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ABSTRACT

This publication provides guidelines for chemistry programs in two-year colleges. Contents include: (1) "Chemistry Program Mission and Review"; (2) "Organizational Structure for Chemistry Programs"; (3) "Financial Support"; (4) "Faculty and Supporting Staff"; (5) "Facilities"; (6) "The Curriculum"; and (7) "Advising, Articulation, and Alliances". (YDS)

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Guidelines for Chemistry Programs in Two-Year Colleges

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A Resource for Institutional Self-Study and Program Review

Developed by the American Chemical Society–Society Committee on Education
Task Force on Two-Year College Chemistry Programs

Implementing these *Guidelines* can help your institution's chemistry programs

- ▶ **support the mission of your institution**
- ▶ **meet the diverse needs, backgrounds, and abilities of entering students**
- ▶ **coordinate with chemistry programs at four-year colleges for transferring students**

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INTRODUCTION

These *Guidelines for Chemistry in Two-Year Colleges,* developed by the American Chemical Society (ACS), provide a comprehensive model for two-year colleges that grant associate degrees and allow institutions to review the quality of their chemistry programs. Those institutions that offer programs in chemical technology should refer to the *Guidelines for Development and Evaluation of Chemistry-Based Technician Programs.*[1]

These guidelines are designed as a

- guide for institutional self-studies and program reviews,
- set of standards for program review and evaluation through the College Chemistry Consultants Service[2], C_3S, and
- resource for regional accrediting groups when revising self-study guidelines and conducting visitations for periodic assessment of programs.

These *Guidelines* are intended to help faculties provide chemistry students with the best possible education in the fundamental areas of modern chemistry and its relationship to other disciplines and to society. To achieve this goal, general curricular goals rather than specific curricular content are defined. Implementing the *Guidelines* can ensure that the chemistry course offerings and programs of an institution

- are consistent with the mission of the institution,
- meet the needs of the diverse backgrounds and abilities of entering students,
- use and enhance the strengths of the institution and the community,
- articulate with the chemistry programs at those four-year colleges to which most students transfer,
- are comparable with programs of recognized quality, and
- augment the continuing education and other local community chemistry education needs.

Sections that follow describe a comprehensive model. The standards are to be considered as characteristics of the model. They are labeled with an "S" notation and numbers to easily locate specific references to areas of interest.

[1,2]Available from the Office of College Chemistry, American Chemical Society.

I. CHEMISTRY PROGRAM MISSION AND REVIEW

S1 The chemistry education program in the two-year college is consistent with the mission statement and purposes of the institution.

S2 The institution has established procedures for ongoing assessment of the effectiveness, level of achievement, and degree of compatibility of its programs with its objectives.

II. ORGANIZATIONAL STRUCTURE FOR CHEMISTRY PROGRAMS

S3 The chemistry faculty have participatory responsibilities in matters such as budget development, chemistry faculty selection, evaluation, promotion, course development, assignment of teaching responsibilities, grading standards, and professional development. The faculty have control of the budget once it is established. Ideally, chemistry programs are administered by the chemistry faculty organized as an independent unit. At those institutions where chemistry faculty are a part of a larger unit, they have sufficient involvement to function autonomously as previously mentioned.

III. FINANCIAL SUPPORT

S4 The institution has made a financial commitment to the continued operation and stability of a quality chemistry program. Specifically, budgetary allocations provide for

- qualified full-time faculty, competitively compensated, of sufficient size and breadth to staff the chemistry courses effectively;
- qualified, competitively compensated, adjunct and part-time faculty, as needed, to provide specific expertise and/or to accommodate term-to-term fluctuations in enrollments (not to serve as replacements for full-time faculty on anything other than a short-term emergency basis);
- sufficient trained laboratory technical support staff to provide necessary preparation, demonstration, and stockroom services;
- secretarial and clerical help, including student assistants, to aid and lessen the noninstructional work load of the faculty;
- media production and assistance as well as library bibliographic assistance necessary to facilitate a high-quality, up-to-date program of instruction;
- instructional support services and learning aids, such as tutorial services, computer facilities, library resources, and electronic access, compatible with the needs of the instructional program and conveniently accessible to the chemistry faculty and students;
- expendable supplies and capital equipment acquisitions required for modern, high-quality laboratory and lecture instruction;
- management and disposal of chemical laboratory wastes;

- facilities that provide for the safety and health of the college community;
- timely equipment maintenance and repair or replacement;
- opportunities for professional growth and development of the faculty, including travel to professional meetings, workshops, seminars, and courses;
- sabbatical and professional development leave; and
- insurance to cover the faculty for liability while carrying out their professional duties and to replace stolen/damaged equipment and supplies.

S5 The institution actively seeks industrial and/or foundation support and strives to convince the governing authorities of the need for differential funding for science laboratory-based programs.

IV. FACULTY AND SUPPORTING STAFF

S6 The minimum academic preparation required of a chemistry faculty member, full-time or adjunct, is a master's degree in a discipline of chemistry. In addition, an ability to communicate an understanding of chemistry to others should be considered in the selection process.

Further academic training and research are highly desirable, particularly if they stress depth and breadth of knowledge in chemistry.

S7 All chemistry faculty members keep abreast of current developments in chemistry, chemistry education, and the applications of chemistry in our society.

S8 The institution has a program to ensure equal opportunity in professional and technical employment for women, minorities, and persons with disabilities.

S9 Full-time faculty size is adequate to teach the full range of chemistry courses on a regular basis to meet the needs of students as outlined in the curriculum section of these *Guidelines*.

S10 The number of credit hours taught by full-time faculty exceeds 75% of the total chemistry offerings.

Full-time faculty are defined as faculty who have continuing (or probationary) contracts. Full-time faculty are normally hired with probationary status; continuing contracts are normally awarded after two to four years of acceptable performance.

S11 Policies regarding salaries, teaching loads, overloads, promotions, tenure and/or continuing contracts, leave policies (sabbatical or other), and hiring practices are sound enough to maintain good faculty morale and to attract and retain quality chemistry faculty.

S12 Teaching loads are such that, after fulfilling all classroom and laboratory teaching responsibilities, meeting required office hours, and satisfying committee assignments, faculty have adequate time and energy for

- continuing course and program development,
- keeping abreast of new developments in their educational field,
- participating in professional activities, and
- engaging in research in chemistry, chemistry education, and teaching effectiveness.

S13 For purposes of faculty load determination, each laboratory contact hour is equivalent to a lecture contact hour in the classroom.

Supervision of a student laboratory, including the preparation for the experimental work, implementation of safety and health regulations, safe chemicals management, and the grading of the laboratory reports, demands time, energy, and expertise equivalent to that required for the preparation and presentation of a lecture.

S14 The normal teaching load in chemistry is 15 contact hours per week or less and/or 450 student contact hours (i.e., the number of students multiplied by the number of contact hours) per week or less.

Teaching loads that exceed this standard risk lowering the quality of the chemistry program.

S15 No faculty member is responsible for more than 25 students in a laboratory at one time, except for organic laboratory where 20 students is the maximum.

This standard is based on prudent safety considerations and practice as recommended in the ACS publication, *Safety in Academic Chemistry Laboratories.*[3]

S16 A member of the chemistry faculty is designated to coordinate all aspects of the chemical safety program in cooperation with appropriate institutional and other departmental safety programs.

S17 Secretarial, stockroom, or technical staff are available to relieve faculty members of the routine chores that detract from academic responsibilities.

Experience has shown that, to relieve faculty from routine laboratory preparation chores, at least one full-time laboratory technician for every four full-time or full-time-equivalent chemistry faculty teaching a 15-hour contact load in chemistry is needed. Part-time and student help are not adequate substitutes for full-time laboratory technicians; rather, they often increase the burden on the faculty.

V. FACILITIES

A. Lecture Rooms and Office Space

S18 Chemistry classrooms and offices are located near the instructional laboratories and preparation facilities.

S19 Chemistry classrooms meet modern standards of lighting, ventilation, and comfort.

S20 Classrooms have adequate provision for using all types of audiovisual aids (e.g., computer, CD-ROM, laser disc, and Internet access), and the availability of a hood (either permanent or portable) for demonstrating chemical phenomena. Equipment for mounting and displaying charts is available. Easy access for laboratory carts to carry demonstration materials is provided.

S21 Faculty offices are readily available to students and located so as to encourage faculty–student contact.

These offices must be sufficiently private to allow for intellectual pursuits, security of materials, and confidential discussions.

[3]Available from the ACS Health and Safety Referral Service, American Chemical Society.

S22 Faculty offices and classrooms are accessible to persons with disabilities.

S23 Each faculty office is equipped with a computer with Internet and electronic mail access.

S24 Equivalent facilities are available for adjunct faculty.

B. Student Instructional Laboratories

S25 Laboratories are well lighted and ventilated and are equipped with such services as gas, water, and electric power.

S26 Well-maintained, working fume hoods and hood space are provided for the safety and health of students and staff.

S27 There is a minimum of 30 square feet of laboratory space per student for the introductory courses, which includes a minimum of 3 lineal feet of working bench space per student. For the second-year courses, there is a minimum of 45 square feet per student, which includes a minimum of 4.5 lineal feet of working bench space per student.

S28 The laboratories are fully equipped with well-maintained and properly functioning safety features such as eye wash, safety shower, fire extinguishers, and industrial first aid kits. Safety instructions are posted in the laboratory, and safety goggles are worn by everyone in the laboratory and preparation areas.

S29 Laboratory facilities comply with the regulations of federal, state, and local agencies.

S30 Laboratories are located to provide convenient routes to stockrooms and preparation areas.

S31 Laboratory facilities have provisions for the safe functioning of persons with disabilities.[4]

S32 For safe supervision of students, laboratories have no more than 25 stations. Where more stations exist, no more than 25 students are assigned to an individual laboratory instructor.

C. Instructional Support Facilities

S33 Service areas, such as the rooms for faculty and student special projects, are conveniently located and large enough to provide for the needs of the students and the faculty for instruments, computers, and study.

S34 An area centrally located to lecture rooms and labs and dedicated to the safe storage, handling, preparation, and distribution of chemicals is provided.

S35 Segregated storage areas are designated for acids, bases, reducing agents, oxidizing agents, and toxic materials. Cabinets and refrigerators that store flammable materials meet the federal and state Occupational Health and Safety Administration regulations.

S36 Material safety data sheets (MSDSs) for all purchased chemicals are available to all professional personnel and student workers. National Fire Protection Association (NFPA) labeling codes are used on all reagents.

[4]Copies of *Teaching Chemistry to Students With Disabilities* can be obtained from the Committee on Chemists with Disabilities, American Chemical Society.

S37 A policy of minimum stockroom chemical holdings is in place, including small (less than 1 liter or kg) quantities for especially hazardous materials.

D. Library/Learning Resource Center

S38 The chemistry library collection, or electronic access to these materials, is within or near the science building. It consists of holdings commensurate with the size and nature of the chemistry offerings and the research activity of the students and staff.

The library collection includes current chemistry and related science periodicals, plus a range of other reference materials suitable for the course offerings of the department.

S39 For institutions with a central, main library, a departmental or science reading room is strongly recommended. Such a room would have the important reference materials and current periodicals close at hand when needed by staff and students, especially those engaged in advanced courses, research, and independent study.

VI. THE CURRICULUM

A. Program Development

S40 The curriculum includes those courses necessary to accommodate varied student and program needs. Each chemistry course is validated by one or more two-year college functions, including transfer, career, general education, basic skills, and community service.

In its program development, the institution recognizes the diversity in the educational background, learning readiness, academic ability, and educational goals of students. It accepts the fact that all students are not prepared to begin chemistry at the same level, and that all programs requiring chemistry do not cover identical topics. Using these *Guidelines* to evaluate a program, the institution should consider the size of the student body and the diversity of the students' educational backgrounds in establishing the framework of chemistry curriculum as well as its methods of delivery.

The chemistry curricular areas outlined in this section include, among others: chemistry for science and engineering majors, chemistry for the allied health occupations, chemistry for engineering technologies, and chemistry for liberal arts students.

Additionally, the number of underprepared students makes it necessary for many institutions to include preparatory or developmental chemistry courses to prepare these students for the college-level courses.

Comprehensive two-year colleges typically offer one sequence of chemistry courses for chemistry and engineering majors. This sequence also satisfies the needs of other science and engineering majors (e.g., physics, biology, and geology), preprofessional health science majors (e.g., premedicine, predentistry,

preveterinary medicine, and prepharmacy), and some natural resource majors (e.g., preforestry and agriculture). It normally includes two years of chemistry—one year of general chemistry followed by one year of organic chemistry.

S41 When variations from the curriculum described in these *Guidelines* are significant (due to regional influences of the transfer colleges, demography, philosophy, or a unique curriculum organization), the chemistry program meets its goals but in a manner appropriate to the institution.

ACS encourages diversity as well as quality in chemistry programs. Each institution should develop its chemistry programs in accordance with its defined mission statement and purposes. Innovation and experimentation coupled with a strong assessment component preserve the vitality of chemistry education. Programs that are innovative in content and teaching methodology are strongly endorsed. Despite the many variations, all good programs help students appreciate the contributions as well as the limitations of science and technology, and develop students' scientific and logical reasoning skills.

S42 Chemistry courses and extracurricular activities incorporate the connections between chemistry and other disciplines, the methods of science, and the effect of chemistry on technology and society.

The commitment to provide for the educational needs of students in a variety of curricular and extracurricular areas is a constant challenge to the chemistry education profession. The profession can contribute significantly to the students' intellectual development and to their ability to function as citizens and community leaders in an increasingly scientific and technological society. Extracurricular activities, such as the ACS Student Affiliate Chapters, student science clubs, seminar and lecture series, and field trips, can provide an understanding of careers in chemistry and related disciplines as well as the relationships among the disciplines.

S43 The chemistry department and the administration are fully committed to safe practices in the use and disposal of chemicals. The safety of students and faculty, as well as the protection of the environment, is given top priority when curriculum and budget decisions are made. This includes

- experiments selected for their instructional value, taking into consideration safety and waste management;
- a standard, comprehensive orientation in safety concepts, attitudes, and practices, complete with an explanation of MSDSs, NFPA labels, and a signed statement verifying that the safety orientation was completed and that the student will adhere to the safety regulations included in each laboratory course;
- proper instruction and implementation of safe practices and hazardous waste management (i.e., waste minimization, recycling, identification, disposal) in all laboratories, as well as in all lecture and laboratory demonstrations; and
- use of safety equipment and practices in accordance with all federal, state, and local regulations governing the safe handling and disposal of chemicals and chemical wastes.

B. Course Scheduling

S44 An annual listing of chemistry courses is published and widely distributed, permitting students to schedule courses in proper sequence.

S45 The schedule of chemistry courses that service the various occupational programs is coordinated with the schedule of the other required courses for these programs.

C. Course Prerequisites

S46 The prerequisites for each chemistry course have been carefully considered and assessed by the faculty. The prerequisites are clearly stated and publicized in the college catalogues, in the schedule of classes, and in all published curriculum brochures and program sheets.

Wide dissemination of the prerequisites minimizes registration problems, promotes student planning, and ensures good public relations.

S47 All those involved in admitting students to chemistry classes (administrators, counselors, faculty, etc.) understand the importance of stated prerequisite requirements and adhere to them when enrolling students in chemistry courses.

Adherence to the established chemistry course prerequisites is necessary to maintain quality programs. Failure to do so increases student failure and dropout rates and lowers the quality of learning.

S48 An effective assessment is made of each student's preparation and readiness for the course by testing, transcript evaluation, and counseling.

S49 Students who do not have the prerequisites for a given chemistry course are required to complete appropriate preparatory course(s) in chemistry, mathematics, and/or developmental skills.

D. The Spectrum of Introductory Chemistry Courses

S50 A spectrum of introductory chemistry courses is offered consistent with the college's mission and goals, its various programs, the student body characteristics, and the enrollment demand.

Generally, introductory chemistry courses are completed during a full-time student's first year. Introductory chemistry courses are differentiated either by the student's major or level of preparation, and include

- chemistry for the science and engineering professions,
- chemistry for underprepared students,
- chemistry for the nonscience/nontechnology students,
- chemistry for allied health and related occupations,
- chemistry for engineering technologies and related occupations, and
- chemistry for other occupational or special-interest groups.

These courses are general in nature and typically include material from one or more of the several subdisciplines of chemistry, except for certain occupationally oriented programs.

Some of these courses stress laboratory work and related knowledge and skills (especially mathematics) more than introductory courses in the other sciences.

For either pragmatic or philosophical reasons, a given introductory course may serve the needs of two or more of the student groups listed above (e.g., preparatory and general education students, or allied health, occupational, and general education students). However, with such combinations, care must be taken to ensure that the needs of any group not be compromised.

General chemistry is the foundation course for science and engineering majors. Once designed, it greatly influences the characteristics of the second-year and preparatory courses, as well as the other introductory chemistry course offerings.

S51 Lecture experiments and demonstrations are used when appropriate in introductory chemistry courses in presenting descriptive material and in generating lasting interest in chemical phenomena. Up-to-date learning aids and multimedia resources are used to enhance students' interest and learning.

S52 Laboratory work in chemistry courses is designed to give students hands-on experience in working with chemical phenomena and appropriate instrumentation. It is also designed to develop competence and self-confidence. Depending on the level and nature of the course, this may include

- gaining a fuller, more practical understanding of and appreciation for chemical concepts;
- anticipating, recognizing, and responding properly to potential hazards in chemical procedures;
- keeping neat, complete experimental records;
- performing accurate quantitative measurements;
- interpreting experimental results and drawing reasonable conclusions;
- communicating effectively through oral and written reports;
- planning and executing experiments through the use of appropriate chemical literature and electronic resources;
- synthesizing and characterizing inorganic and organic compounds; and
- analyzing data statistically, assessing the reliability of experimental results, and discussing the sources of systematic and random error in experiments.

S53 Laboratory work gives students hands-on experience in the use and understanding of modern laboratory instruments.

Depending on the nature and level of the course, laboratories typically are equipped with

- electronic analytical balances,
- pH meters, and
- spectrophotometers and other instrumentation appropriate to the curricula.

E. Chemistry for Science and Engineering Majors

S54 The curricula for students intending to major in chemistry match that of local transfer institutions that offer ACS certification for baccalaureate degrees. It is important to remember, however, that the first two years of chemistry serves more than just chemistry majors. The guidelines written by the ACS Committee on Professional Training (CPT) for the ACS-certified program give a great deal of latitude to the transfer institutions in the design of the curriculum. It, therefore, is possible that two different four-year schools in the area may have two different curricula. Hence, careful articulation with all institutions to which the two-year college students transfer is important.

S55 Ideally, the prerequisites for this course are the equivalent of one year of high school chemistry and three years of high school mathematics, including two years of algebra, or equivalent placement scores. For students whose preparation is deficient, the college offers and requires the successful completion of a preparatory chemistry course, or its equivalent, as well as the necessary mathematics courses.

The second year of the curriculum is typically a one-year course in organic chemistry; however, some two-year colleges offer analytical chemistry or biochemistry because of the requirements of nearby transfer institutions. Again, the importance of careful articulation cannot be overstated.

The constituency of these chemistry courses is broader than chemistry majors. The courses are organized around traditional chemistry topics, but serve the needs of students in other majors by incorporating a historical perspective as well as references to current developments in chemistry that have implications in other disciplines.

S56 Laboratories for science and engineering majors are equipped with additional instrumentation appropriate to the curriculum, such as

- recording spectrophotometers (infrared, ultraviolet/visible, nuclear magnetic resonance);
- atomic absorption and flame emission photometers;
- GC, HPLC, ion chromatographs; and
- GC–MS.

Departments stay abreast of changes being made in instrumentation and continually update their programs. Rapid advances are being made in the areas of modern computer simulation, computer/calculator-based data acquisition and processing, and in small- and micro-scale experiments. Appropriate use of these technologies complements available instrumentation.

S57 As appropriate for the courses taught, the program includes training and experience in the use of information from the enormous and rapidly expanding chemical literature equivalent to that in the major transfer institutions.

Because of the increasing volume and complexity of chemical literature, students are no longer able to acquire skills in information retrieval without some formal instruction. These skills (e.g., using Chemical Abstracts and other compilations) may be taught through coordinated instruction by integrating them into courses and through library exercises and/or research papers, as well as online interactive computer file experiences. This can be accomplished in many ways, such as cooperative library arrangements and electronic access.

F. Preparatory Chemistry Courses

S58 The curriculum includes a preparatory course for students who intend to pursue the general chemistry course but have not previously studied chemistry or have inadequate preparation in the subject. The preparatory course includes a limited introduction to basic terminology and principles of chemistry. The course emphasizes concepts, critical thinking, and chemical calculations required to be successful in chemistry and includes a laboratory component along with lecture/discussion sessions.

When combined with an effective student assessment and chemistry placement program, the preparatory course helps ensure that students entering the general chemistry sequence are positioned for success in the general chemistry program.

G. Chemistry Courses for Other Programs

S59 Considering enrollment trends and the demands of occupational curricula, the college tries to provide as many separate courses as possible for each of the following student groups:

- nonscience/nontechnology students (e.g., the arts, liberal arts, business)
- students majoring in one of the allied health professions or other related fields
- students majoring in engineering technology and related fields
- students majoring in other specialized curricula (e.g., fire science, forensic science, auto mechanics)

When fiscal demands necessitate the combination of two or more groups in the same course, the needs of students in any one group are not compromised. However, in some fields, the scheduling or the amount of time and topical coverage devoted to chemistry are so completely determined by the program that it precludes combining groups.

1. Nonscience/nontechnology students

S60 If a chemistry course for nonscience students is offered, it is transferable and includes a laboratory component to satisfy the general education science requirement for graduation. The mathematical requirement will usually be elementary algebra. The goal of the course is to acquaint students with the fundamentals of chemistry, its historical foundations, and its relationship to other sciences, technology, and society.

Typically such courses are interdisciplinary and include a laboratory component.

2. Allied health professions and related occupations

S61 For allied health transfer students (e.g., nursing, physical therapy, home economics) and other related majors that do not require general chemistry, the institution offers a course sequence comparable to that required at the institutions to which most of their students transfer.

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Increasingly, this is a one-year sequence that includes carefully selected topics from general and inorganic chemistry, followed by topics in organic chemistry and biochemistry. Applications to living systems are emphasized. Generally, the first term requires algebra as a prerequisite. This course includes a strong laboratory component.

S62 If the institution has two-year programs in the health professions, there is a minimum of a one-term chemistry course to service these programs. The content of this course is developed in cooperation with the faculty and advisory committees for these occupational programs. Prerequisites for this course are consistent with those of the programs serviced.

3. Engineering technology and related occupations

S63 For institutions with engineering technology programs that require a background in chemistry, there is an appropriate chemistry course offered. The content of this course is developed in cooperation with the faculty and advisory committees for these programs, with prerequisites consistent with those of the programs serviced.

4. Other occupations and special-interest groups

S64 In institutions where occupational programs other than those discussed above (e.g., forensic science, fire science, auto mechanics) or where other departments, local industries, or community special-interest groups have indicated a need for a special chemistry course or program, the college has responded by satisfying the need. Such courses are assigned to the chemistry faculty who develop them in cooperation with the occupational faculty or representatives of the industries or special-interest groups concerned. These courses are either a part of the regular chemistry curriculum or included as the chemistry component in the continuing education, community services, or contract education program of the college.

VII. ADVISING, ARTICULATION, AND ALLIANCES

The quality and success of chemistry programs in two-year colleges is dependent upon articulation with secondary schools, transfer institutions, and local industry. Equally important for articulation is strong coordination and ongoing communication within the two-year college between chemistry faculty and counselors who advise students on course placement, sequencing, transfer options, and career opportunities. Alliances and communication among all these stakeholders enhance student success.

A. Advising

S65 The primary role of the academic advisor, whether a full-time counselor or a faculty advisor, is to assist students in developing educational goals.

ACS encourages two-year colleges to provide information to chemistry students about transfer programs, allowing them to combine a basic chemistry education with studies in other disciplines. For example, a major in chemistry with

supporting work in biology is recognized as a wise program for students planning careers in medicine, dentistry, or pharmacy. In addition, many careers in the chemical industry, government, and other areas are open to graduates who have a good background in chemistry combined with such subjects as computer science, law, economics, environmental science, and library science, as well as history, literature, and philosophy.

S66 Counselors and advisors are not only familiar with the career opportunities for students in transfer programs, but are also familiar with the academic preparation necessary for entry into the various chemistry courses. They encourage students with strong interests and abilities in chemistry to continue their education in chemistry, biochemistry, chemical engineering, or chemical technology.

S67 Counselors and advisors advise transfer students in their selection of chemistry and related courses to ensure that they will coordinate and articulate successfully with those institutions to which they plan to transfer. Students anticipating transfer to a four-year institution are counseled to complete all terms of sequential courses (e.g., the general chemistry sequence and the organic chemistry sequence, as well as other science and mathematics sequences) before transfer.

Counselors and advisors have established clear lines of communication with the chemistry and other science departments of the schools to which students normally transfer, as well as with the broader college articulation offices.

S68 Chemistry faculty and science administrators work closely with counselors to make sure that the information students, faculty, and advisors have is up to date and accurate.

Colleges are encouraged to use discipline-specific counselors and advisors to promote familiarity with chemistry and chemistry-related programs and to facilitate articulation with the four-year colleges and industry.

S69 Colleges have faculty participate in activities that develop their understanding of the chemical industry, the relationship between chemistry and the other disciplines, and the mutual effect of chemistry on technology and society. The faculty can then, in turn, encourage their students to participate in such activities.

These activities include ACS meetings at the national, regional, and local levels, Student Affiliates chapter meetings, other sister society activities, industry internships, cooperative programs, and other experiential learning opportunities.

B. Articulation and Alliances

All chemistry offerings are articulated with all potential transfer institutions on an ongoing basis. This is particularly true where chemistry programs at transfer institutions in a given geographical region are not uniform and when those institutions change their chemistry curriculum. Transfer institutions that are unfamiliar with the two-year college program may not consider the two-year college experience to be equivalent to that of the first

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two years of their institution and may not accept certain courses for transfer. An active articulation program, which is based upon building alliances, linkages, and partnerships among two-year and four-year colleges, is apt to prevent such problems.

Students wishing to acquire American Chemical Society certification as a chemistry major at the completion of the bachelor's degree should be aware of the approved program as outlined in the publication, *Undergraduate Professional Education in Chemistry: Guidelines and Evaluation Procedures.*[5]

Two-year college chemistry transfer programs choosing to match the first two years of an ACS-certified transfer program in chemistry must offer courses that are consistent with the current version of those guidelines for the baccalaureate degrees. At the time of preparation of this publication, the Committee on Professional Training has developed six chemistry degree options: biochemistry, chemical physics, chemistry education, materials, polymers, and environmental chemistry.

Chemical engineering programs are approved by the Accreditation Board for Engineering and Technology, which includes representatives of the American Institute of Chemical Engineers.

S70 The college provides a mechanism for coordinating and communicating to students, faculty, and advisors the terms of articulation agreements between high schools and two-year colleges and two-year colleges and baccalaureate degree programs.

Alliances with high schools that promote either early enrollment at the two-year college or advanced standing for certain high school courses are appropriate ways to recruit students. Agreements with baccalaureate degree programs that specifically describe the courses and performance required for efficient transfer are the keys to student-centered advisement. Bridge programs between two-year and baccalaureate degree programs, such as collaborative faculty projects and group meetings, faculty articulation conferences and workshops, internships in research, and undergraduate research, enrich students and faculty in two-year colleges and increase student retention in the attainment of the baccalaureate degree.

S71 The college works with appropriate faculty and administration of its "feeder" high schools and with other potential sources of students to keep them aware of the curriculum requirements and career potentials for the graduates of its transfer chemistry programs.

S72 The chemistry faculty, administrators, counselors, and advisors are informed of curriculum revision and transfer requirements, curriculum requirements for the occupational programs, and current career opportunities. This information is used when necessary to revise the chemistry courses and sequences and the counseling and advising.

S73 The college conducts regular and detailed follow-up studies of its transfer students and communicates this information, in a timely manner, to the faculty, administrators, counselors, and advisors. These follow-up studies include academic and/or employment data and former students' opinions.

[5]Available from the Committee on Professional Training, American Chemical Society.

S74 The college has sharing agreements with neighboring four-year and two-year institutions and industries, effectively expanding the chemistry offerings, library, laboratory facilities, and expensive instrumentation.

Programs at two-year colleges are strengthened and enriched by the use of resources from other nearby agencies. Second-year and specialized occupational courses especially can be extended and enhanced in this manner. Likewise, availability of research facilities for use by faculty members and independent study students may be increased.

If two or more institutions in the same geographical area are unable to offer a complete two-year college chemistry program individually, they might combine resources and facilities to provide a full, strong two-year chemistry program. Furthermore, such an alliance or partnership could meet the specialized chemistry needs for occupational programs and the general education needs in science for the nonscience students.

S75 The college assists schools in its local area with the enrichment of their chemistry programs.

S76 The college sponsors programs that help promote a favorable image of chemistry among the general public.

Please address comments and questions regarding these *Guidelines* or any other ACS programs, publications, and services to the Office of College Chemistry, American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036 (phone 202-872-4587, or e-mail at education@acs.org).

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