

NOT JUST FOR GRAD SCHOOLS ANYMORE

Undergrad research benefits students and mentors while ensuring a dynamic future for chemistry

EVEN A CURSORY READING OF THE scientific literature reveals how, over the past 125 years, chemists have described a molecular world that is the foundation for advances in nearly every discipline of science and technology. But poring through journals, monographs, and textbooks doesn't bring to light a more subtle revolution: the emergence of undergraduate research as a pedagogical tool that exposes students to exciting developments in chemistry and ensures a bright and dynamic future for our discipline.

The importance of research in undergraduate education is articulated superbly by Shelli Frey, a chemistry major at Haverford College: "Research is the natural complement to traditional class work and should be utilized in undergraduate settings to give the student a more complete understanding of how chemistry works. The student takes general concepts and techniques learned in the classroom and carries them to a research setting, grappling with uncertainty—even failure—and occasionally seeing the ramifications and beauty of chemistry. In the lab, I am a problem solver who asks questions, designs protocols, sets up instruments, records data, and analyzes results."

Undergraduates rely on their research advisers to realize their scientific potential, so our educational system needs committed mentors. To motivate students, we must involve them in every aspect of research, from experimental design to the writing of journal articles. Only then can they regard themselves as contributors to a vibrant and relevant enterprise. If undergraduates are reassured that they can advance scientific knowledge, they will prosper in research. To witness the metamorphosis of a student into a scientist is the greatest reward of mentoring undergraduate research.

The American Chemical Society and several agencies that fund research in

chemistry (including the National Science Foundation [NSF], the National Institutes of Health, the Research Corporation, and the Camille & Henry Dreyfus Foundation) recognize the importance of undergraduate research as both a pedagogical exercise that benefits students and a vehicle for the intellectual development of mentors. Nowhere else is this philosophy more crucial than at undergraduate institutions, where faculty rely almost entirely on under-



AWAKENING Fostering undergraduate research is key to helping students develop their chemical talents, says de Paula, seen here with Shelli Frey, an undergraduate who works in his lab.

graduates to perform research, which is defined in every sector of the scientific community as "a scholarly activity that leads to new knowledge." It makes good sense to support these institutions; they are significant producers of graduates who go on to earn doctorates in science and engineering. For example, 15 undergraduate institutions—including early pioneers in undergraduate research—were among the top 25 institutions ranked according to the proportion of their graduates who earned doctoral degrees in science between 1951 and 1980.

But funding research at undergraduate institutions also brings other rewards. First, the research community becomes more diverse when small, well-equipped undergraduate laboratories contribute to

science. Second, more undergraduates are exposed to research than would be possible if large universities and chemical companies were the only venues for this activity. Finally, vibrant research programs invigorate faculty and students alike, often leading to innovations in the classroom.

All these rewards underscore the importance of supporting research at all academic institutions, including undergraduate schools. However, as important as early introduction to research appears to be for producing new generations of chemists, several challenges face the expansion of undergraduate research programs. NSF's Research Experience for Undergraduates program provides opportunities to many students, but it is impossible for the colleges and universities that participate in the program to provide a research opportunity to every student

because of limits on funding and laboratory space. Thus, it is important to empower more institutions to create undergraduate research programs. Undergraduate institutions can count on advice from such organizations as the Council on Undergraduate Research, which offers conferences and workshops on establishing undergraduate research programs. In cases where institutional resources preclude the implementation of research programs, liaisons with other colleges, universities, and chemical companies can help. Finally, it is imperative that large universities continue to improve their records of providing undergraduates with opportunities to do research.

Teaching and empowering undergraduates through research requires much effort. But research awakens talents that may otherwise remain dormant in students, including those who do not perform well in traditional classroom activities. Helping undergraduates thrive in research—an intense intellectual activity—is an important way in which today's chemists can influence the future of their discipline.

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