Update: Have *BIO2010* Goals Been Achieved?

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Leaders in biology education are celebrating the progress made since the publication of *BIO2010: Transforming Undergraduate Education for Future Research Biologists.* The landmark report, published in 2003 by the National Research Council (NRC), called on institutions of higher education to revamp both the curricula and teaching methods in the life sciences to meet the challenges of the 21st century.

BIO2010 urged much deeper connections between the biological sciences and mathematics, the physical sciences, and computer science. In addition, the report called on faculty to move out of the lecture hall and into the field and lab to help develop hands-on learning and higher-order thinking in their students.

"There's been an incredible response," says John Jungck, vice president of the International Union of Biological Sciences and professor of biology at Beloit College. "One of the real highlights has been the collaboration between mathematicians and biologists in developing courses, majors, labs, and undergraduate research programs."

Claudia Neuhauser, director of graduate studies in biomedical informatics and computational biology and vice chancellor of the University of Minnesota, Rochester, credits *BIO2010* with influencing curricula around the country. "It's viewed as a very critical piece in catalyzing change in biology education," she says. Instead of using lectures to cram all of biology into students' first year, she says, professors more frequently are introducing new students to major themes and better quantitative and critical thinking skills, as *BIO2010* recommended.

New majors have emerged, such as computational biology and bioinformatics. "The flowering of so many of these programs illustrates it's not within traditional disciplines of biology and mathematics but the cross-fertilization that's extraordinarily exciting," says Jungck.

Holly Gaff, chair of the Bio SIGMAA section of the Mathematics Association of America and assistant professor at Old Dominion University, says, "The biggest change is the availability of funds from agencies like NSF [National Science Foundation] and NIH [National Institutes of Health] for math-biology education." With money comes change, she says.

Jungck and Gaff organized a conference at the National Academies of Science in May, "Beyond *BIO2010*," to highlight success stories and look toward the future of biology education (see *http://bioquest.org/beyondbio2010/abstracts/*). Among the outstanding examples:

- At Sweet Briar College, professors of mathematics and biology collaborated on a new biomathematics curriculum.
- Utah State University created a biology and applied mathematics instruction model and uses real-world projects to bring math into the biology lab.
- North Carolina A&T State University, a historically black college, developed campus-wide biomathematics research and training programs to inspire undergraduate students to pursue research careers.
- In California, the five Claremont colleges created an open-ended research program that brings together interdisciplinary teams to tackle math-biology projects in the lab.

BIO2010 spurred a number of other important follow-up initiatives, such as Vision and Change in Undergraduate Biology Education, a 2009 conference that drew 500 faculty and students.

The NSF launched the Undergraduate Biology and Mathematics (UBM) grants program. "The UBM is one of those outcomes from *BIO2010* that has the capability of being expanded in a variety of ways to encourage integrative undergraduate education," says AIBS Board member Lou Gross, professor of ecology and evolutionary biology and mathematics at University of Tennessee, Knoxville, and director of the National Institute for Mathematical and Biological Synthesis (*www.NIMBioS.org*). Through the UBM, small teams of biology and mathematics faculty and students tackle different research projects at their universities. Since 2004, 48 UBM grants, ranging from $173,000 to $905,000, have been awarded.

The NRC launched an annual *BIO2010*-inspired summer institute. "Since 2003 we've been bringing together 40 to 50 faculty from research-intensive universities to spend a week talking about science and education and trying to create a cadre of individuals who are committed and knowledgeable about these issues," says Adam Fagen, senior program officer with the Board on Life Science at the NRC. More than 250 faculty have completed the program, directly affecting 100,000 students each year. Biology education as a distinct discipline has taken off, Fagen adds, and is a fundamental area of scholarship on par with plant or molecular biology.

In the past, an obstacle to transforming biology education has been the Medical College Admissions Test (MCAT). *BIO2010* noted that science departments feel pressure to teach to the test, to the exclusion of other important topics. Here, too, has been progress. In 2009, the Howard Hughes Medical Institute and the Association of American Medical Colleges issued a report, *Scientific Foundations for Future Physicians*, which drew on *BIO2010* recommendations and urged a more interdisciplinary, integrated approach to undergraduate education. The report is expected to influence the questions on the MCAT in coming years.

Despite tangible progress, challenges persist. Departmental silos remain major barriers to creating interdisciplinary study. Most community colleges are not yet on board with new biology curricula and teaching methods. "One of the main challenges is assisting faculty to know what works," Gross says. "The evaluation associated with these initiatives is extremely difficult to establish when you're doing individual kinds of grants, which is mostly what NSF has done."

He and Jungck say what is needed is a broad, well-funded initiative by the NSF for undergraduate biology—just as chemistry, physics, and calculus undergraduate education had. "We need to have a much bigger investment in community colleges and the first two years of undergraduate education at all institutions," Jungck says.

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