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American Society for Biochemistry and Molecular Biology

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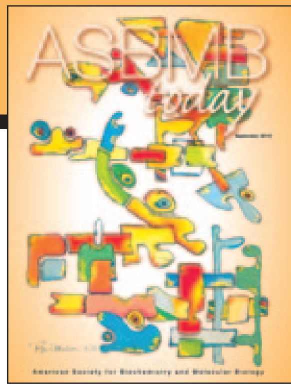

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president's message

Too Many Ph.D. Trainees?

BY SUZANNE PFEFFER

This year, overall biomedical research funding is sadly flat, and university growth has reached a plateau. State budgets are in crisis, and university endowments are still recovering from deep losses suffered during the economic downturn. Given the current circumstances, it would be impossible for all of our current Ph.D. students to move on to academic positions. In this respect, what might be viewed as good news is the fact that a large proportion of our graduate students apparently don't want to pursue academic positions (1). But current circumstances have led some to suggest that we are training too many Ph.D. graduate students (2). Are we?

By definition, a Ph.D. is awarded to a scholar who has demonstrated expert command of his or her chosen field and contributed original and publishable research findings in that area. Graduate students are important contributors to the discoveries made in most of our laboratories, and they are invaluable participants in the current research enterprise worldwide. Moreover, having mastered graduate-level courses and passing qualifying examinations, Ph.D. biochemists and molecular biologists have acquired a broad range of expertise. Graduates also learn how to write papers, how to present their work orally, how to work as part of a team and, most importantly, how to use data to solve problems analytically. There is a continuing need to train a scientifically educated cadre that can contribute to our society at the highest level, as teachers, writers, policy analysts, consultants, lawyers and, of course, research scientists.

Given that most of our graduates will not pursue academic careers, why don't our training programs acknowledge that fact adequately and inform students about career options at the outset of graduate training? Are we doing enough to give students teaching experience or asking our colleagues in biotech what we should add to our curricula to better train their future employees? Are our annual job fairs sufficient, or should our programs add more alumni visits and panel discussions? And, if a student wants to become a teacher or patent lawyer, why should a Ph.D. require longer than four years? A Ph.D. metric of two first-author papers is not unusual at many institutions but harder than ever to achieve. Publishing papers seems to have become a lot more difficult in recent years, in part because we can do so much more, more readily, and referees can ask for more as well. But separate from the challenges of publication, the time to degree issue is not being addressed adequately. (I will return to this topic in a future column.)

My colleague Paul Berg notes, "We convey the message that Ph.D. students should aim high in their ambitions and, for the right students, that's a wonderful challenge. But, if you now admit students whose ambitions lean toward nonacademic careers, the goals of a major research contribution and two first-author papers in a high-impact journal are totally unrealistic. One thought is to encourage students to craft a first proposal that explores a problem related to possible career choice: analyze a Business School case study of an interesting biotech company or a study of some particular education experiment or even examine the basis for a prominent patent infringement case and follow the legal outcome and ramifications." Sounds to me like a wonderful idea for an elective course to offer year one or year two Ph.D. students.

Another challenge to offering broader graduate student training experiences relates to the mechanisms by which we fund graduate study. Today, most graduate students are supported by research grants to individual investigators and by federally funded training grants. National Institutes of Health training grants were designed "to prepare qualified individuals for careers that have a significant impact on the health-related research needs of the Nation." Optimally, it would be great for students to include a year of teaching or public policy or biotech as part of a training experience. But that can't be justified with NIH grant support to a specific research project, or by most (but not all) predoctoral training programs. National Science Foundation graduate fellowships are more flexible, in that they permit recipients to acquire additional skills that will "more broadly prepare them for professional and scientific careers." Unfortunately, not enough of our students are funded by this mechanism. Indeed, fellowships to cover one-year (post-Ph.D.) science teacher training or public policy internships would go a long way to support our graduates in post degree transitions.

In an important and eloquent recent letter to the Wall Street Journal (July 9, 2010), Dr. John Lechleiter, chairman, president and CEO of Eli Lilly and Company, highlighted America's growing innovation gap. "Unfortunately, America's economy is in danger of losing what has always been our greatest competitive advantage: our genius for innovation…" Lechleiter noted that the U.S. is sixth among the top 40 industrialized nations in terms of innovative competitiveness, but 40th out of 40 in terms of the "rate of change in innovation capacity" over the past decade. We also ranked last in terms of what we as a nation are doing to combat this trend. "Human beings — with their talent and energy, creativity and insights — are a priceless resource, but one that is woefully underdeveloped in this country… With our kids falling further behind on international comparisons in education, we've got to get serious about broad improvement in science and math instruction in our grade schools and high schools," he wrote.

Similar conclusions were reached in 2007 by the National Academy of Sciences Committee on Prospering in the Global Economy of the 21st Century, in their report, "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future" (3). The committee was charged by Congress to address two questions: What are the top 10 actions that federal policymakers could take to enhance the science and technology enterprise so that the United States successfully can compete, prosper and be secure in the global community of the 21st century; and, what implementation strategy could be used for each of those actions? The committee's highest priority recommendations include a proposal designed to increase America's talent pool by vastly improving K-12 science and mathematics education. They proposed to recruit 10,000 science and mathematics teachers annually by awarding four-year scholarships and, "thereby educating 10 million minds." We obviously need more qualified science teachers, and many of our Ph.D. graduates would be wonderful in these roles.

Curriculum development also is important, and, earlier this year, the Howard Hughes Medical Institute awarded $70 million to 50 research universities to "develop creative, research-based courses and curricula; to give more students vital experience working in the lab and to improve science teaching from elementary school through college." Another approach, taken by the Gordon and Betty Moore Foundation, supports science technology museums, notably "innovative programs and exhibits that will measurably increase scientific awareness and critical inquiry… including professional development for teachers." Even the professional golfer Phil Mickelson has teamed up with ExxonMobil to create a Teachers Academy whose mission is to enhance third through fifth grade math and science education.

American Society for Biochemistry and Molecular Biology members are active in K-12 educational activities and ASBMB's Education and Professional Development Committee's mission includes providing resources and direction for K-12 education. Perhaps we should be doing more to nurture the science teachers of the future. Should ASBMB be sponsoring enrichment programs for teachers to spend summers working in

ASBMB member labs? Should our annual meeting include sessions on biochemistry and molecular biology curriculum development for teachers? It already has been suggested that ASBMB offer one-day registration to enable local teachers to attend at least part of our annual meeting, and we certainly can consider scholarships for local teacher participation. We aren't the "American Society for Science Teachers," but we do have an obligation to educate our youth, support K-12 teachers and maintain the pipeline for outstanding scientists for the decades ahead. Why aren't more biochemistry departments offering joint degrees that enable students to earn a master's degree in education (and teaching credential) co-terminal with a Ph.D.? We can help and encourage students to consider careers in teaching, where they can make a profound difference in educating scientists of the future and in developing an educated and sympathetic public. Lechleiter noted that innovation leadership requires "a society that understands and appreciates scientific inquiry." This can start with our K-12 teachers.

There always will be individuals with a burning desire to do research who are willing to chance the perils of academia. It is our obligation to provide these trainees with the opportunity and encouragement to reach their goals. Ph.D.-trained scientists can make invaluable contributions to our society beyond academia, and I feel strongly that the scientific community should not decrease the number of graduate students we are training right now. This approach comes with added responsibility: We must all do much more to prepare students for, and inform them about, the wide variety of positions that await them.

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1. Alberts, B. (2008) Hybrid Vigor in Science. *Science* **320**, 155.
2. Benderley, B .L. (June 14, 2010) The Real Science Gap. Miller-McCune.
3. National Academies of Science (2007) Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. National Academies Press.

For more information:

- The Howard Hughes Medical Institute education awards: http://bit.ly/aRjTwM
- The Gordon and Betty Moore Foundation: http://bit.ly/6uUBP0
- Mickelson ExxonMobil Teachers Academy: http://bit.ly/auN6Ls

Education videocast

Go to ASBMB Today online (www.asbmb.org/asbmbtoday) to see a videocast interview in which Suzanne Pfeffer talks more about education.

The STEM of the Problem

KYLE M. BROWN AND GEOFFREY HUNT

There is growing concern that American education in science, technology, engineering and math — known as STEM — is coming up short. Worried about the long-term health of the American economy, industry leaders recently testified before a congressional committee that American students are not prepared adequately for careers in STEM disciplines (see "Renewing America COMPETES" in the April 2010 issue of ASBMB Today). Equally troubling, a recent Pew Center poll found that less than half of all Americans believe in evolution, and two out of three do not see global warming as an immediate threat.

Responding to these concerns, the U.S. Congress and the Obama administration have developed new programs to bolster STEM education. Previous efforts have lacked adequate momentum to get started; will new programs receive the support they need to succeed?

Clouds on the Horizon

In its 2005 report, "Rising above the Gathering Storm," the National Academies painted a troubling picture of the future of America's economic vitality. The report noted that years of declining educational proficiency in STEM subjects was leading to the erosion of American competitiveness.

To reverse the trends, the Academies recommended making STEM education improvement a core policy theme.

Failure to COMPETE

Specifically responding to the recommendations of the Academies, and building on then-President Bush's American Competitiveness Initiative, Congress passed the America COMPETES act in 2007.

COMPETES created or restructured a large number of STEM education programs focused on kindergarten through the 12th grade. Based on the recommendation of the Academies, COMPETES authorized the U.S. Department of Education to fund university programs focused on K-12 STEM teacher training at both the bachelor's and master's degree levels. The department also was authorized to give grants to states and local school boards to expand Advanced Placement and International Baccalaureate programs.

But, the ambitious programs set forth in COMPETES have failed to become a congressional priority. In 2008, an Academies panel reviewed the country's response to "Rising Above." The panel found that several initiatives authorized by COMPETES, including those for teacher training, lacked adequate funding, leaving many programs unfunded and others struggling for existence. Meanwhile, the United States continues to fall behind other countries in terms of both undergraduate and graduate STEM degrees, according to the 2010 version of Science and Engineering Indicators released by the National Science Foundation.

New Efforts

Despite a difficult budgetary situation, many in the U.S. Congress, the administration and elsewhere continue to work to improve STEM education.

Earlier this year, the National Academies Board on Science Education released a preliminary report that attempts to install a new national framework for K-12 science education, with hopes of revising and normalizing current standards and benchmarks used by educators, to raise the level of knowledge attained at each grade. The report aims to shift the disjointed, compartmentalized approach to science pedagogy currently in use to a cohesive agenda that will allow for a continual development of scientific knowledge on a yearly basis.

Furthermore, President Obama has made education a priority. Reflecting the momentum this issue has gained over the past decade, the U.S. Department of Education recently has awarded funds to the Smithsonian Institution to promote science education in school districts nationwide. In addition, the White House's "Educate to Innovate" campaign is aimed at expanding STEM literacy through awareness and programs outside of the classroom. Meanwhile, the president has encouraged states applying for funds from his "Race to the Top" initiative to increase focus on science education in their proposals.

Even as securing adequate funding for STEM education programs increasingly is in doubt, the full U.S. House of Representatives and a U.S. Senate committee have approved versions of a renewal of COMPETES. Current versions of COMPETES call for the White House's Office

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Congress Adjourns until Fall with Most Appropriations Bills Unfinished

BY PETER FARNHAM

Once more, the U.S. Congress heads into its traditional August recess with work unfinished on almost all regular appropriations bills – an event so commonplace for so many years that it has become the new norm, as predictable as the notorious Washington, D.C. humidity that Congress leaves each August to escape.

As of mid-August, the U.S. Senate Appropriations Committee has approved nine of 12 appropriation bills, but none have reached the Senate floor. The U.S. House of Representatives has passed two bills, and another nine have been approved by the relevant appropriations subcommittee.

Senate Approves $1 Billion Increase for NIH

On July 29, the U.S. Senate Appropriations committee approved the U.S. Departments of Labor, Health and Human Services, and Education and Related Agencies Appropriations Act, 2011 (S.3686), funding the agency at an overall level of $77.6 billion in discretionary funding. The National Institutes of Health would receive $32.0 billion, which was the President's request; this is $1.0 billion more than NIH received in fiscal year 2010, a 3.2 percent increase (approximately the rate of biomedical inflation). This funding level results in an estimated $31.4 billion in research and development investment at NIH.

Sen. Arlen Specter, D-Penn., offered an amendment during the markup to increase the NIH budget by an additional $1 billion, but the amendment failed. Committee chairman Tom Harkin, D-Iowa, expressed sympathy for the amendment, but the committee simply did not have enough money to fund the amendment. He also noted that a great deal of the stimulus money approved for NIH last year ($10 billion) had not been spent, which should cushion the impact of no real growth at NIH in 2011.

The Senate committee report includes language related to a number of American Society for Biochemistry and Molecular Biology and other Federation of American Societies for Experimental Biology society concerns:

- **Cures Acceleration Network:** Fifty million dollars goes to the Office of the Director. The report notes that the committee hopes to fund CAN at higher levels in future years, but that that there will be limited time in fiscal year 2011 to award grants because of start-up issues like establishing the review board. (ASBMB Today readers will remember that this proposal, offered by Specter, was adopted last year during the final debate on the health care reform bill.)
- **The Funding "Cliff":** This term refers to the drop-off of funds available for supporting research at NIH when the additional $10 billion in stimulus money no longer is available. The report notes that the softest possible landing is critical to maintaining the scientific momentum gained over the past two years and to ensuring that young investigators have a bright future in biomedical research. The report also notes that the committee "hopes that this will mark the first of several years of growth for the NIH that, if not spectacular, are at least steady and predictable." (Again, the term "growth" is a debatable word choice, since the 3.2 percent increase barely keeps up with biomedical inflation.)
- **Basic Research:** The report includes the following statement: "The Committee believes that basic biomedical research should remain a key component of both the intramural and extramural research portfolio at NIH."
- **Career Development Awards:** The report notes that the committee supports the preservation of K-Awards as a critical training mechanism.
- **Clinical and Translational Science Awards Program:** The report notes that the committee "strongly supports the CTSA program" and "believes that stronger involvement from all 27 ICs would help the program reach its full potential." The report requests that "the Director consider developing a formal, NIH-wide plan on how to align the CTSAs with the programmatic and funding priorities of the ICs."

House L/HHS Action

The U.S. House Labor, Health and Human Services, Education and Related Agencies Appropriations Subcommittee approved its version of the bill on July 15. The House version provides $77.5 billion in discretionary funds for the HHS, $189 million (0.2 percent) less than the request. NIH would receive the same as in the Senate bill, $32.0 billion.

Unfortunately, report language accompanying the bill will not be made available until after the full House Appropriations Committee considers the bill. (Bill language usually is written at the subcommittee level.) There is no indication as to when the bill will go to the full committee. However, neither the House nor Senate bills will go to their respective floors before the November elections. Look for continuing resolutions after Congress returns in September.

NSF Fares Somewhat Better than NIH

The U.S. Senate Appropriations Committee approved the Commerce, Justice, Science and Related Agencies Appropriations Act, 2011 (S.3636) on July 22. The bill includes $7.35 billion for the National Science Foundation, $71 million (1.0 percent) less than the President's request. This translates to a 7.2 percent increase.

In contrast, the U.S. House Commerce, Justice, and Science Appropriations Subcommittee met the President's request of $7.42 billion for the NSF when it approved its version of the bill on June 29. The House bill also provides the NSF education budget with a $66 million increase over the President's request. If the increase holds, it would be the second year in a row that Congress has increased the NSF education budget. The Senate bill does not provide an increase over the request, but it does deny the request to merge a number of broadening participation programs into a single program, citing different purposes and methods of engaging students and colleges.

A Look Ahead

It is highly likely that there will not be floor action on any remaining appropriations bills until after the elections on Nov. 2. This is especially true with the two bills discussed above, Labor/HHS and CJS, as they contain programs that frequently provoke floor fights. Thus, Congress will return after Labor Day and take up only "must pass" legislation, which is likely to be a continuing resolution to fund the government until after the November elections, at which time Congress may return for a lame-duck session to try to wrap up the remaining appropriations bills.

It is not certain that a lame-duck session will occur, however. The politics of such a session would be a very important factor. It appears as though control of the House of Representatives may be "in play," with at least the possibility existing that the Democrats will lose their majority. (It almost is a foregone conclusion that the Democrats will lose seats.) If this were to occur, the Democrats may try to hold a "lame-duck" session to pass bills that they know they will be unable to pass in the next Congress. The GOP will, of course, stall and delay as much as possible to keep anything controversial from passing prior to the new Congress convening after the new year.

Our prediction: look for an exciting fall, both in terms of politics and substance.

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The Stem of the Problem *continued from page 5*

of Science and Technology Policy to coordinate federal STEM education policy. Whereas the 2007 version focused extensively on K-12 education, current versions re-examine STEM education beyond high school, changing the way NSF funds graduate student fellowships. The House version even calls for the possible creation of an NSF postdoctoral fellowship program.

Even if passed before the current congressional term expires, there is no guarantee the programs created by COMPETES will be supported adequately. Yet, it does seem that recent efforts have significantly, albeit slowly, changed the inertia of STEM education. And, Newton's first law tells us what happens to a body in motion.

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A Capitol Celebration of Science

BY WEIYI ZHAO

What makes science fun and cool? If you don't know, you can find out at the inaugural USA Science and Engineering Festival, Oct. 10 – 24. The nearly month-long festival culminates in an expo on the National Mall in Washington, D.C. For two days, Oct. 23 and Oct. 24, the Mall will be transformed into a playground of science, technology, engineering and mathematics. More than 400 organizations, government agencies, universities, colleges, research institutes and K-12 schools have partnered with the festival organizers to host myriad exhibits filled with hands-on learning activities for people of all ages.

This is not your average science fair. For starters, 12 Nobel laureates sit on the festival's advisory board. During the week leading up to the expo, students in many U.S. cities will get a chance to "lunch with a laureate" — an opportunity for small groups of middle and high school students to engage in informal conversations with Nobel prize-winning scientists. The festival also has a "Nifty Fifty" group of notable science, technology, engineering and mathematics professionals, such as Bonnie Bassler, Francis Collins and Mark Perks (representing the American Society for Biochemistry and Molecular Biology), who will visit D.C.-area middle and high schools throughout October to talk to students about science and their careers.

On the first day of the expo, a Rubik's Cube competition, open to all schools and community youth organizations in the greater Washington, D.C., area, will be attended by Erno Rubik, inventor of the Rubik's Cube. For those with a flair for science and art, the expo will host live musical performances, comedy, theater and magic shows, guaranteed to energize, inspire and impress. For example, the TalkingScience Cabaret, a project of the Science Friday Initiative, will combine scientist-musicians and stage acts to illustrate scientific principles. And, Darlene Cavalier, founder of the Science Cheerleader and former cheerleader for the Philadelphia 76ers, will partner with Going Pro Entertainment, a nationwide network of cheerleading and dance consultants, to showcase professional cheerleaders-turned-scientists.

ASBMB will be hosting two exhibits on the Mall, titled "Molecular Machines" and "A Taste of Genetics." In the "Molecular Machines" exhibit, we will work with Tim Herman, director of the Milwaukee School of Engineering Center for BioMolecular Modeling (see page 13 for information on the CBM high school outreach SMART program) to teach visitors about shapes and interactions of proteins, nucleic acids, lipids and carbohydrates using molecular models and cutting-edge computer visualization tools. Visitors to "A Taste of Genetics" will learn basic DNA structure and base-pairing rules by building double-stranded DNA models using licorice and marshmallows.

You can join the fun by volunteering to work at the ASBMB exhibits on Oct. 23 and Oct. 24. To thank you for your efforts, you'll receive an ASBMB T-shirt.

In addition to the Mall activities, a number of satellite events are taking place during the same weekend across the country. So, even if you can't make it to Washington, D.C., you still can teach, learn and celebrate science.

Weiyi Zhao (wzhao@asbmb.org) is the ASBMB manager of

For more information:

- The USA Science & Engineering Festival: http://www.usasciencefestival.org
- Festival satellite events: http://bit.ly/9bfQ54
- Mark Perks and the Nifty Fifty: http://bit.ly/9u1u5x
- The TalkingScience Cabaret: http://bit.ly/8ZQopi
- Darlene Cavalier the Science Cheerleader: http://bit.ly/qxOAW
- To sign up as an ASBMB exhibit volunteer, go to http://tinyurl.com/2944sbg

Promoting Concept-driven Teaching Strategies

BY J. ELLIS BELL

The American Society for Biochemistry and Molecular Biology recently received a National Science Foundation grant for a five-year initiative that will focus on network building to create and disseminate assessment tools for the foundational core knowledge and skills required for biochemistry and molecular biology degrees and to promote student-centered teaching approaches.

The project's major objectives are 1) to develop a set of core concepts and skills specific to biochemistry and molecular biology; 2) to develop validated assessment tools and 3) to create a central resource of pedagogical approaches based on cognition research that are useful to biochemistry and molecular biology educators.

The project also will build a network of faculty interested in adopting validated, student-centered teaching approaches by bringing together individuals with expertise in concept inventory development, education research, process skills and assessment. It will draw upon efforts in concept inventory development, education theory, pedagogical approaches and assessment.

Through this project, the society hopes to impact biochemistry and molecular biology education at the program, departmental, course and faculty levels. As part of the initiative, we will collaborate with other groups, including the Carrick Education Group in Australia, which is working with the International Union of Biochemistry and Molecular Biology. We hope the product of the initiative, a web-based central resource of biochemistry and molecular biology education information and tools, will help establish objectives, outcomes and assessment strategies based on validated tools and pedagogical approaches. Importantly, the initiative will serve as a hub to connect faculty members from a variety of institutions, which will minimize isolated and overlapping development of assessment tools, strengthen education research, improve the quality of publications and promote the formation of new networks.

The project has four specific aims:

1. Identify foundational concepts in terms of core knowledge, principles, research and skills.
2. Create a taxonomy of foundational concepts and skills and link them to topics outlined in ASBMB's undergraduate curriculum recommendations.
3. Develop and evaluate appropriate assessment tools for the topics identified in the first specific aim.
4. Create a tool kit that can be accessed easily by the academic community.

In the coming year, there will be many ways to get involved in the network's activities, including a symposium titled "Promoting Concept-driven Teaching Strategies in Biochemistry and Molecular Biology through Concept Assessments" at the 2011 ASBMB annual meeting (see page 26) and an ASBMB special education symposium at the University of Richmond (see page 31).

A series of regional workshops organized by the Undergraduate Affiliates Network also are being held across the country. The workshops will include an overview/update of the project, an introduction to the workshop's specific goals, a hands-on activity relating to these goals and a keynote talk by a working group member or local "expert."

The specific goal of the first workshop will be "foundational concepts and skills" and will include a guided exercise in developing an assessment tool for one concept and one skill. The workshop will conclude with a discussion session to define assignments and deadlines for the participants, including plans for local interactions and development of a "white paper" on the workshop outcomes.

To learn more about the project and how you can help, contact me or Weiyi Zhao (wzhao@asbmb.org).

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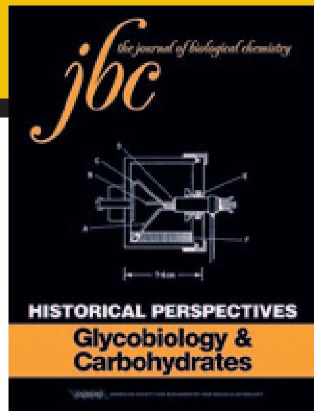
Regional Workshop Goals

- 2011–2012: Taxonomy of concepts and skills—links to potential revisions of ASBMB-recommended curriculum and active-learning strategies
- 2012–2013: Development and testing of assessment tools
- 2021–2014: Development and testing of assessment tools
- 2014–2015: Dissemination of results/tool kit development



Historical Perspectives:

The JBC Publishes New Classics and Reflections Collections

BY NICOLE KRESGE

The Journal of Biological Chemistry is proud to offer a new set of free classroom tools based on the popular Classics and Reflections articles. The "Historical Perspectives" are edited collections grouped around specific topics, such as protein synthesis, lipids and metabolism.

The collections include new introductions from the editors. The JBC Classics shed light on the events and experiments that led to many of the important discoveries published in the journal since its founding in 1905. The Reflection articles are authored by biochemists whose contributions have helped mark the many advances in biochemistry and molecular biology and give great insight into the personal and professional lives of groundbreaking scientists.

The Historical Perspectives present the staples of biochemistry and molecular biology classes in a new light and make it easier to learn and teach about these subjects and how they advanced throughout the years.

Currently, there are three Historical Perspectives available at http://bit.ly/cRSo2Q: "Lipid Biochemistry," "Glycobiology and Carbohydrates" and "Bioenergetics." Each collection can be downloaded as a single PDF, or individual articles from the collections can be downloaded by themselves.

Historical Perspectives on Lipids

The lipid collection contains articles that fall into two general categories — lipid biosynthesis and lipid signaling — and covers research ranging from Horace A. Barker and Earl R. Stadtman's 1949 JBC paper that examined the synthesis of short-chain fatty acids, to Nobel laureates Sune Bergström and Bengt Samuelson's papers in the 1960s on the biosynthesis and structure of several prostaglandins.

Historical Perspectives on Glycobiology

The Classics and Reflections included in the glycobiology collection trace many of the discoveries that have led to our current knowledge of carbohydrates, including a paper published in 1908 in which Stanley R. Benedict reported an analytical method for determining the reducing sugar content of biological fluids such as urine, leading to the now-famous Benedict solution.

Historical Perspectives on Bioenergetics

The papers selected for the bioenergetics collection touch on various aspects of bioenergetics and the biochemists that pioneered the field. For example, Nobel Prize laureate Paul Boyer's 1979 JBC Classic paper and his Reflection article explain the research that resulted in the elucidation of the mechanism of energy coupling in oxidative phosphorylation.

Additional collections will be added to the website in the coming months. Upcoming topics include protein chemistry, methods in biochemistry, vitamins and coenzymes, enzyme mechanisms, signal transduction and metabolism.

Nicole Kresge (nkresge@asbmb.org) is the editor of ASBMB Today.

JBC Teaching Tools

In addition to the Classics and Reflections, the Journal of Biological Chemistry website (www.jbc.org) has several other teaching tools that are freely available to download.

One of the most popular tools is "JBC in the Classroom"— a series of articles from the ASBMB Undergraduate Affiliate Network newsletter, Enzymatic. The articles explain how to use JBC papers as teaching tools for biochemistry and molecular biology. For example, in a recent Classroom article, Takita Sumter, professor of biochemistry at Winthrop University, explains how she uses JBC papers to help students understand the relationship between protein structure and function.

The site also has a collection of fun science videos from Stanford University instructor Tom McFadden (featured in the June 2010 issue of ASBMB Today) such as the "Regulatin' Genes" rap and a ballad to apoptosis.

Additionally, figures included in any article published since 1995 are available to download as a PowerPoint slide for use in the classroom. A figure search option is located at the bottom of the advanced search page on the JBC website. Many of the best images published in the JBC have been featured as journal covers, which can be found in the cover image gallery, linked from the journal's archive page.

ASBMB Announces 2011 Award Winners

BY ANGELA HOPP

The American Society for Biochemistry and Molecular Biology named 12 scientists as the winners of its annual awards. The recipients, who will give talks at the annual meeting April 9–13 in Washington, D.C., are:

Michael Brown and **Joseph Goldstein**, from the University of Texas Southwestern Medical Center at Dallas, have been named the winners of the inaugural Earl and Thressa Stadtman Distinguished Scientist Award. Brown and Goldstein shared the 1985 Nobel Prize in Medicine or Physiology for their discovery of the LDL receptor and the process of receptor-mediated endocytosis. In recent years, they discovered sterol regulatory element-binding proteins and the process of regulated-intramembrane proteolysis.

Axel T. Brunger, Stanford University professor and Howard Hughes Medical Institute investigator, won the inaugural DeLano Award for Computational Biosciences for his work in structural biology. The award is given to a scientist for innovative and accessible development or application of computer technology to enhance research in the life sciences at the molecular level. Brunger's concepts and strategies helped provide the foundation of much of modern structural biology.

Charles E. Chalfant, an associate professor at Virginia Commonwealth University School of Medicine and a research career scientist at the McGuire Veterans Administration Medical Center in Richmond, Va., won the Avanti Young Investigator Award in Lipid Research for his work on lipid-signaling pathways regulating alternative pre-mRNA processing and eicosanoid biosynthesis. The award recognizes outstanding research contributions by young investigators with no more than 15 years of experience.

Job Dekker, an associate professor at the University of Massachusetts Medical School, won the ASBMB Young Investigator Award, which recognizes outstanding research contributions to biochemistry and molecular biology by those who have no more than 15 years of postdoctoral experience. Dekker developed and applied powerful new technologies to study the three-dimensional organization of chromosomes and genomes.

Christine Guthrie, a professor at the University of California, San Francisco, won the ASBMB-Merck Award, which recognizes outstanding contributions to research in biochemistry and molecular biology. Guthrie, an American Cancer Society research professor of molecular genetics, pioneered the use of budding yeast as a model organism to elucidate the mechanism of messenger RNA splicing.

Arthur Gutierrez-Hartmann, a professor at the Anschutz Medical Campus of the University of Colorado-Denver School of Medicine, won the inaugural Ruth Kirschstein Diversity in Science Award, which honors an outstanding scientist who has shown a strong commitment to the encouragement and mentoring of underrepresented minorities entering science. Gutierrez-Hartmann studies the role of ETS transcription factors in development and cancer.

Yusuf Hannun, professor and department chairman at the Medical University of South Carolina, won the Avanti Award in Lipids for his work on bioactive sphingolipids, a class of lipids that, when defective, can cause disorders with significant medical impacts.

Arthur E. Johnson, a distinguished professor at the Texas A&M Health Science Center's College of Medicine, won the Fritz Lipmann Lectureship. The award, issued every other year, was established by friends and colleagues of Nobel Prize winner Lipmann for conceptual advances in biochemistry, bioenergetics or molecular biology.

Cheryl A. Kerfeld, a structural biologist and the head of the Department of Energy Joint Genome Institute's Education and Structural Genomics Program, won the ASBMB Award for Exemplary Contributions to Education. Kerfeld, who also serves as an adjunct professor at the University of California, Berkeley, was named the winner for encouraging effective teaching and learning of biochemistry and molecular biology through her own teaching, leadership in education, writing, educational research, mentoring and public enlightenment.

Melissa J. Moore, a professor at the University of Massachusetts Medical School and a Howard Hughes Medical Institute investigator, has been named the winner of the William C. Rose Award. Moore, noted for her work with gene splicing and messenger RNA, was nominated for the award in recognition of her outstanding contributions to biochemical and molecular biological research and her demonstrated commitment to the training of younger scientists.

George R. Stark, a distinguished scientist at the Cleveland Clinic's Lerner Research Institute and emeritus professor of genetics at Case Western Reserve University, won the 2011 Herbert Tabor/Journal of Biological Chemistry Lectureship. The award recognizes outstanding lifetime scientific achievements and was established to honor the many contributions of Herbert Tabor to both the society and the journal, for which he has served as editor for nearly 40 years.

Look for more information on the award winners and their lecture topics in upcoming issues of ASBMB Today.

Angela Hopp (ahopp@asbmb.org) is managing editor for special projects at ASBMB.

For more information:

To see past award lectures, go to http://bit.ly/acEFS6.

SMART Teams

Transforming Students into Future ASBMB Members

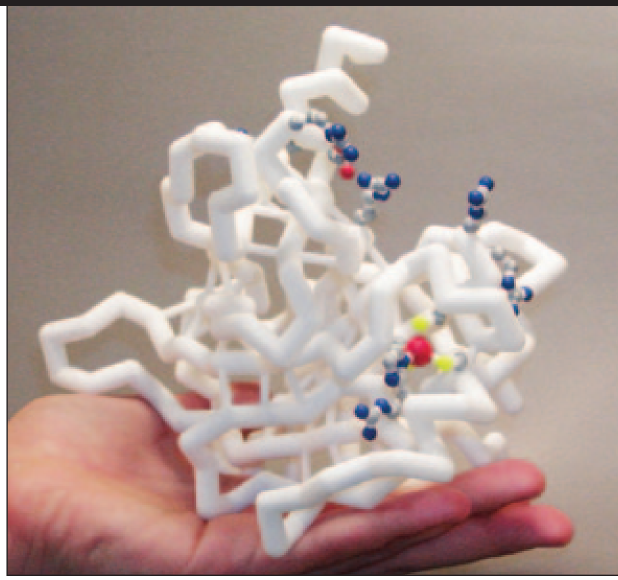
BY TIM HERMAN

The vitality of any professional organization critically depends on its ability to introduce new members into its ranks. Both the past and current presidents of the American Society for Biochemistry and Molecular Biology have articulated the goal of making ASBMB more responsive to the needs and interests of its youngest members. For most of us, the effort to attract young scientists to ASBMB involves improving the ways we teach our discipline to undergraduates or the development of better mentoring programs for graduate students and postdoctoral fellows.

At the Milwaukee School of Engineering Center for BioMolecular Modeling, we have been developing programs that introduce high school students and their teachers to the "real world of science" through protein-modeling activities:

- Last year, more than 2,400 high school students from around the U.S. constructed physical models of the influenza virus hemagglutinin protein using an 8-foot-long Mini-Toober (foam-covered wire) as part of the Science Olympiad Protein Modeling competition. To prepare for this event, the students learned about basic principles of protein structure and function, the Protein Data Bank and the use of the Jmol molecular visualization tool.
- In a second program called SMART Teams (Students Modeling a Research Topic), students learn to use our 3-D printing technology and are matched with a local research lab. The SMART Team visits the lab, learns about the work that is being done there and then designs and builds a physical model of a protein that is central to the work of the lab.

The SMART Team program is an effective way to introduce teams of high school students to "real science" — i.e., science as it is practiced in the laboratory (1, 2). Why does this work? Social scientists who study the various ways in which novices are introduced to a professional community have concluded that one effective strategy is to engage novices in the work of the community as "legitimate peripheral participants" (3). SMART Teams do this by involving high school students in the creation of a "thinking tool" — a physical model of a protein — that is not currently present in the research lab but is valued by those who work there. To design a protein model that is useful in a research project, the students must understand the questions being asked, why they are important and the way in which young people — not unlike themselves — go to the bench every day to set up experiments that result in one more piece of evidence to support a story illustrated by the model. The physical model becomes much more than a physical representation of the protein's structure. The model becomes a physical embodiment of the process whereby our understanding of the structure and function of the protein became known.



A physical model of the p53 tumor suppressor protein, based on 1tup.pdb.

Twenty SMART Teams from all across the U.S. attended the ASBMB annual meeting in Anaheim, where they presented their modeling projects as part of the Undergraduate Research Poster Competition. Watch for SMART Teams at next year's annual meeting. And, when you see a group of excited young high school students walking around with a physical model of a protein, introduce yourself — and welcome them into science community.

Tim Herman (herman@msoe.edu) is the director of the Center for BioMolecular Modeling at the Milwaukee School of Engineering. If you'd like to meet him, he will be staffing one of the ASBMB booths at the USA Science and Engineering Festival in October.

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Richard Hanson: *A Maestro of Metabolism*

BY NICK ZAGORSKI

Cleveland may be a fairly big city, but even amongst its masses, Richard W. Hanson sometimes finds it hard to hide.

"I often joke around that it is impossible to have an affair in this town and keep it a secret," says Hanson, who, incidentally, has been married happily for nearly 50 years. "Quite often, someone comes up to me and says, 'Hi, Dr. Hanson, do you remember me? I took your class back in so-and-so year.'"

"In fact, I visited a proctologist recently who turned out to be one of my former students."

The class in question is an introductory biochemistry course, which Hanson, when he's not hard at work in the lab elucidating the physiological role and regulation of the metabolic enzyme phosphoenolpyruvate carboxykinase, has taught at Case Western Reserve University School of Medicine in Cleveland for more than 30 years now. Each year, more than 230 students enroll in the biochemistry course, and, each year, almost all of them leave happily— and more knowledgeable about biochemistry than when they started.

To understand the secret behind these positive reviews— Hanson's classes routinely are the highest rated each year— one needs only to consider one of his favorite authors, William Shakespeare. (Hanson regularly quotes the Bard in his writings, and even has an iPhone app with Shakespeare's complete works.) For, if "all the world's a stage," then that includes university auditoriums.

"He views teaching biochemistry as theater," says William Merrick, Hanson's longtime colleague in the biochemistry department. "Once he comes in, the show begins."

Not only does his teaching style help students understand a complex subject that most fear and only take because the course is a requirement, but it keeps Hanson spirited as well. "My colleagues often ask me if I get tired of teaching the same material over and over again, and I say never, for every class is different, and every year is different; it is always a challenge to have students leave your course feeling that they actually understand biochemistry and to tell you it was their favorite course."

"In my view, there are two types of teachers, 'simplifiers' and 'complicators,'" he continues. "The latter take a complicated subject and make it more complicated. I am a simplifier, always concerned about the complexities of the biochemistry, and I try to make the subject clear to the students; this approach has worked very well for me over the years."

He employs a similar style in lab, always looking to simplify matters and be as supportive as possible, and, with those modest guidelines, he has successfully shepherded more than 80 graduate students and postdoctoral fellows onward in their careers. He obviously has had some success in this regard, since his first graduate student, Shirley M. Tilghman, is the current president of Princeton University.

And, this has made Hanson one of Case Western Reserve University's most celebrated educators; he has won numerous awards for his teaching and service, including the Hovorka Prize, one of the university's highest awards, and was recently appointed a "Distinguished University Professor," an honor that he shares with only six other current members of the university faculty. And, this month, the university will honor Hanson's career in the lab and classroom with a special one-day symposium in his name.

However, official honors take a back seat to the personal acknowledgements from former students. "When I began my career in science, I thought that the most important thing that I would do was research, but, as I grow older, I realize that the greatest contribution that anyone can make in our society is to be a positive influence on the lives of those you teach," he says. The fact that so many people still remember me and my course is touching, because it means that, in some small way, I have made a positive impact on their lives and careers. So, truthfully, some of the best things I hear start with, 'Do you remember…?'"

A Lifelong Commitment

Part of Hanson's dedication to teaching comes from remembering his own experiences; he notes he was fortunate to have several valuable mentors during his educational period— which, if you ask him, is still continuing.

It all started at high school in New Jersey in the 1950s, when his biology teacher, Sister Mary Cephus, helped

Richard Hanson and colleague Parvin Hakimi, who developed the PEPCK-C^{mus} mouse strain, stand by one of the treadmills where the "mighty mice" strut their stuff.

instill a passion about the life sciences into a bright-eyed adolescent boy.

A pivotal moment, though, occurred at the next step in his education. Coming from a modest background, Hanson did not have much money for college, but, he found a great opportunity at Northeastern University in Boston, which offered a cooperative work program; students went to school for half of the year and then worked the other half to pay for it.

Hanson ended up working as a technician in the laboratory of Peter Bernfeld at Tufts University School of Medicine and experienced firsthand the many facets of biochemical research; these included science's frustrations, but also the joys, such as the publication of his first-ever journal article in 1960, in the Journal of Biological Chemistry.

"That was a proud moment," recalls Hanson, "because, in what was the golden age of biochemistry, I was a co-author on a paper that was published in the most prestigious biochemistry journal."

In fact, Hanson became committed to the JBC over the years, a reflection of his loyal nature. He would serve on the journal's editorial board for 10 years before becoming an associate editor, a post he has held since 1985. A longtime member of the American Society for Biochemistry and Molecular Biology, Hanson also has given exceptional service to the society as a whole, including serving as ASBMB president from 1999 to 2000 (during which time he helped usher in the society's third journal, Molecular and Cellular Proteomics).

And, whenever his research produces exciting biochemical discoveries, Hanson, who never got caught up in the pressure of trying to continually publish in Science or Nature— he sees them more as magazines that publish what is trendy and exciting at the moment— always immediately thinks about publishing the findings in the JBC.

And, that has led to frequent contributions over the years (more than 90 articles in all, including many reviews), for, while remaining true to the JBC, Hanson also has remained true to his science. Though he's adapted his studies to make use of new advances, he's always been a basic biochemist at heart.

"I've had a lifelong love affair with metabolism," he says. "And, even with the ups and downs of the field, I've never thought of doing anything else."

PEP, PEP Hooray

The romance began in 1960. Following his graduation from Northeastern University, Hanson headed to Rhode Island and began graduate school at Brown University, joining Paul F. Fenton's group in the department of biology. He had met one of Fenton's recent graduates while working with Bernfeld and had heard positive reviews, so, he decided that studying under Fenton would be a good choice.

"I tell my students that life is like walking down a road and reaching a fork," Hanson says. "You don't quite know where either path will take you, and it is often very difficult to go back once you choose one of the forks in the road, so each decision is important."

In Hanson's case, the seemingly innocuous decision of picking an adviser would lead to a decades-long journey elucidating the details of intermediary metabolism, or, as Hanson likes to describe it, "a series of happy accidents that were superimposed on each other."

He started this accidental adventure with his graduate project comparing the metabolic differences in two strains of mice that differed in their propensity to develop obesity, a subject that would become one of great interest in the current era of molecular genetics. He then continued studying lipid metabolism as an officer at the Army's Nutrition Laboratory in Denver. That experience, followed by his subsequent postdoctoral fellowship at the Fels Research Institute at Temple University, beginning in 1965 with renowned biochemist and cancer researcher Sidney Weinhouse, really would launch his career.

Under the tutelage of another supportive mentor, and in a lab full of great colleagues, Hanson first began working on the protein that would become his calling card: phosphoenolpyruvate carboxykinase, better known as "PEPCK."

The enzyme, which is involved in glucose production, along with the related enzyme pyruvate carboxylase recently had been discovered by Merton F. Utter in the department of biochemistry at Case Western Reserve University School of Medicine— where, in another happy accident, Hanson would end up moving in 1978 to become chairman of the department— and Hanson was examining their role in the initiation of glucose homeostasis in developing rat livers. Along the way, he and colleague John Ballard had, surprisingly, found PEPCK in adipose tissue, which seemed bizarre, as adipocytes do not make glucose.

Soon, together with Gilbert Leveille and their longtime collaborator Lea Reshef, they realized that PEPCK was involved in an abbreviated pathway that converted pyruvate into glycerol-3-phosphate for triglyceride synthesis, which was hence named glyceroneogenesis.

That discovery highlights just one example of the many wonderful collaborations Hanson has had; he likes to note that the numerous excellent scientists he has worked with have given him much more than he has given back. He especially acknowledges Reshef, an Israeli scientist who worked closely with him for more than 30 years, studying the factors that control PEPCK-C gene transcription. "Lea has been a wonderful collaborator; I am not a molecular biologist, so I owe a great deal of my success in studying gene expression to her insights," he says. "She was full of ideas and always willing to share with me her vision and enthusiasm for studying PEPCK-C."

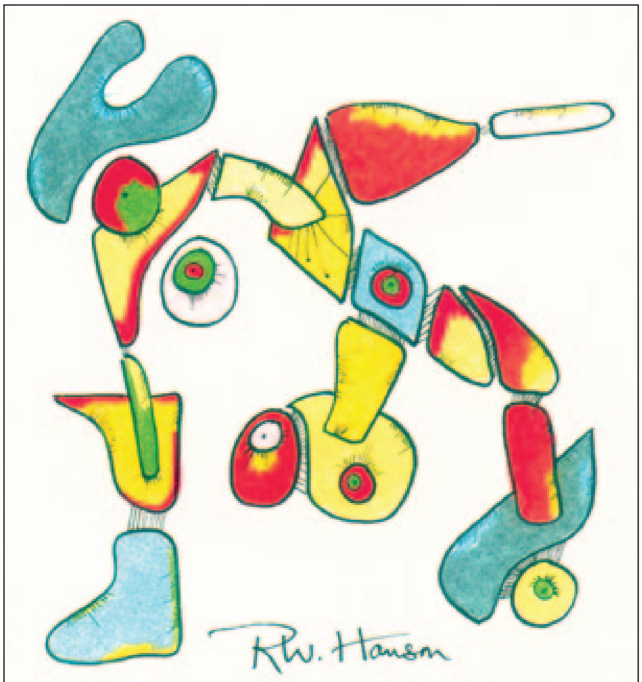
Following that 1967 glyceroneogenesis breakthrough, which resulted in a paper in the JBC's Classics series, Hanson began a fruitful series of studies on the factors that regulate the levels of PEPCK-C in mammalian tissues; he and his colleagues isolated the genes for both the cytosolic (PEPCK-C) and mitochondrial (PEPCK-M) forms of the enzyme and began focusing on the hormonal and dietary factors that affected PEPCK-C gene transcription. He never wavered in his pursuits, even as the prominence of metabolism gave way to the era of molecular biology, though he commented that at times it made funding more difficult to come by.

During the past decade, though, partially spurred by the rise in interest in the causes of obesity and diabetes, metabolism studies have made a very strong comeback. This certainly came as a welcome turn of events to Hanson, at least until he found himself thrust right in the middle of the metabolic resurgence.

Of Mighty Mice and Men

Going back to his graduate school days, Hanson had significant experience with animal models as tools to understand metabolic function and, over the years, had developed strains of mice in which PEPCK was either deleted or overexpressed in specific tissues. For example, in 2002, in collaboration with Reshef and her student Yael Olswang, they found that ablating PEPCK-C gene expression specifically in adipose tissue produced lipodystrophy in many affected mice, validating the enzyme's central role in adipose-tissue glyceroneogenesis.

As a follow-up, in 2007, Hanson, together with his longtime colleague Parvin Hakimi, decided to generate mice in which PEPCK-C was overexpressed in skeletal muscle, another tissue like adipose tissue that has PEPCK-C activity but does not synthesize glucose. "I didn't know exactly what to expect," Hanson says, "but I was pretty sure these mice



A Renaissance Man

In addition to his exceptional work in the lab and lecture hall, Hanson also is known for his work as an artist (as illustrated above and on our cover). As typical, Hanson takes a more modest view of his abstract drawings, which developed from his penchant for doodling during meetings and seminars; "I see it as a sickness I have that every once in a while results in something nice to look at," he says. Hanson, though, is certainly appreciative of art in general, and, over the years has bought many pieces from local Cleveland artists and put them up in the biochemistry building. As Merrick likes to joke, "he's established a lovely gallery here consisting of all the art his wife wouldn't let him take home."

would only have subtle changes in their metabolic profile; boy, was I in for a shock."

These PEPCK-C^{mus} mice turned out to have a dramatic phenotype, which included exceptional endurance (they could run on a treadmill 30 times as long as a regular mouse), hyperactivity even at advanced ages and lean, muscular bodies despite eating twice as much as normal. They also displayed incredible longevity, with one female reaching more than 4.5 years of age (typical lab mice live 2–3 years), though Hanson notes they didn't quite break the record and win the Methuselah Prize for the longest-living mouse (which, for the curious, currently stands at 1819 days).

It's a scientifically fascinating discovery, the mechanistic basis of which his lab currently is trying to unravel, and, not surprisingly, one that produced intense media interest as well, much to Hanson's chagrin. "It was nonstop action for a while; I think our video of the mice running on the treadmill got more than 300,000 hits in the first few weeks after the study came out, not to mention all of the interview requests I received, even a few from documentary film producers who wanted to include our mouse video in movies about athletic performance and potential sports doping."

The attention was a bit too much for the modest scientist, a man who says that "he never wants to work at a university where he is the smartest; it's surely not a good place to work!"

"It was wonderful that our lab and the university received some positive attention, but, at the same time, this kind of sensational news worries me as a scientist, because we still are far away from developing performance-enhancing treatments in humans, and we really do not understand the factors that lead to the phenotype we observe with these mice."

He often quotes the famous dictum of Euripides that was modified by Sidney Brenner in his review of the book by James D. Watson, "Avoid Boring People," "Whom the gods would destroy, they first expose to the public press."

A Promise of a New Day

Considering that Richard Hanson still is going strong with his teaching, research and editorial duties at 75 years of age, one might suspect that he shares some genetic traits with his PEPCK-C^{mus} mice.

However, Hanson admits things don't get easier as one gets older and already is preparing for the next fork in the road of life. He's getting ready to close up his lab and officially will become an emeritus professor in 2014.

However, he plans to continue collaborative research with his friend and close colleague, Satish C. Kalhan at the Cleveland Clinic, on studies of whole-body metabolism in mammals. "I especially am interested in amino-acid metabolism, and working with Satish is a learning experience for me," he notes. In addition, he will continue to study the PEPCK-C^{mus} mice, which now are being used, in collaboration with Nathan A. Berger, to better understand the effect of exercise on the development of colon cancer.

And, he definitely will keep on teaching for as long as he is able; "I think Hanson could give up doing research," Merrick says, "but you would have to drag him kicking and screaming out of that classroom before he'd ever stop."

The education won't be confined to the students in his biochemistry class. Given his scientific expertise, he's going to act as a mentor-of-sorts to other scientists who are interested in the "new metabolism."

"Following the rise of molecular biology and genomics, a lot of researchers veered toward what they saw as a more exciting area of science," he explains. "And now, even though we have a revival of interest in metabolism, we have a 'lost generation' of scientists who perhaps truly don't understand many of the fundamentals of metabolism."

And, although today's scientists typically are focused on broader scientific queries than just a single enzyme or pathway, Hanson notes that PEPCK makes a fine ambassador to new science.

"Through all of our work, we've shown that PEPCK is a great example of a tightly regulated gene with tissue-specific activity, as well as differing developmental expression patterns," he says. "And, there are still many unanswered questions regarding its function."

"So, even though it's been around for a while, like me, I think PEPCK is a very modern and appealing protein."

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In Science Education, the Reality Is Virtual

BY NICK ZAGORSKI

There was a time, not too long ago, when all you needed to teach a science course was a piece of chalk. However, even the staid lecture halls of universities aren't immune to technology's relentless advance, particularly in computing and online applications, and the past several years have seen many institutions incorporate modern technologies into the teaching environment. Below are just three examples of some innovative approaches to integrate technology into science teaching, highlighting the fact that, with today's tools, virtually anything is possible.

Two Houses, One Home

When San Diego's Scripps Research Institute was setting up its campus in Jupiter, Fla., a few years back, its founders wanted to make sure their new endeavor would not be perceived as a second-class satellite center; Scripps Florida was an expansion of this renowned institution, just one that was situated across the country, as opposed to across the street.

Of particular importance was trying to make the Florida students feel a bicoastal connection, so, Scripps set out to provide them access to the courses available in California.

The institute fitted the principal lecture halls on each campus with multiple digital cameras and projectors to allow students in one room to watch the proceedings in the other room in real time.

Curt Wittenberg, who oversees Scripps' first-year molecular biology course, which has been at the forefront of using the new technology, notes it has been an interesting adaptation process.

"Right around the time we began implementing the technology, we also were switching the class from a lecture to discussion-type format," he says. "Combine that with the fact that this course is team-taught, and each member has his or her own degree of affinity for the technology, it made for an interesting transition."

The early years were more adventurous, as the hookup initially only allowed passive viewing; thus, if a student in Florida had a question, they had to type it via instant messenger to a teaching assistant in California who would then relay it to the professor.

Today, the virtual lecture halls are a technophile's dream. A professor can see and hear both sets of students (he or she controls the camera remotely at the podium), and Scripps even has added SMART boards (digital whiteboards), which allow teachers to include interactive visual aids.

Recently, Scripps also has adapted the systems to behave as a virtual conference room for use in seminar courses and journal clubs. Projecting the classroom on the opposite coast on the screen in the front of the room creates the illusion that the room extends twice as far; and, with picture-in-picture technology, the students can display graphs or figures as they discuss their journal papers.

"It's certainly different from when we faculty were students," Wittenberg says, "But, we've managed to adapt pretty quickly, and it's a fun and innovative way to make our two campuses feel like one."

A Holiday in Lab

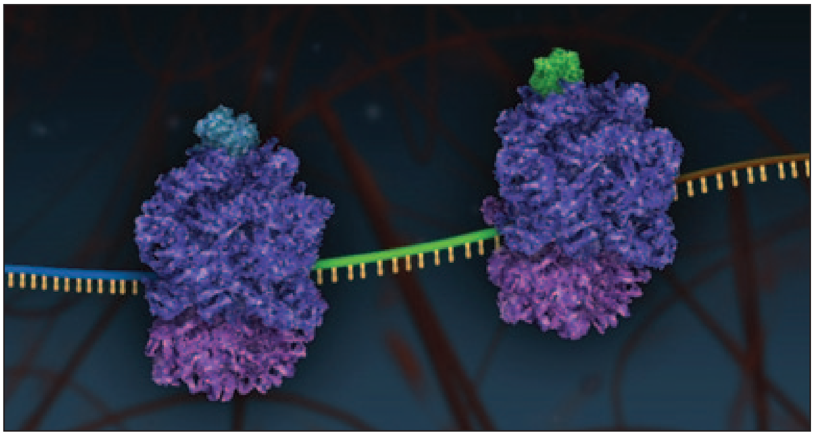
No matter what the actual content, the word "lecture" is not particularly attractive. For Dennis Liu, program director for the Howard Hughes Medical Institute annual Holiday Lecture series — in which some of HHMI's top investigators speak to high school teachers and students — a way to spice up the lectures was to make them part of a bigger package.

"I'm a self-professed science explainer," he says. "Back when I was in academia, I never minded writing papers or grants; that was kind of fun. But what always jazzed me the most was trying to explain some obscure or esoteric concept, particularly in a one-on-one setting."

"So, back in the 1990s, when we thought about how to make the Holiday series more engaging, we realized there was this great new media called the Web," he continues. "So, we set out to design companion resources that would help explain each lecture topic further."

Although early efforts were limited to creating online teacher guides, over time, Liu and his small production team began incorporating animations, video clips and activity ideas that students could interact with before, during and after each talk. Soon, all of the online "goodies" evolved into HHMI's Biointeractive website, providing a great educational resource year-round.

Among the site's many features, one of the most innova-



A frame from an animation originally developed to illustrate the research of Princeton scientist Bonnie Bassler for her 2009 Holiday Lecture appearance.

tive might be the award-winning "virtual lab" series, developed by Liu and staff member Satoshi Amagai.

The virtual labs offer fully interactive biomedical simulations, which help students visualize and appreciate key scientific techniques, without dealing with some of the tediousness and repetition involved in real benchwork.

"The point of these labs is verisimilitude," Liu explains. "We don't want to tell students exactly how to make an SDS-PAGE gel, just have them realize it's a wonderful tool to separate proteins based on size."

However, although the virtual labs do offer many advantages to educators — they're easy, free, have built-in assessments and make it easy to track student compliance — Liu notes he doesn't see them as replacements for the real thing; however, in schools that don't have any lab infrastructure, the virtual labs make decent substitutes.

Currently, this online series features five simulations: bacterial identification, cardiology, neurophysiology, immunology and how to make transgenic flies. Liu and his team already are planning for the 2010 Holiday lecture in December, though, and a new high-pressure liquid chromatography simulation may be on the virtual horizon.

Science's Second Coming

Virtual lectures and virtual labs are one thing, but virtual worlds take the immersive, interactive experience to a whole new level. And, for those interested in science, the place to be is the SciLands continent in the Second Life world.

Have you ever thought about talking a stroll on the Martian surface? Or maybe flying through a hurricane after you've helped Gregor Mendel examine his pea plants? SciLands can make that happen.

Once the domain of text-based chat rooms and message boards, visually based online communities have gained momentum as meeting places for like-minded individuals seeking a little escape from their immediate surroundings. Though such worlds principally have been geared toward massive online games like World of Warcraft, virtual communities designed for social and educational activity also are popular.

One of the most popular social destinations is Second Life, developed in 2003. Like other platforms of its kind, Second Life offers individuals a chance to create an alter ego, or avatar, and explore a virtual community, created and updated by the user population, where events range from the mundane to the exotic.

The educational appeal of Second Life, especially in the sciences, was apparent quickly; with just a modicum of programming and scripting skills, users could develop virtual exhibits that could replicate experiments that might be too risky, expensive or time-consuming in real life, all packaged in a colorful game-like environment that encourages learning and is accessible from any Internet connection.

As a result, many universities and science organizations developed "lands" in second life, and many of them got together eventually and formed a region dedicated to science and technology, called SciLands.

For example, one can visit Genome Island, developed by Texas Wesleyan University professor Mary Anne Clark, and try various fun activities, such as crossing pea plants, looking at X-linked inheritance in a cat colony and carrying out a bacterial transformation.

And, Clark recently taught a fully in-world genetics course for nonmajors to examine the applicability of this teaching approach, which combines the convenience of online learning with the social interaction of a traditional small-class setting.

Nick Zagorski (nzagorski@asbmb.org) is a science writer at ASBMB.

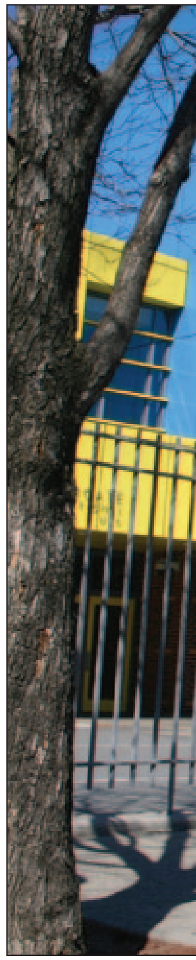
For more information:

- HHMI's Biointeractive website: www.hhmi.org/biointeractive
- HHMI's virtual lab series: http://bit.ly/hKQaN

Science on Wheels

Delivering Hands-on Experiments to Schools across the Country

BY NANCY VAN PROOYEN



On a monitor attached to a microscope, a blue-green amoeba slowly crawls across the screen with a wave-like motion. The eyes of the students huddled in front of the screen widen, as this is the first time many of them have seen live cells and small organisms. The microscope is housed in a hands-on science laboratory located in a high-tech, brightly painted bus called the "BioBus."

The Bus

In August 2007, Ben Dubin-Thaler, or "Dr. Ben," founded Cell Motion Laboratories Inc., an educational nonprofit, weeks after defending his doctoral dissertation on cell mobility at Columbia University. Instead of getting a job, he purchased a 1974 San Francisco transit bus from Craigslist and transformed the inside of the bus into a functional wet-lab, outfitted with three state-of-the-art microscopes and computers. All of the equipment is research-grade and was acquired through donations or grants. The BioBus even has a classroom comprised of three rows of blue vinyl-covered, cushioned benches and a large computer screen centered on the back wall.

"While teaching in college and graduate school, I noticed that when other people had this chance to play and experiment, they became excited and happy about science, in contrast to what often happened while sitting through lectures or reading a textbook. The BioBus is my way of bringing the fun and excitement of scientific experimentation to all people," says Dubin-Thaler.

What also is amazing about the BioBus is that it's carbon-neutral. Its daily energy needs are provided by the solar panels on the roof of the bus, a wind turbine attached to the front of the bus and an engine that runs on used vegetable oil. And, Dubin-Thaler designs his projects so that they use salvaged materials when possible, in an effort to reduce waste.

The BioBus travels throughout New York state and around the country, bringing an interactive science education to more than 10,000 students each year. The program focuses on students who normally do not have access to high-tech laboratory equipment. The BioBus makes stops at public schools, summer camps, parks, museums, community gardens, urban farms and after-school programs. In addition, the bus parks at various locations around the city and opens its doors to the curious public.

The Classes

BioBus classes are taught by doctoral-level scientists and are structured to complement each school or program's curriculum at all grade levels. Students explore the microscopic world around them, normally invisible to the naked eye. As soon as the students board the bus, they immediately start looking through a microscope. Dubin-Thaler's current biology experiments range from looking at pond water and identifying micro-organisms to monitoring the beating heart of the transparent crustacean daphnia. In collaboration with the New York University Materials Research Science and Engineering Center, students also observe Brownian motion of paint drying, which is very dramatic, microscopically. Also, with the help of a Cornell University ecologist, students study insect-plant relationships by examining aphids and predatory mites.

After the BioBus leaves a school, teachers and students are given follow-up activities based on the digital microscope images and movies captured on the bus. This allows curiosity about science to continue in the classroom. "Teachers and principals always talk about how much excitement the BioBus brings to their school, and we've been invited back to every school we've visited, which speaks to the impact we are having," says Dubin-Thaler.

In January, the Awesome Foundation awarded its first New York City $1,000 grant to Dubin-Thaler to build a laser tractor beam onboard the BioBus. Construction of the laser will be published in an open-access science education journal, which will allow schools and science enthusiasts to build their own lasers. The laser tweezers will be used to immobilize bacteria to capture cell division and feed bacteria to amoeba.

The Future

So, what's next for the BioBus? Fun new experiments are being developed constantly. For example, researchers at the New York Botanical Garden and the Academy of Natural Sciences in Philadelphia are creating a project on algae. Also, there are plans underway to acquire a second bus, which will serve as an in-depth classroom. This bus will teach follow-up classes after the BioBus has visited.

The BioBus is not alone in its quest to take science on the road. Various schools and organizations throughout the country have created similar traveling labs, and some have been running for more than a decade. Each program quickly becomes oversubscribed. Mobile labs are successful because the people running the programs share all of their resources. There even is an organization called the Mobile Laboratory Coalition, which assists in and advises the development of new mobile-lab programs. The excitement of science is spreading with the help of these labs. Exposing students to research-level hands-on experiments is the best way to inspire the next generation of scientists.

Dubin-Thaler explains, "the BioBus is about changing young people's lives by getting them really excited about exploring their world through science."

Nancy Van Prooyen (vanprooyennm@mail.nih.gov) is a postdoctoral fellow at the National Cancer Institute.

Running the Bus

To run the BioBus, a team of more than 50 volunteer scientists, educators, writers, web developers and mechanics is required. Scientists play an important role on the BioBus as educators and positive role models. If you are interested in volunteering or donating to the bus, go to the BioBus home page at www.biobus.org for more information and a schedule of upcoming events.

A Few Things to Consider When Searching for a Graduate Program

BY PETER J. KENNELLY

It's (Nearly) All Good

Prospective graduate students should take comfort in the fact that the number of institutions that offer high-quality graduate training programs in biochemistry, molecular biology and related areas is very high. Thus, it is difficult to make a "bad" choice. Their goal, therefore, is to narrow down this list of good alternatives to a set of five or six programs with people and characteristics that best fit their own goals and interests. In doing so, it is not necessary to consider every potential university— just a sufficient number to develop a good sense of what's available and a discerning eye to see past the glossy veneer of typical recruiting materials.

Applications: How Many and How High Should I Aim?

As a rule of thumb, to provide themselves with a reasonable probability of getting one or more offers of admission, aspiring Ph.D. students should submit five to six applications. One of those applications should be to the students' dream school, one they assume— perhaps wrongly— lies beyond their reach. Conversely, one application should go to a "backup" school, one that is very likely to extend an offer of admission. The remaining three to four applications should be targeted to some "just right" schools— institutions whose programs are well matched to the students' interests and preferences, and for which they feel their credentials render them a competitive (30:70 to 50:50) applicant.

What separates a "just right" school from a "dream" school? In most cases, it is simply a matter of perception. The reputation of an "elite" school generally is derived from its association with one or more historically important and/or contemporarily prominent scientists and discoveries. In addition to high name recognition, a school's popularity among potential applicants also can be affected by its location. All things being equal, students are more likely to apply to a university located in a major coastal city than one located in the rural Midwest or Great Plains.

What's in a Name?

It is best to think of the molecular life sciences as a broad, multidimensional continuum. Because no universal standard exists for subdividing this continuum into departments, disciplines or programs, students should not attach too much importance to labels. Prospective employers will be much more concerned about what the students can do and how well they can do it— as manifested by their publication record and letters of reference— than whether the students' diplomas read Ph.D. in biochemistry, biology, biophysics, chemistry, cell and molecular biology, pharmacology, molecular genetics, etc. When investigating potential graduate-training programs, wise students will look past the labels and examine the specific types of research and training activities offered by a particular program, department or school.

I'm Not Sure What I'm Interested in

Although many graduating seniors will have formed well-defined interests around which to focus their graduate training experience, many will not. Students who find themselves in this latter, exploratory mode should consider targeting programs that employ a research rotation system. These rotations generally consist of a series of short research projects that afford the opportunity to perform small projects in several different laboratories before deciding upon a major professor. Exploratory applicants also should check out one of the many "umbrella" programs in which multiple departments partner to form a large, multiunit, graduate training program. Such programs offer a wide range of faculty members and research topics from which to choose.

It's All about Mentors

The cornerstone of the graduate school training experience is the execution of an independent research project under the direction of a faculty mentor. During the course of a four-plus-year period of study, typical graduate students will spend at least 75 percent of their time working on this project. A graduate student's major professor, aka thesis adviser, thus plays a dominant role in the graduate research experience. A major professor serves as teacher, guide, role model, evaluator and day-to-day supervisor.

Therefore, after identifying a set of institutions with good track records in graduate education and a desirable combination of program size, curriculum, etc., prospective applicants should focus on the affiliated faculty members and their research. Do they find several faculty members whose research is appealing? In general, it is advisable to apply only to the programs in which applicants can identify three to five possible mentors. Why multiple mentors and not just one? Because not all prospective major professors will have openings in their laboratories during a given year, because the applicants could find themselves in competition with other new students who may be interested in the same mentor, or because the person may not meet the applicants' initial expectations.

> ***"…wise students will look past the labels and examine the specific types of research and training activities offered by a particular program, department or school."***

The Case for a Life Experience

Graduate school constitutes a transitional experience in an aspiring scientist's professional development. Hence, it represents an ideal vehicle through which to sample a novel life experience by exploring a new region of the country and its distinctive vernacular, foods, music, traditions and geography, without making a long-term commitment. Getting away from the comfortable and familiar provides students with the chance to literally broaden their geographic and cultural horizons, as well as to learn new things about themselves.

I Got Accepted! Now What?

Before signing on the dotted line, students should find some time to check out the school in person. Although this may involve some expense, it is well worth it, considering the magnitude of a student's commitment. A visit will provide an opportunity to find out the many things that either were not presented or could not be conveyed in a website or brochure, including the personalities of the faculty members and the morale of the graduate students.

If I were permitted to ask only one question of each faculty member during a visit to a prospective graduate school, it would be this: "What are your former students doing now?" If the career progression of the program's graduates matches the applicants' own aspirations, it is likely that this school will provide them with suitable training. Other issues to clarify before signing on the dotted line include finances and time to degree. For what portion of their career are typical graduate students supported as teaching assistants, which requires that they work part time in the instructional program, versus research assistants, which allows them to devote their full time to research and study? What is the typical range of time to degree?

Keep Things in Perspective

Earning a doctoral degree in biochemistry or molecular biology demands talent, hard work and perseverance. During those times when students gets a bit discouraged, it is important to remember that the laboratory in which they are working and learning is a million-dollar playground in which someone else bought the toys! So, my advice is "keep your eye on the prize, and enjoy the very special opportunity that you have been afforded."

Peter J. Kennelly (pjkennel@vt.edu) is a professor and head of the department of biochemistry at Virginia Polytechnic Institute and State University. He also is chairman of the ASBMB Education and Professional Development Committee.

Graduation Survey Coming Soon

After a yearlong hiatus, the ASBMB graduation survey has been sent to all departments we have on file as having a biochemistry, molecular biology, biotechnology or chemistry degree with an emphasis in biochemistry. If your department offers such a degree, please make sure a representative responds to the survey. This survey gives the society information about the demographics of graduates and allows us to track trends. For additional information, contact us at survey@asbmb.org.

It Takes a Village

The Role of Postdocs, PIs, and Institutions in Training Future Scientists

BY ZOË FONSECA-KELLY, DARWIN J. OPERARIO, L. DAVID FINGER JR. AND ANTHONY J. BAUCUM II

For postdoctoral researchers intent on having successful careers, spending every waking moment at the lab bench is the professional equivalent of burying your head in the sand. With the current economic climate, the increased interdisciplinary nature of today's research and an increasing global reliance on science and technology, postdocs who gauge their success solely on bench productivity do so at their own professional peril. Postdocs, principal investigators, institutions, funding agencies and nonprofits must all make strides in postdoctoral education and training that emphasize developing both research skills and professional competencies to ensure that postdocs achieve future success and that science in general becomes more productive.

Postdoc — Develop Thyself

We have all heard it before: most postdocs (approximately 75 percent) will not end up in an academic career. So, the question remains, what can postdocs do to make sure they have the skills to succeed in a nonacademic career? Or, if they desire a tenure-track position, what can they do to set them aside from their competition? Postdocs need to take responsibility for their nonbench education. If their institutions have postdoctoral offices (PDOs), their first step should be to find out what programs are offered and to avail themselves of those programs. Many PDOs hold periodic research and/or career symposia that postdocs can take advantage of on their home turf. Next, a postdoc needs to find mentorship not just from his or her individual PI, but from multiple people who relate to his or her career and personal goals.

The postdoc should talk to his or her PI and offer to help with grant writing, budgeting, lab management, reviewing papers and mentoring students — all of these are transferable skills that can be used in many career paths. Postdocs should seek out resources that can enhance the mentor-mentee relationship and utilize them. They should look for organizations in which they can take on a leadership role in a nonlab setting, for example, the National Postdoctoral Association or the American Society for Biochemistry and Molecular Biology. Whether in or out of academia, the skills acquired and the networking contacts obtained will be invaluable. Remember, most people are hired because they know someone, not because they answered an advertisement. Although PIs and institutions share responsibility for providing advanced mentored training to a postdoc, the postdoc must be his or her own first and strongest advocate.

The Changing Role of Postdoctoral Mentoring

Accepting a postdoc, a trained independent researcher, into the laboratory today involves more than bringing on a highly skilled technician. The required inclusion of a mentoring plan for all National Science Foundation grants that support postdocs is just one example that illustrates the changing culture within U.S. scientific research. PIs need to remember that taking on a postdoc involves a significant mentoring investment. Mentoring does not just involve overseeing the individual, but committing to the promotion and success of the protégée's career.

The summary of the 2004 – 2005 Sigma Xi postdoc survey results, "Doctors Without Orders," states: "Postdocs reporting the greatest amount of structured oversight and formal training are much more likely to say they are satisfied, to give their advisers high ratings, to experience relatively few conflicts with their advisers and to be more productive in terms of numbers of publications compared with those with the least oversight and training" (1).

Good PIs get their reputations for a variety of reasons, regardless of institutional affiliation. In addition to a history of solid research, the most successful PIs possess a multitude of nontechnical skills that have brought them to this point in their careers. Some of these skills may have been developed on the fly if they were not lucky enough to receive such training during their postdoctoral fellowships. PIs should think back to their days as junior faculty and ask themselves if there were skills that they wish they had developed before leading a laboratory. If so, these skills should be fostered in their postdocs. This training may require PIs to encourage their postdocs occasionally to leave the bench to network, write grants and learn leadership, budgetary and personnel management skills. In addition, if there is an area in which a PI does not possess expertise, they should encourage their postdocs to find other mentors who are well versed in that area to help the postdoc pursue his or her career and life goals.

For both postdocs and mentors, a great starting place to develop a mentor-trainee relationship is with an individual development plan. Templates for plans are available on the NPA and Federation of American Societies for Experimental Biology websites. Individual development plans are useful for formalizing a training plan covering all aspects of career development for the intended length of the postdoc. When developing a plan, both PI and postdoc should incorporate the six core competencies defined by the NPA to evaluate current skills and identify areas for growth. These building blocks should provide a path toward a well-rounded and productive postdoctoral experience.

Institutions and the Development of Future Scientists

The National Institutes of Health, the NSF and other governmental and nongovernmental organizations play key roles in both training future academic scientists and maintaining scientific literacy of the general populace. This begins with strong scientific curricula from elementary school through high school and beyond, but it also directly links to both the government and the private sector's ability to provide solid jobs for people well-trained in the scientific method.

For the 75 percent of postdocs who do not enter the academic ranks, there has to be well-paying and rewarding work available. People holding doctoral degrees in the sciences have a strong skill set that goes beyond just memorizing facts and knowing a narrow area. Their skills include: critical thinking, management skills, problem solving and the ability to synthesize information. Diverse companies seek out individuals with these skills to join their ranks as highly prized contributors to their company's missions.

Times are changing, and the NSF, NIH and other organizations are recognizing that training scientists is not just about training individuals who will be supported by their grants. They are realizing that it is important to train critical thinkers who will go forth and help to create a culture of scientific thought and intellectual curiosity that will underlie future scientific breakthroughs. The recruitment and training of postdocs is critical to these endeavors, and, organizations, such as the NPA, FASEB and ASBMB, that advocate for postdocs are key to providing a voice for the education of our future scientific leaders.

Zoë Fonseca-Kelly (zoekelly@upenn.edu) is a postdoctoral fellow at the University of Pennsylvania; Darwin J. Operario (djo03@health.state.ny.us) is a postdoc/research affiliate at Wadsworth Center/N.Y. State Department of Health; L. David Finger Jr. (LFingerJr@coh.org) is a biophysicist project scientist at the Ernest Orlando Lawrence Berkeley National Laboratory and a visiting postdoctoral fellow at the City of Hope Beckman Research Institute and Anthony J. Baucum II (Anthony.baucum@vanderbilt.edu) is a postdoctoral fellow at Vanderbilt University. All are members of the NPA.

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1. Davis, G. (2005) Doctors Without Orders. *American Scientist* **93**, supplement.

For more information:

- The National Postdoctoral Association: www.nationalpostdoc.org
- A FASEB individual development plan: http://tinyurl.com/2bnt2hm
- The ASBMB career resources site: http://bit.ly/9GV0cy

This article describes one of the themes that is part of the ASBMB annual meeting, which will be held April 9–13, 2011, in Washington, D.C.

Education and Professional Development: Coping with the Ups and Downs

BY CARLA MATTOS AND PETER J. KENNELLY

The way scientists perceive and cope with the inevitable ups and downs of exploratory research, instruction and mentorship is crucial to their success and satisfaction. Students particularly are prone to magnifying routine setbacks into personal failures that, if left unchecked, can extinguish their interest in a scientific career. As the stresses continue to mount, many promising students cite pressure as a key reason in their decision to turn away from a career in science. Consequently, the American Society for Biochemistry and Molecular Biology 2011 annual meeting Education and Professional Development theme – "It Didn't Work! Coping with 'Failure' for Students and Professionals" – focuses on common sources of stress and frustration in the classroom and laboratory.

The program is organized into five sessions. On Saturday, April 9, the activities will focus on education and outreach in coordination with the 15th annual ASBMB undergraduate poster session sponsored by the Undergraduate Affiliates Network. Prior to the poster session, Erin Dolan (Virginia Polytechnic Institute and State University) will speak on "Wiki Wizardry: Using Information Technology for Outreach." Afterwards, students will be invited to a workshop titled "Preparing for Graduate School" featuring a panel of graduate students.

Frustrations at the Bench

On the morning of Sunday, April 10, a session titled, "It's Not Your Fault. Dealing with Frustration at the Bench," will focus on approaches to bolstering the confidence and performance of research trainees. Ann Stock (University of Medicine and Dentistry in New Jersey-Robert Wood Johnson School of Medicine) will lead off with a talk on "Overcoming Student Perceptions of Failure: Helping Students Develop a Constructive Approach." Next, in "An Ounce of Prevention: Failure-resistant Experimental Design," Peter J. Kennelly (Virginia Polytechnic Institute and State University) will discuss ways to avoid fueling the "It didn't work/I failed" syndrome. Finally, Phillip Pekala (East Carolina University) will speak on addressing peer reviews in "Manuscripts and Grant Applications: Reading and Responding to Critiques."

Mattos

Kennelly

The Classroom

On Sunday afternoon, the emphasis will shift to the classroom, where new faculty members are asked to sink-or-swim with little formal training. In a session titled "Classroom of the Future: Classroom Management Skills," speakers will offer a series of primers on managing the classroom environment. Valeri Farmer-Dougan (Illinois State University) will speak on "Strategies for Engaging Students in Large Classroom Settings." Rebecca Foushee (Fontbonne University) will discuss how to distinguish problem students from students encountering problems in a talk titled "Identifying Academically Struggling Students." And, finally, Gabriele Bauer (University of Delaware) will provide an overview on contemporary techniques for "Dealing with Disruptive Behavior" in the classroom.

The Research Laboratory

On Monday, April 11, the morning's session will shift the instructional venue to the research laboratory, in the "Classroom of the Future II: Mentoring Students in the Research Laboratory" session. David O'Connor (University of Wisconsin-Madison) will speak about the benefits of setting clear ground rules for new trainees in "The Importance of Defining Expectations." F. Ann Droughan (University of Tennessee) will then discuss the challenges encountered mentoring students of diverse origins and culture in "Communicating Across the Cultural Spectrum." And lastly, Sharon Milgram (National Institute of Health) will give a talk entitled "Techniques for Building Student Confidence," which will focus on approaches to developing competence-based confidence in students.

Collaborating

Monday afternoon's session will focus on "The Art of Collaboration." In a team-oriented research environment, unexpected outcomes and difficulties can lead to misunderstanding, tension and conflict between collaborators. Carla Mattos (North Carolina State University) will discuss "Collaboration within the Laboratory Group." Next, Peter J. Roach (Indiana University School of Medicine) will survey common practices and pitfalls in "External Collaboration: Some Basic Rules of the Road." And Karen Allen (Boston University) will discuss seeking out partners in "Identifying and Negotiating with Potential Collaborators."

To conclude, Jennifer Loertscher (Seattle University) and Vicky Minderhout (Seattle University) will present a workshop on Process-oriented Guided Inquiry Learning.

Although we can't eliminate the frustrations inherent in our challenging profession, we hope these presentations will help you enjoy a greater share of its rewards.

Carla Mattos (carla_mattos@ncsu.edu) is an associate professor of biochemistry at North Carolina State University. Peter J. Kennelly (pjkennel@vt.edu) is a professor and head of the department of biochemistry at Virginia Polytechnic Institute and State University.

It Didn't Work! Coping with "Failure" for Students & Professionals

Sponsored by the ASBMB Education and Professional Development Committee

Session: Fostering Interactions between College/University Scientists and High School Students & Teachers

Sponsored by the ASBMB Education and Minority Affairs Committees

Wiki Wizardry: Using Information Technology for Outreach, *Erin Dolan, Virginia Polytechnic Institute and State University*

Preparing for Graduate School: a Workshop for Undergraduates, *Chairwoman: Carla Mattos, North Carolina State University (No presenters available at this time)*

Session: It's Not Your Fault: Dealing with Frustration at the Bench

Overcoming the Perception of Failure: Helping Students Develop a Constructive Approach, *Ann Stock, UNDNJ-Robert Wood Johnson School of Medicine*

An Ounce of Prevention: Failure-resistant Experimental Design, *Peter J. Kennelly, Virginia Polytechnic Institute and State University*

Manuscripts and Grant Applications: Reading and Responding to Critiques, *Phillip Pekala, East Carolina University*

Session: Classroom of the Future I: Classroom-management Skills

Strategies for Engaging Students in Large Classroom Settings, *Valeri Farmer-Dougan, Illinois State University*

Identifying and Assisting Academically Struggling Students: What to Do and When to Do It, *Rebecca Foushee, Fontbonne University*

Dealing with Disruptive Behavior, *Gabriele Bauer, University of Delaware*

Session: Classroom of the Future II: Mentoring Students in the Research Laboratory

The Importance of Defining Expectations, *David O'Connor, University of Wisconsin-Madison*

Communicating Across the Cultural Spectrum, *F. Ann Draughon, University of Tennessee*

Techniques for Building Student Confidence, *Sharon L. Milgram, National Institutes of Health*

Session: The Art of Collaboration

Collaboration within the Laboratory Group, *Carla Mattos, North Carolina State University*

External Collaboration: Some Basic Rules of the Road, *Peter J. Roach, Indiana University School of Medicine*

Identifying and Negotiating with Potential Collaborators, *Karen Allen, Boston University*

Session: Using Active Learning in the Biochemistry and Molecular Biology Classroom: A Workshop for Instructors

Supported by an educational grant from NSF
Chairs: Jennifer Loertscher (Seattle University) and Vicky Minderhout (Seattle University)

Session: Promoting Concept-driven Teaching Strategies in BMB through Concept Assessments

Supported by an educational grant from NSF

What Are Concept Assessments and How Might They Be Used?, *Cheryl Bailey, University of Nebraska-Lincoln*

Foundational Concepts for the Molecular Life Sciences, *Michael M. Cox, University of Wisconsin-Madison*

Creating Networks to Enhance Teaching Pedagogy, *J. Ellis Bell, University of Richmond*

Teaching and Learning Concepts, *Richard S. Moog, Franklin & Marshall College*

The Reality of Back to School: Back to What?

BY REGINA STEVENS-TRUSS

It's "back to school" time. This can be heard in many settings all over the country at this time of the year, and it means different things to different people. A kindergartener preparing for his or her first day of school and a ninth grader getting ready for the first day of high school may both have images of new beginnings, whereas a college senior, preparing for post-baccalaureate studies, may have images of an end.

For some people, "back to school" conjures up positive images like a new classroom, new classmates, new teachers and new school supplies. And, while some people find this time of the year exciting, only a few of them are looking forward to science and math. Unfortunately, these subjects continue to lag behind other subjects that excite students. In fact, many students approach learning science and math like they do taking medicine; they "swallow while holding their nose."

We all understand that in order to succeed in this changing global economy, students have to be well trained in science and math. So, perhaps "back to school" should be a time for scientists to think about how to keep the younger generation interested and engaged in these subjects. But, in order to do that, we must reflect on successes and failures and think about the needs of the next generation as they relate to education.

The National Center for Educational Statistics recently published a report titled "Status and Trends in the Education of Racial and Ethnic Groups" (1). The 181-page congressionally mandated document is a must-read for anyone interested in the state of education. It highlights some positive trends and some challenges that still exist, and looks at the demographic changes in the U.S. So, what can those of us in higher education learn from this report?

Racial Demographics

The NCES study found that the racial demographics of the country have significantly changed in the past 20 years, becoming more diverse. The report states that from 1980 to 2008, we have seen a shift in the percentage of our racial composition, with the Hispanic population expanding the fastest, experiencing an increase from 6.4 percent of the population in 1980 to 15.4 percent in 2008. The Caucasian population has seen a decline from 80 percent to 66 percent, while the Black population remains at 12 percent. The data also suggest that the trend will continue in the future. If this is true, and nonwhite ethnic groups will comprise the majority of our population in the near future, then our educational plans also must change to meet their needs as well.

Achievement Trends

The NCES report paints a mixed picture for academic achievement trends in the various ethnic groups in the U.S. Although the population that takes college entrance exams has become more diverse, the NCES report found that on both the SAT and ACT exams, American Indian/Alaska, Black and Hispanic students continue to score below their Asian and Caucasian cohorts. In fact, the report suggests that fewer American Indian/Alaska, Black and Hispanic students enroll in high school upper-level math classes.

On a positive note, however, the number of U.S. high school students taking Advanced Placement courses doubled in a nine-year period (from 0.7 million students in 1999 to 1.5 million students in 2008), with Black and Hispanic students making up the largest percentage increase.

Still, the study found that, at the national level, American Indian/Alaska, Black and Hispanic students continue to lag behind their Asian and Caucasian cohorts on assessment tools such as the National Assessment of Educational Progress exam. But, these students scored higher than the international average on the Trends in International Mathematics and Science Study.

These data suggest that, even though some of our national trends are going in the right direction, we need to work on shortening the achievement gaps between our students.

Making an Impact

So, what can we do? The time may be ripe for this question. The U.S. Department of Education and many state departments of education have begun the process of

"These data suggest that, even though some of our national trends are going in the right direction, we need to work on shortening the achievement gaps between our students."

addressing problems seen in schools with low-achieving students. It is understood widely that science and mathematics education will be important to the future of any nation in the changing global economy. Making sure that our students continue to perform at or above the international average should be our priority. And, with this priority comes the question of how to reach the changing demographics of our students and positively impact their achievements.

It may be a good time for American Society for Biochemistry and Molecular Biology members to shift some of our priorities and embrace K-12 education as part of our mission. To jumpstart this effort, the ASBMB Educational and Professional Development and Minority Affairs Committees have planned a special-interest session for the 2011 ASBMB annual meeting, titled "Fostering Interactions between College/University Scientists and High School Students and Teachers" (see page 26 for more information). The session will allow higher education faculty and students to converse with junior high school and high school teachers about student engagement and learning.

After all, K-12 grade students are the scientists of tomorrow. So, let's get back to school and to education.

Regina Stevens-Truss (Regina.Stevens-Truss@kzoo.edu) is an associate professor of chemistry at Kalamazoo College and a member of the ASBMB Minority Affairs Committee.

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1. Aud, S., Fox, M., and KewalRamani, A. (2010). Status and Trends in the Education of Racial and Ethnic Groups. U.S. Department of Education, National Center for Education Statistics, Washington, D.C.

What's New with the EPD?

BY PETER J. KENNELLY

Where's Ellis?

The first thing you may have noticed is that the author of this article is not Ellis Bell. Following a long and successful tenure as chair of the Education and Professional Development Committee, Ellis stepped down. However, his energy and enthusiasm will continue to make an impact, as he has agreed to stay on as a regular member of the EPD.

So, Who Is the New Guy?

My name is Peter Kennelly, and I currently am head of the biochemistry department at Virginia Polytechnic Institute and State University. In addition to having several million dollars in extramurally funded research and approximately 30 doctoral students, our department is home to more than 500 undergraduate biochemistry majors. For the past 20 years, I have served as a career adviser for our students, using a one-hour elective course of my own design to address the challenges of effectively serving a large student body. Although I don't have all the answers, my job as department head keeps me well aware of the many challenges American Society for Biochemistry and Molecular Biology members face. I will do my best to serve you well.

What Is the EPD?

The EPD's role is to devise ways in which ASBMB can aid students, postdoctoral trainees and young professionals as well as the people who mentor and educate them. A major partner in these efforts is the Undergraduate Affiliate Network (see page 31).

The Challenges Ahead

As noted by ASBMB President Suzanne Pfeffer, the educational and employment landscape for science has undergone dramatic changes to which we must adapt. It is more important than ever that we find ways as a community to nurture the curiosity and enthusiasm of nascent scientists by supporting quality science education and participating in science outreach at the K-12 level. Professional preparation must incorporate new skills that reflect the growing importance of careers in the commercial/industrial sector and the burgeoning of interdisciplinary research.

One of our primary goals is to find ways to connect with the students who represent the future of our society. If future biochemists and molecular biologists are to see ASBMB as their professional society, we must reach them when they are forming their professional identity — in college or perhaps even earlier. To do so, we are working to make the EPD website an accessible and attractive resource for information on the full spectrum of biochemistry and molecular careers. EPD members are partnering with other educators to develop and disseminate resources to serve science teachers in the form of core concepts and skills, laboratory and classroom exercises and assessment tools. Extending ASBMB recognition to undergraduate degrees in biochemistry and molecular biology is under consideration as a means for both fostering educational excellence and highlighting the relation between the ASBMB and a student's college major.

All of this will take time, effort and careful consideration. However, rest assured that the ASBMB members who go the extra mile by serving on the EPD (and UAN) are talented and committed. This year, we welcome three new members who are starting their three-year terms on the EPD:

- **Lisa Gentile** is associate professor and chairwoman of the department of chemistry at the University of Richmond and a recipient of the ASBMB Award for Exemplary Contributions to Education. She has a strong track record in developing science research and outreach programs and is currently co-director of a Howard Hughes Medical Institute-funded undergraduate science research program.
- **Weiping Jiang** is director at R&D Systems. He also is a member of the Journal of Biological Chemistry editorial board. Weiping's addition is part of a long-term effort to communicate with and serve our members, current and potential, working in the commercial/industrial sector.
- **Joseph Provost** is professor and chairman of the department of chemistry at Minnesota State University Moorhead. He has long been active in science education. He currently is a councilor in the chemistry division of the Council on Undergraduate Research, a past member of the Biochemistry and Molecular Biology Education editorial board and a past chairman of the ASBMB UAN. In addition to his experience and ability as an educator, Joseph's familiarity with organizations that play a role in enhancing STEM education make him a valuable asset.

Peter J. Kennelly (pjkennel@vt.edu) is a professor and head of the department of biochemistry at Virginia Tech.

Making Undergraduate Science Education a Priority

BY NEENA GROVER

In addition to promoting graduate and postdoctoral education, the American Society for Biochemistry and Molecular Biology has made it a priority to foster undergraduate science education. For example, nearly 200 students present their research each year at the ASBMB annual meeting undergraduate poster competition, and specific programming for undergraduate students and faculty is becoming commonplace at all ASBMB-sponsored meetings.

The ASBMB also established the Undergraduate Affiliate Network, a national organization comprised of university-based chapters dedicated to advancing undergraduate research, research-based undergraduate education and K-12 outreach. The result is an interconnected community of undergraduate students and faculty that can participate in developing new directions in education.

In the past few years, more than 50 UAN chapters have been established across the country. Individual chapters are divided into six geographical regions, each of which can organize at least one meeting per year in which undergraduate students and faculty members can present their research. The regional meetings also provide an opportunity to encourage students to present their work at the ASBMB annual meeting via a travel-awards program, which gives grants to four students at each meeting.

Via the UAN network, undergraduate faculty members are finding a cohort to discuss their pedagogical research and are building a network for collaborations that will impact biochemistry and molecular biology education. With this increased interest, education-themed special symposia have become a standard part of the UAN activities; the next one is scheduled for July 21–24, 2011 at the University of Richmond. This meeting aims to discuss various different pedagogies currently being used in active and student-centered approaches. Experienced and novice faculty members will share expertise and new ideas in sessions on POGIL, the scholarship of teaching and learning, incorporating service-learning and visualization.

Several awards are given to UAN chapters and members each year to help them travel to the ASBMB annual meeting, to participate in local science fairs, to organize regional meetings, to participate in summer research, to develop creative outreach activities in their communities and for other creative chapter activities. High school students and teachers have become part of these activities and have earned prestigious scholarships and research awards for their work as well. An undergraduate honor society, Chi Omega Lambda (ΧΩΛ), also has been established to recognize exceptional UAN juniors and seniors who are earning their degrees in molecular life sciences.

Over the past two years, the UAN funded a pilot program to engage high school teachers and students in research. Four UAN faculty members were funded through this program: J. Ellis Bell, Joseph Provost, Todd Weaver and myself. Because of this program, we all have incorporated 7-12 research opportunities into our grant applications, and we are beginning to make an even broader impact on K-12 science education in our communities.

The UAN also publishes a newsletter six times a year. Enzymatic highlights the activities of various chapters and showcases faculty and student involvement and achievements around the country. It also routinely includes science outreach articles, undergraduate reviews of interesting web entries and a feature called "JBC in the Classroom," in which contributors explain how they use Journal of Biological Chemistry articles as teaching tools.

As fall approaches, regional UAN directors will be gathering for a retreat during which many of the UAN initiatives and programs are created, revamped and improved. If you have ideas on how to increase undergraduate faculty and student participation within the society, please send them to me or Weiyi Zhao (wzhao@asbmb.org).

Neena Grover (ngrover@coloradocollege.edu) is an associate professor of biochemistry and chairwoman of chemistry and biochemistry at Colorado College.

For more information:

- To participate in the 2011 education meeting, contact Ellis Bell at jbell2@richmond.edu.
- To learn more about the UAN, go to www.asbmb.org/UAN.
- To submit articles for publication in Enzymatic, contact Marilee Benore at marilee@umd.umich.edu.

YouTube: Broadcasting Your Technique?

How YouTube Is Changing the Way Science Is Learned

BY LOLA OLUFEMI

We are fortunate to live in a time where there is no limit to the knowledge that is readily accessible. A simple search through the most popular websites can unleash vast amounts of information on any given subject. One such site is YouTube (www.youtube.com). Founded in 2005 by three former employees of the PayPal division of eBay, YouTube serves as a video-sharing website, which allows users to upload and view videos ranging from music videos to sports clips to family events.

YouTube users have taken sharing science one step further by literally broadcasting laboratory techniques. With digital cameras, computers and smart phones in hand, science gurus are taking advantage of this website by posting videos that illustrate techniques as simple as casting an agarose gel to methods as complicated as antibody purification. YouTube is now virtually changing the way science is presented, taught and learned in classrooms and labs everywhere.

A New Dimension in Learning

Five years ago, the scientific community probably had no idea how "YouTube" and "laboratory techniques" could end up in the same sentence. However, utilizing YouTube to post videos offers a new dimension in learning. The strength of these videos is that they allow the person in the video to demonstrate, verbatim, how a specified technique is performed, including all of the little details we often overlook when using a written protocol.

Utilizing such avenues of exposure makes science an open forum, allowing groups that have developed certain techniques to easily share them with interested colleagues. Viewers can pause, rewind or restart the videos as needed to further familiarize themselves with the techniques. With the convenience that laptops and cell phones offer, these videos easily can be viewed anywhere from the comfort of a couch to a busy airport to the lab. One literally can prepare for the next experiment without carrying around a bulky lab notebook filled with protocols.

Teaching Tools

Scrolling through these videos, one notices that research labs are not the only ones taking advantage of YouTube. University teaching laboratories also have realized the benefits of this form of media. For example, the Massachusetts Institute of Technology has long tried to make all curricula available online through its OpenCourseWare initiative. OpenCourseWare is now readily available through MIT's channel on YouTube. The channel features MIT's "digital lab techniques manual," which guides entire lab lessons.

Using these types of "how-to" videos in teaching labs offers an alternate approach in presenting lesson plans. The videos can be used

An Abnova video shows how to use a Qiagen gel extraction kit.

to guide labs from the convenience of a student's work bench, possibly keeping them more engaged in learning. This offers students an opportunity to learn independently, giving them easy access to the material covered. It also reduces the burden on instructors, allowing them to prepare lesson videos that can be reviewed by students before or after lab sections. The videos also can be used in K-12 science classes, giving younger students the opportunity to learn and experience science hands-on.

Product Demonstrations

Biotech companies such as Fisher Scientific, Abnova and Invitrogen also have joined the bandwagon by posting videos that illustrate the utility of their products. Anyone who has ever worked in a lab can relate to the confusion encountered when using new products. These companies have tried to eliminate this issue by posting product demonstration videos. The videos describe the principle behind the product, show how to use it correctly and explain the product's benefits.

For example, Abnova's channel features videos that illustrate an array of laboratory techniques such as RNA extraction, dialysis and purification. This can help viewers who are interested in purchasing the featured product to become familiar with it before investing in it or to compare the product's utility with that of competitors' products.

What to Expect

After watching several of these "how-to" videos, one soon comes to the conclusion that some of the videos are more helpful than others. Some videos are vague, whereas others require the viewer to have some background knowledge. The best-prepared videos are those that easily can be used by someone who is not familiar with the techniques described.

The most informative videos contain four parts: an introduction, a list of items required, an explanation of the technique and a demonstration. This layout is beneficial because it allows the user to determine the requirements and feasibility of the experiment before performing it. The explanation of the technique and its supporting principles is an invaluable aspect of these videos, in that it teaches the viewer the basis of these methods instead of allowing them to blindly follow the demonstration. Agreeably, these videos offer much more than a protocol — they give the user step-by-step by guidance, making it easier to learn techniques, and they allow the researcher to quickly identify where mistakes may have been made.

With science and technology constantly advancing, it will be interesting to see how YouTube and videos impact science in the future. Videos demonstrating techniques may accompany the methods section of journal articles or lab textbooks, entire lab sections could be taught by video and written protocols could become obsolete. The possibilities are endless.

In the meantime, enjoy viewing and sharing your favorite techniques from the comfort of your computer screen.

Lola Olufemi (olufemi_lola@yahoo.com) is a doctoral candidate/NSF BRIDGE fellow at the Southern Illinois University School of Medicine.

Does It Work?

To determine the utility of science technique YouTube videos, I performed a simple gel extraction using an Abnova video that demonstrated how to use a Qiagen gel extraction kit. I am very familiar with this technique, having performed more than my fair share of gel extractions. However, when I followed the video, I noticed some details in the demonstration that were not mentioned in the protocol that accompanies the kit; these were details that I never have paid attention to nor performed. Although this technique is relatively simple, following the video revealed a few fine points that may be overlooked when following a written protocol — details that potentially can affect the quality of data produced. In my case, including these details actually made a difference in the amount of DNA I recovered from the extraction.

For More Information:

- Abnova videos: www.youtube.com/user/ABNOVA1
- Fisher Scientific videos: www.youtube.com/user/FisherScientificUK
- Invitrogen videos: www.youtube.com/user/Videoinvitrogen
- MIT's OpenCourseWare: www.youtube.com/user/MIT

Helping the Next Generation of Scientists

BY LORI M. CONLAN

What may have seemed to be a random series of career choices has become, in retrospect, a well-planned career path. I found a way to combine my love of science and desire to help people into one fulfilling career. During the past 15 years, I moved from bench work to career education and focused on the needs of postdoctoral fellows and graduate students in the life sciences.

Finding My Path

As an undergraduate at Michigan State University, I studied with William W. Wells, a prominent professor in the biochemistry department. The research was interesting, but, what I adored most was the interaction with my lab mates; they made science fun and exciting. This period began my fascination with how small the scientific community is and how much we all need to support each other to succeed.

I decided to go on to graduate school, though I had no intention of ever running my own lab. Although research was fun, I visualized myself more as an educator — applying my scientific brain, yet still with a "people component" to my career. I knew that a doctoral degree would open more doors for me. My time in grad school not only taught me how to do science, it trained me to think through a problem, to persevere, to stand up for my ideas and, it solidified my impression that members of the scientific community need to support each other to achieve success. My adviser, Cynthia Dupureur, encouraged me to interact with every visiting scientist who came to our department. She understood that I wanted to do something different, so she set up meetings for me with professors at liberal arts colleges, as well as a visit to our industry collaborators at New England Biolabs, where I met with everyone, from the patent lawyer to the bench scientists. While figuring out my career path, I discussed the options with everyone I met.

Building a Network

I was still searching for the career that fit me, so I used my position as a member of the school graduate student organization to coordinate career seminars for my fellow grad students. I looked to my network to find people who had used their degrees in a different way and invited them to give seminars on their jobs, all the while absorbing their information to help me decide whether one of these was the career path I was meant to follow.

As my graduation date drew closer, I still had not picked a path. Plus, I was not yet ready to leave research. What I really wanted was to broaden my scientific horizons and to try something new. I carefully explored postdoc labs, as I really wanted to have a supportive mentor who understood that I did not wish to go into academia. I had forged a great relationship at conferences with Marlene Belfort at the Wadsworth Center and knew that her lab would be perfect. Marlene was a successful scientist who also understood work-life balance. Her lab had a genetic focus but also did traditional biochemistry. I liked the flexibility of projects and the camaraderie in the lab.

Lori M. Conlan received her bachelor's degree from Michigan State University and her doctorate in biochemistry and biophysics from Texas A&M University. She worked for several years as a postdoctoral fellow at the Wadsworth Center before transitioning from the lab to focus on career issues for the next generation of scientists. Conlan started as the director of the Science Alliance, an international career development program for graduate students and postdocs sponsored by the New York Academy of Sciences. She now is at the NIH in the Office of Intramural Training and Education, assisting 4,000 postdocs.

Turning Point

My turning point in choosing a career came in the summer of 2003. One day, I received two envelopes in the mail. The first contained the scores from my NRSA grant application, and the second was from the American Association for the Advancement of Science. My grant had made the funding line, and AAAS was offering me a position as a program manager for Science's NextWave, the precursor to the current ScienceCareers.org. I had a choice to make: continue to do research or move and take a job planning career events. My husband, also a scientist, had just started his postdoc. For his career, it was important for us to keep our postdocs, so I decided to take the grant.

Now, however, I knew what I wanted to do, and, more importantly, I learned that the type of job I wanted existed and was accessible! While planning all of those career talks, I found that my passion was career development. I planned the next two years of my postdoc wisely. I worked hard at the bench and published a few more papers. Papers are the currency in science, no matter what job you take in the end, and any employer would want to see demonstrated productivity, no matter what the field. In my lab, if you brought in your own fellowship money, you were assigned a technician, which gave me the opportunity to gain supervisory experience. I continued to be involved in the postdoc association, planning events and helping the new group get started. I followed what was happening in postdoc education by being involved with the National Postdoctoral Association, and, most importantly, I continued to build my network.

> **"My current job focuses on combining people and science."**

Helping the Next Generation of Scientists

When my fellowship ended, it was time to find a job. I relied heavily on my network and was eventually connected with a job at the New York Academy of Sciences, running their global career development program — Science Alliance. The job was amazing, and it really fit my personality and passions. I went around New York, the country and the world, giving talks to prepare postdocs and graduate students entering the job market. I was recruited to the National Institutes of Health a few years later to join its Office of Intramural Training and Education as the director of postdoctoral services.

My current job focuses on combining people and science. My scientific background gives me credibility and allows me to understand the challenges of working in a lab and searching for a job. I plan career events almost weekly on topics, both at and away from the bench. I give presentations that focus mostly on skill development: "How to write a CV/resume," "How to succeed in an interview," "How to manage a job search," "Improving lab dynamics" and more. I also plan events on career exploration, inviting fellow scientists in all career fields to come to the NIH to share their experiences. Most of the talks I have given are archived on our website at www.training.nih.gov. My mission is to give postdocs the resources to find a career that will satisfy their ambitions.

Throughout my journey, I have kept my scientific network close. I rely on them to field questions from my fellows and to look for new ideas for novel career development content. I love to travel around the country giving career development talks and representing the NIH and its support for the next generation of scientists. Plus, all of the traveling gives me an excuse to connect with my network, in person, while I'm in town for business. Never forget how small the scientific community is, and use its size to your career advantage.

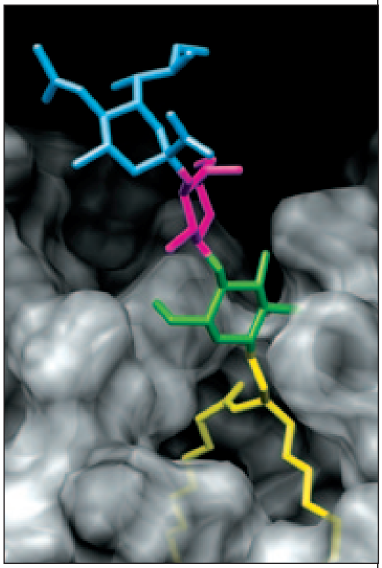
Gregarious Gangliosides

BY RONALD L. SCHNAAR

Gangliosides — sialic acid (Sia) bearing glycosphingolipids — are quintessential social molecules, building close relationships among themselves, with proteins and lipids on their own membranes and with lectins on adjacent membranes. With so many connections, gangliosides are well positioned to make things happen (or not happen), playing the role of mediators. Their roles are being revealed by an equally social international community of ganglioside researchers who act as a bridge between the lipid and glycobiology communities, and between those communities and biologists from diverse disciplines in which gangliosides play regulatory roles.

Gangliosides typically are anchored to the outer leaflet of the plasma membrane by their ceramide lipid moiety, with their glycans extending into the extracellular space. Their ceramides have long unsaturated hydrophobic chains, causing gangliosides to "hang" with each other and with cholesterol, other sphingolipids and select proteins in lateral domains termed "lipid rafts." Gangliosides also frequent another class of lateral signaling domain that Sen-itiroh Hakomori of the Pacific Northwest Diabetes Research Institute calls the "glycosynapse." Whether in lipid rafts or glycosynapses, gangliosides cluster in lateral domains where they influence the activity of co-resident signaling molecules, including receptor tyrosine kinases involved in diverse aspects of physiology and pathology.

When the insulin receptor (IR) associates with the simple ganglioside GM3 (Sia-Gal-Glc-Cer), it is less responsive to activation. Blocking GM3 expression — either pharmacologically or in knockout mice — reduces insulin resistance. In one cellular model, the IR appears to associate either with an activating membrane partner, caveolin, or with GM3, but not with both. By competing for IR-caveolin binding, GM3 converts the IR from a responsive to an unresponsive state. GM3 also damps the responses of other tyrosine kinase receptors, including the epidermal growth factor receptor and the vascular endothelial growth factor receptor, VEGFR-2. In the latter, a more complex ganglioside, GD1a (Sia-Gal-GalNAc-(Sia)-Gal-Glc-Cer), has the opposite effect, enhancing VEGF responsiveness. GM3, a major endothelial cell ganglioside, may be a natural angiogenesis suppressor, whereas GD1a, shed from the surface of some tumor cells, may induce angiogenesis.



Ganglioside GM3 in a lipid bilayer (gray) from a molecular dynamics simulation using the GLYCAM force field. DeMarco, M. D., and Woods, R. J. (2009) *Glycobiol*. 19, 344-355.

Besides making lateral associations, gangliosides "shake hands" with complementary glycan-binding proteins (lectins) on adjacent cells to mediate cell-cell recognition. The disialoganglioside GD3 (Sia-Sia-Gal-Glc-Cer) engages a lectin on natural killer cells (Siglec-7) to suppress NK-mediated cytotoxicity. High-resolution X-ray crystallography of Siglec-7 bound to GD3 reveals an extended network of hydrogen bonds that, along with charge and hydrophobic interactions, defines the distinct glycan binding specificity and affinity of Siglec-7. Another member of the Siglec family, Siglec-4 (myelin-associated glycoprotein), is expressed on myelin and binds to gangliosides GD1a and GT1b on axons to stabilize them and regulate axon regeneration. The leukocyte adhesion lectin E-selectin, which initiates inflammation, binds to low-abundance gangliosides with very long glycan chains on human neutrophils, including gangliosides that have a 14-sugar linear chain terminated with sialic acid and carry multiple pendant fucose residues. These examples reveal that the diversity of ganglioside glycans (there are hundreds) support a variety of cell-cell recognition roles.

By their associations with each other, with signaling molecules in their own membranes and with lectins on apposing membranes, the gregarious gangliosides are lipids that grease the wheels of cellular communication.

Ronald L. Schnaar (schnaar@jhu.edu) is a professor in the department of pharmacology and molecular sciences and the department of neuroscience at the Johns Hopkins University School of Medicine.

FURTHER READING

Lopez, P. H., and Schnaar, R. L. (2009) Gangliosides in Cell Recognition and Membrane Protein Regulation. *Curr. Opin. Struct. Biol.* **19**, 549 – 557.

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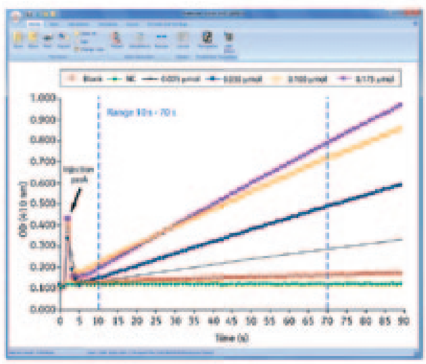

Overlay plot of esterase catalysed pNPA reactions at different concentrations.

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