the in-depth courses.

Laboratory courses provide an important aspect of in-depth course work for certified graduates. In general, associated classroom and laboratory courses (e.g., the second semester of organic chemistry lecture and laboratory) count as a single course in satisfying the requirement for four in-depth courses even if they have separate course numbers. Likewise, a laboratory that represents the first laboratory exposure to a foundational area is not considered an in-depth course. For a laboratory course to be considered as one of the four in-depth courses required for certification, it must represent an advanced laboratory experience that includes the integration of student skills and builds on the foundation laboratory experiences. In-depth laboratory experiences involve experiment design, execution, data analysis, and use of the chemical literature. In these courses, students are typically in the laboratory for at least six hours per week. Such courses may have an accompanying classroom component. No single laboratory or lecture course can be used to satisfy both foundation and in-depth requirements.

**5.5 Frequency of Course Offerings.** The most effective programs teach five foundation courses annually. Approved programs must teach at least four foundation courses annually, covering at least four of the five foundation areas. For programs on the quarter system, this requirement translates to teaching at least six of eight foundation courses every year. Each foundation course must be taught at least once in any two-year period. If any foundation courses are not taught annually, the program must make arrangements to ensure that students can complete the requirements for certification in four years.

While permanent full-time chemistry faculty usually teach all of the foundation courses, in some cases it may be appropriate to include courses taught by faculty outside the chemistry department. For example, a student might obtain a foundation biochemistry experience through a course taught in a biochemistry or biology department. In cases where course work in one of the foundation areas is taught by another department, the chemistry faculty must teach all of the remaining foundation courses annually.

Because in-depth courses determine the rigor of the undergraduate experience, the chemistry faculty must teach at least four semester-long or six quarter-long in-depth courses annually, exclusive of research. These courses must correspond to at least twelve semester or 18 quarter hours. The frequency of the in-depth course offerings must allow students to complete the requirements for a certified chemistry degree in four years. Although courses taken outside the chemistry program may be used to satisfy an individual student's in-depth course requirements, the program is still required to teach at least four in-depth semester (six quarter-long) courses, as defined in Section 5.4, in each academic year.

**5.6 Laboratory Experience.** The certified graduate must have 400 hours of laboratory experience beyond the introductory chemistry laboratory. Laboratory course work must cover at least four of the five traditional chemistry subdisciplines and may be distributed between the foundation and in-depth levels. Laboratory course work is an ideal place in the curriculum to develop the student skills described in Section 7. The laboratory experience must include synthesis of molecules, measurement of chemical properties, determination of structures, hands-on experience with modern instrumentation such as that listed in Section 4.2, data analysis, and computational modeling. Laboratory experiences should be designed to teach students to understand the operation and theory of modern instruments and use them to solve chemical problems. In