EDUCATION

Experts Urge Bold New Undergrad Biology Courses for the 21st Century

Biology 101 must undergo a dramatic shift in its texts, teachers, and testing to prepare all students—not just science majors—for their futures in an increasingly scientific and technological society, experts said at a groundbreaking conference sponsored by the National Science Foundation (NSF) and AAAS.

Rote memorization is the rule in most classes, leaving many students unsure how scientists do their work and unable to evaluate scientific claims. But participants at the Washington, D.C., event offered innovative curricula and a renewed focus to develop these skills in their students.

"Realizing that the status quo in science education is not achieving the results we need, we have to undertake this bold challenge, breathing new life into our classrooms," said NSF Director Arden Bement.

In the field. Students in the NSF Research Experiences for Undergraduates participate in ongoing field studies as part of an innovative science curriculum.

CREDIT: JAMES COTTER/UNIVERSITY OF MINNESOTA MORRIS, COURTESY OF THE NATIONAL SCIENCE FOUNDATION

Tasks like memorizing the parts of a cell "and spitting back the answers on multiple-choice exams" are more common than critical-thinking exercises and hands-on experimentation, said Bruce Alberts, editor-in-chief of the journal *Science*. "It's really taken all the joy and interest out of science education—it's corrupted."

The "Vision & Change in Undergraduate Biology Education" conference, held 15 to 17 July, marked the midpoint of an intensive 3-year effort by AAAS's Education and Human Resources unit and NSF. In 2006, the organizations held a series of conversations with more than 200 faculty members, administrators, and undergraduate students, seeking input on how to improve the curriculum.

The conversations formed the basis for this summer's conference, which drew 500 faculty members, education administrators, and policy-makers to discuss how to rebuild biology education into a pursuit as vibrant and relevant as the science itself. "Right now, the biology we teach does not reflect the biology we do," said Felicia Keesing, an associate professor of biology at Bard College.

Students want to know more about the connections and the applications of the science they learn, and they prefer interactive teaching methods. But for the most part, the current textbooks and testing regimes thwart this type of learning, Keesing said.

In plenary speeches and smaller working groups, the conference participants outlined the essential elements of a 21st-century biology course: hands-on research programs, more technology in the classroom, student-centered presentations and opportunities for teaching others, and communities of professors and students working on collaborative, often international projects.

Biology faculty should be prepared to expand and update their own education to accomplish these goals, said Carol Brewer, a conference co-chair and associate dean at the College of Arts and Science at the University of Montana. "Teaching methods should be as innovative as the science taught in class," she noted.

Alan I. Leshner, conference co-chair and AAAS CEO, said the conference was among the most important in his 30 years in Washington, D.C. But he cautioned the participants to be wary of solutions that might only support a scientific workforce while leaving behind most undergraduates. Leshner, who is also the executive publisher of *Science*, said all citizens need to understand how researchers work in order to make informed decisions in a world where "science is assuming a near-omnipresent role."

Alberts and others pointed to the findings of a July survey by the Pew Research Center for the People & the Press and AAAS as a sign of how undergraduate biology education may be falling short. The survey's results, which found significant divergence in how scientists and the public view the research on climate change and evolution, "struck me as a symptom of our striking failure" to share how scientific knowledge is developed and evaluated, said Alberts.

—Benjamin Somers and Becky Ham

AAAS PACIFIC DIVISION

San Francisco Bay: The Coming Flood?

SAN FRANCISCO—Humans have had a disruptive impact on San Francisco Bay since the days of the Gold Rush, with mining sediment, development, and industrial waste tainting waters and harming wildlife throughout the famous estuary. But now Bay researchers see the potential for human-caused change on an unprecedented scale as a result of the warming climate.

At the annual meeting of the AAAS Pacific Division here, top Bay experts detailed the current and future impacts of climate change on the complex Bay ecosystem, from the high peaks of the Sierra Nevada to the coastline outside the Golden Gate. The most pervasive threat, they said, could come from rising seas, with some models predicting Bay levels could rise by up to 140 centimeters (about 55 inches) by the end of the century.

That could inundate low-lying urban areas, including international airports in San Francisco and Oakland, and submerge tidal marshes that are essential to the Bay's health. And with water levels already 20 to 30

Published by AAAS

Rising waters. Research by the U.S. Geological Survey and others shows that if water levels in the San Francisco Bay rise 140 cm by 2100, as some models predict, thousands of acres of tidal marsh and developed land (in blue) would be vulnerable to inundation.

cm higher than a century ago and a storm-spawning El Niño system emerging in the Pacific, this winter could foreshadow trouble ahead.

"Sea-level rise during the next El Niño could provide a preview of what sea level in the Bay will look like in the future," said Dan Hanes, a U.S. Geological Survey (USGS) oceanographer and former professor of civil and coastal engineering at the University of Florida. "If there is a storm coincident with high tides anytime during an El Niño winter, there will be significant flooding in the region."

The AAAS Pacific Division's 90th annual meeting, from 14 to 19 August at the California Academy of Sciences and San Francisco State University, drew more than 475 scientists, engineers, teachers, students, journalists, and others. Marking the 150th anniversary of Charles Darwin's *On the Origin of Species*, the meeting focused on how nature changes through evolution and how humans must build a sustainable relationship with nature to ensure the future health of all life.

But the events at the meeting included a diverse range of issues: the search on Earth and beyond for "weird life," or life that does not share a biochemical heritage with known plants and creatures; project-based science learning; recent advances in pharmacology and toxicology; and communicating science to the public.

The AAAS Pacific Division, with 30,000 members, has long focused attention on the San Francisco Bay. In 1977, 1980, and 1994, the division held symposia on the estuary and produced reports that still provide valuable insight to today's researchers. This year, at a day-long symposium, more than a dozen researchers from universities, government agencies, and nongovernmental organizations depicted the Bay as dynamic and resilient, but under extraordinary stress.

Great progress has been made in reducing sewage discharges and the concentrations of many heavy metals, said Jay A. Davis, an environmental scientist at the San Francisco Estuary Institute. But mercury, dioxin, and polychlorinated biphenyls (PCBs) remain problems, and brominated fire retardants (PBDEs) have been found in Bay food webs at concentrations not seen elsewhere in the world, Davis said.

Tidal marshes and wildlife such as the endangered California Clapper Rail are slowly rebounding. At the same time, though, more than 250 invasive species—cordgrass, kelp, and clams, even goldfish and catfish—are establishing the Bay as "among the most invaded estuaries in the world," said Edwin Grosholz, a benthic ecologist at the University of California-Davis.

Climate change could compound such problems by stirring up Bay-floor sediment that contains toxicants and by making the Bay more hospitable to other invaders. And those, researchers said, are just some of the problems posed by the changing climate.

Noah Knowles, a USGS research hydrologist, explained that Bay waters could turn more salty if less precipitation falls in the Sierra Nevada as predicted by some climate models. More ominously, Knowles said that if Bay levels rise by a projected 50 to 140 cm, the threat to developed areas might compel policy-makers to consider improving existing protective levees and building new ones—at a cost of billions of dollars.

Outside the Golden Gate, Hanes reported, the reduced flow of sediment from the Bay may be related to the shrinking size of the Ebb Tide Delta, a radial-shaped underwater ridge that protects the coast. The shrinking ridge, combined with rising seas and bigger Pacific waves, may be contributing to significant, damaging coastal erosion.

CREDIT: SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

SCIENCE POLICY

New AAAS Database Could Aid Voting Reform

With concerns persisting about the function—and malfunction—of the U.S. voting system, AAAS has launched the nation's first Web-based, searchable database that provides access to a broad range of voting-related research.

The project will give researchers, election administrators, journalists, and others fast, free access to studies on issues ranging from voting technology and ballot design to voter behavior and impediments to voting. The database debuted with about 500 entries and is expected to grow considerably.

Worries about the voting system emerged after problem-plagued elections in 2000 and 2006. The National Science Foundation and AAAS convened scholars, election administrators, and others for a workshop in 2004; the Carnegie Corporation of New York and AAAS held another in 2006. Plans for a database emerged from those talks, said Mark S. Frankel, director of the AAAS Scientific Freedom, Responsibility and Law Program.

"There is a growing consensus in America that improvements to the election process are very much needed," said Frankel, who oversees the database. "More research and greater understanding of the U.S. voting system are imperative in order to implement effective changes."

Find the AAAS Research Database on the U.S. Voting System and Voting Technology at http://votingtech.aaas.org.

SCIENCE & SCHOOLS

Oregon Teacher Wins AAAS Education Prize

Michael Lampert, a physics teacher in Salem, Oregon, is the winner of the 2009 AAAS Leadership in Science Education Prize for High School Teachers.

The West Salem High School teacher, a former doctoral candidate in atomic physics, is a 20-year veteran who has transformed his classroom into a center of innovative teaching techniques. But one initiative set him apart: He trained his high school students to teach science to second graders, with the lessons based on state standards for science education. The prize committee praised that project as "the essence of good teaching."

In its third year, the AAAS Leadership in Science Education Prize for High School Teachers, supported by AAAS Fellow Edith Neimark, recognizes a high school teacher who has contributed significantly to the AAAS goal of advancing science education by developing an innovative and effective classroom strategy, activity, or program.

—Molly McElroy and Becky Ham

ELECTIONS

AAAS Annual Election: Preliminary Announcement

The 2009 AAAS election of general and section officers will be held in November. All members will receive a ballot for election of the president-elect, members of the Board of Directors, and members of the Committee on Nominations. Members registered in more than one section will receive ballots for elections for each section they are enrolled in.

Candidates for all offices are listed below. Additional names may be placed in nomination for any office by petition submitted to the Chief Executive Officer no later than October 26. Petitions nominating candidates for president-elect, members of the Board, or members of the Committee on Nominations must bear the signatures of at least 100 members of the Association. Petitions nominating candidates for any section office must bear the signatures of at least 50 members of the section. A petition to place an additional name in nomination for any office must be accompanied by the nominee's curriculum vitae and statement of acceptance of nomination. Biographical information for the following candidates will be enclosed with the ballots mailed to members in October.

Slate of Candidates

GENERAL ELECTION

President: Nina V. Fedoroff, U.S. Dept. of State; Alice P. Gast, Lehigh Univ.

Board of Directors: Roger N. Beachy, Donald Danforth Plant Sciences Ctr.; Stephen Mayo, California Institute of Technology; Susan Rosser, San Francisco State Univ.; Kenneth Prewitt, Columbia Univ.

Committee on Nominations: James McCarthy, Harvard Univ.; Pamela Bjorkman, California Institute of Technology; Diana H. Wall, NREL, Colorado State Univ.; Vinayak P. Dravid, Northwestern Univ.; Maxine Singer, Carnegie Institution for Science; Barbara Schaal, Washington Univ.; Tom Lovejoy, The Heinz Ctr.; Eric Barron, National Ctr. for Atmospheric Research

SECTION ELECTIONS

Agriculture, Food, and Renewable Resources

Chair Elect: Charles Arntzen, Arizona State Univ.; Eugene Nester, Univ. of Washington

Member-at-Large of the Section Committee: Jan Leach, Colorado State Univ.; Ken Moore, Iowa State Univ.

Electorate Nominating Committee: Ian Pepper, Univ. of Arizona; Shauna Somerville, Univ. of California, Berkeley; Jean Steiner, USDA-ARS Grazinglands Research Laboratory; Eleanore Wurtzel, Lehman College

Anthropology

Chair Elect: Cynthia Beall, Case Western Reserve Univ.; Dean Falk, Florida State Univ.

Member-at-Large of the Section Committee: Susan Antón, New York Univ.; Nina Jablonski, Pennsylvania State Univ.

Electorate Nominating Committee: Thomas Greiner, Univ. of Wisconsin, LaCrosse; Stephen Leigh, Univ. of Illinois, Urbana-Champaign; Jim McKenna, Univ. of Notre Dame; Kathleen O'Connor, Univ. of Washington

Council Delegate: Paul Leslie, Univ. of North Carolina, Chapel Hill; Pat Shipman, Pennsylvania State Univ.

Astronomy

Chair Elect: John Huchra, Harvard Univ.; Meg Urry, Yale Univ.

Member-at-Large of the Section Committee: Kevin Marvel, American Astronomical Society; Margaret Meixner, Space Telescope Science Institute

Electorate Nominating Committee: Giuseppina "Pepi" Fabbiano, Harvard Univ.; Jay Gallagher, Univ. of Wisconsin-Madison; Loren Acton, Montana State Univ.; Jay Pasachoff, Williams College

Council Delegate: Lori Allen, National Optical Astronomy Observatory; Tammy Smecker-Hane, Univ. of California, Irvine

Atmospheric and Hydrospheric Sciences

Chair Elect: Nominees to be announced

Member-at-Large of the Section Committee: Nominees to be announced

Electorate Nominating Committee: Nominees to be announced

Biological Sciences

Chair Elect: Kevin Struhl, Harvard Univ.; Mary Lou Guerinot, Dartmouth College

Member-at-Large of the Section Committee: Loren Rieseberg, Univ. of British Columbia; Peter Burgers, Washington Univ., St. Louis

Electorate Nominating Committee: Charles Aquadro, Cornell Univ.; Teresa Wang, Stanford Univ.; Jennifer Stone, Univ. of Massachusetts; Chris Amemiya, Benaroya Research Institute

Council Delegate: William Lucas, Univ. of California, Davis; Erin Irish, Univ. of Iowa; Susan Wessler, Univ. of Georgia; Rick Harrison, Cornell Univ.; Lynn Cooley, Yale Univ.; James S. Clegg, Univ. of California, Davis; Robb Krumlauf, Stowers Institute for Medical Research; James Marrs, Indiana Univ.; Peter Santi, Univ. of Minnesota; Eric Shelden, Washington State Univ.; Marc Feldman, Stanford Univ.; Anindya Dutta, Univ. of Virginia; David Gilbert, Florida State Univ.; Mosur Raghuraman, Washington State Univ.; Nancy Walworth, Univ. of Medicine and Dentistry of New Jersey; Bonnie Bartel, Rice Univ.; Ronald Hoy, Cornell Univ.; Victor D. Vacquier, Univ. of California, San Diego

Chemistry

Chair Elect: Nominees to be announced

Member-at-Large of the Section Committee: Nominees to be announced

Electorate Nominating Committee: Nominees to be announced

Dentistry and Oral Health Sciences

Chair Elect: Gary Armitage, Univ. of California, San Francisco; Nominee to be announced

Member-at-Large of the Section Committee: Kenneth Yamada, National Institutes of Health; Richard Lamont, Univ. of Florida

Electorate Nominating Committee: Dennis Mangan, Univ. of Southern California; Anne George, Univ. of Illinois, Chicago; Mina Mina, Univ. of Connecticut Health Ctr.; Mark Lingen, Univ. of Chicago

Education

Chair Elect: Judith Ramaley, Winona State Univ.; Elizabeth Stage, Univ. of California, Berkeley

Member-at-Large of the Section Committee:

Published by AAAS

Sean Decatur, Oberlin College; Carlos Gutiérrez, California State Univ., Los Angeles
Electorate Nominating Committee: Rainer Glaser, Univ. of Missouri; Thomas Higgins, Harold Washington College; Patricia Mabrouk, Northeastern Univ.; Marilyn Suiter, National Science Foundation

Engineering
Chair Elect: H. Vincent Poor, Princeton Univ.; Ibrahim Hajj, American Univ. of Beirut
Member-at-Large of the Section Committee: Gary May, Georgia Institute of Technology; Braden Allenby, Arizona State Univ.
Electorate Nominating Committee: Rao Surampalli, U.S. Environmental Protection Agency; Dereje Agonafer, Univ. of Texas; Cynthia Bruckner-Lea, Pacific Northwest National Laboratory; Richard Alkire, Univ. of Illinois, Urbana-Champaign

General Interest in Science and Engineering
Chair Elect: Linda Trocki, Consultant; Judith E. Parker, Consultant
Member-at-Large of the Section Committee: Mary Mead Hammond, Carlson, Hammond & Paddock, LLC; Joan Horvath, Takeoff Technologies, LLC; Michael Isaacson, Univ. of California, Santa Cruz; James O'Brien, Tidewater Community College
Electorate Nominating Committee: Don Jordan, Univ. of South Carolina; Bassam Shakhashiri, Univ. of Wisconsin-Madison; Peter Farnham, American Society for Biochemistry and Molecular Biology; Deborah Illman, Univ. of Washington

Geology and Geography
Chair Elect: Patrick Bartlein, Univ. of Oregon; Ellen Mosley-Thompson, Ohio State Univ.
Member-at-Large of the Section Committee: Thomas Cronin, U.S. Geological Survey; Feng Sheng Hu, Univ. of Illinois, Urbana-Champaign
Electorate Nominating Committee: Susan Cutter, Univ. of South Carolina; George Malanson, Univ. of Iowa; Bruce Molnia, U.S. Geological Survey; Henry Pollack, Univ. of Michigan
Council Delegate: Thomas C. Johnson, Univ. of Minnesota; Douglas J. Sherman, Texas A&M Univ.

History and Philosophy of Science
Chair Elect: Jane Maienschein, Arizona State Univ.; Jeffrey L. Sturchio, Consultant
Member-at-Large of the Section Committee: Sally Gregory Kohlstedt, Univ. of Minnesota; Fae Korsmo, National Science Foundation
Electorate Nominating Committee: Ron Amundson, Univ. of Hawaii, Hilo; David Hounshell, Carnegie Mellon Univ.; Jay Malone, Univ. of Florida; Audra Wolfe, Chemical Heritage Foundation

Industrial Science and Technology
Chair Elect: Nominees to be announced
Member-at-Large of the Section Committee: Nominees to be announced
Electorate Nominating Committee: Nominees to be announced

Information, Computing, and Communication
Chair Elect: Nominees to be announced
Member-at-Large of the Section Committee: Nominees to be announced
Electorate Nominating Committee: Nominees to be announced

Linguistics and Language Science
Chair Elect: Barbara Abbott, Michigan State Univ.; Mark Liberman, Univ. of Pennsylvania
Member-at-Large of the Section Committee: Jennifer Cole, Univ. of Illinois, Urbana-Champaign; Andrea Levitt, Wellesley College
Electorate Nominating Committee: Nominees to be announced

Mathematics
Chair Elect: John Ewing, Math for America; Donald Saari, Univ. of California, Irvine
Member-at-Large of the Section Committee: Mary Ellen Bock, Purdue Univ.; De Witt Sumners, Florida State Univ.
Electorate Nominating Committee: Carl Cowen, Purdue Univ.; James Donaldson, Howard Univ.; Wade Ellis, West Valley College; Robert Megginson, Univ. of Michigan
Council Delegate: Philippe Tondeur, Univ. of Illinois, Urbana-Champaign; Michel Lapidus, Univ. of California, Riverside

Medical Sciences
Chair Elect: Edward Benz, Harvard Univ.; Charles M. Rice, Rockefeller Univ.
Member-at-Large of the Section Committee: Harriet Robinson, Emory Univ.; Peter Palese, Mt. Sinai School of Medicine
Electorate Nominating Committee: Dan Longo, NIA/NIH; Larry Corey, Univ. of Washington; Ruth Ruprecht, Dana Farber Cancer Institute; Lisa Guay-Woodford, Univ. of Alabama

Neuroscience
Chair Elect: Bernice Grafstein, Weill Cornell Medical College; Howard Eichenbaum, Boston Univ.
Member-at-Large of the Section Committee: Don Cleveland, Univ. of California, San Diego; Lynn Nadel, Univ. of Arizona
Electorate Nominating Committee: Charles Glabe, Univ. of California, Irvine; Michael E. Greenberg, Harvard Medical School; Earl Miller, Massachusetts Institute of Technology; Phyllis Wise, Univ. of Washington
Council Delegate: Amita Sehgal, Univ. of Pennsylvania; Diana Woodruff-Pak, Temple Univ.

Pharmaceutical Science
Chair Elect: Stuart Feldman, Touro College; John Slattery, Univ. of Washington
Member-at-Large of the Section Committee: Ah-Ng "Tony" Kong, Rutgers Univ.; Uday Kompella, Univ. of Colorado
Electorate Nominating Committee: Michael Mayersohn, Univ. of Arizona; Jashvant Unadkat, Univ. of Washington; Murali Ramanathan, SUNY, Buffalo; David Ross, Univ. of Colorado

Physics
Chair Elect: William Zajc, Columbia Univ.; Eric Heller, Harvard Univ.; J. Murray Gibson, Argonne National Laboratory
Member-at-Large of the Section Committee: Sekazi Mtingwa, Massachusetts Institute of Technology; Jolie Cizewski, Rutgers Univ.
Electorate Nominating Committee: S. Jim Allen, Univ. of California, Santa Barbara; B. Lee Roberts, Boston Univ.; Thomas Glasmacher, Michigan State Univ.; Katharine Gebbie, National Institute of Standards and Technology
Council Delegate: John Negele, Massachusetts Institute of Technology; Joe Hamilton, Vanderbilt Univ.; Robert Beichner, North Carolina State Univ.; Pierre Meystre, Univ. of Arizona; David Gross, Univ. of California, Santa Barbara

Psychology
Chair Elect: John Cacioppo, Univ. of Chicago; Nora Newcombe, Temple Univ.
Member-at-Large of the Section Committee: Jocelyne Bachevalier, Emory Univ.; Sue Carter, Univ. of Illinois, Chicago
Electorate Nominating Committee: Joe Martinez, Univ. of Texas; Janet Werker, Univ. of British Columbia; Sheri Berenbaum, Pennsylvania State Univ.; Hill Goldsmith, Univ. of Wisconsin

Social, Economic, and Political Sciences
Chair Elect: Kenneth Bollen, Univ. of North Carolina; Arthur Lupia, Univ. of Michigan
Member-at-Large of the Section Committee: Julia Lane, National Science Foundation; Walter Mebane, Univ. of Michigan
Electorate Nominating Committee: Edward Carmines, Indiana Univ.; David Collier, Univ. of California, Berkeley; Edward Lazear, Stanford Univ.; Nancy Lewis, East-West Ctr.

Societal Impacts of Science and Engineering
Chair Elect: Nominees to be announced
Member-at-Large of the Section Committee: Nominees to be announced
Electorate Nominating Committee: Nominees to be announced

Statistics
Chair Elect: Tom Louis, John Hopkins Univ.; Jessica Utts, Univ. of California, Irvine
Member-at-Large of the Section Committee: M. Elizabeth Halloran, Univ. of Washington; Stanley Lemeshow, Ohio State Univ.
Electorate Nominating Committee: Marie Davidian, North Carolina State Univ.; Nick Jewell, Univ. of California, Berkeley; Ed Korn, NCI/NIH; Javier Rojo, Rice Univ.

AAAS News and Notes

Science **325** (5948), 1637-1640.
DOI: 10.1126/science.325_1637