National Science Foundation
Directorate for Biological Sciences

BIO ADVISORY COMMITTEE
Room 375 Stafford I
September 10 and 11, 2009

Minutes

Thursday, September 10

Welcome and Approval of Minutes

Dr. Barbara Schaal, Chair of the Advisory Committee for Biological Sciences (BIO AC), convened the fall 2009 meeting at 8:30 am. All members were in attendance except Drs. Eva Pell, David Prior, Daniel Wubah; Dr. Michael Mares participated by telephone.

Dr. James P. Collins, Assistant Director of the Directorate for Biological Sciences (BIO), welcomed the members and guests. The minutes from the last meeting were unanimously approved the Committee.

Budget and Science climate/view of administration priorities - *Dr. James P. Collins, Assistant Director, BIO*

Dr. Collins reported on the budget, the science climate and current administration science priorities. Much of the rest of the meeting was devoted to four discussion topics – undergraduate biology education, scientific research collections, broadening participation and international activities. Each discussion topic was developed and lead by a sub-committee of the BIO AC in liaison with a designated BIO senior manager.

Discussion 1 – Undergraduate Biology Education (Muriel Poston and Barbara Wakimoto, discussion leaders, with Ellen McCulloch-Lovell and Bill Zamer, BIO liaison)

The discussion began with a review of the 2009 AAAS Vision and Change Conference: "*Transforming Undergraduate Biology Education: Mobilizing the Community for Change*." The conference featured over 550 participants and over 175 posters which dealt with key concepts including: 1) how students learn and tools that might be used, 2) assessing student learning and innovations, 3) implementing innovations and assessing their impact, and 4) changing institutional approaches. It was pointed out that AAAS has been working with the Division of Undergraduate Education in the Education and Human Resources (EHR) Directorate to support STEM education across all disciplines.

Subsequent discussion focused on learning assessment, teaching faculty and undergraduate education in biology:

Assessing student learning. The discussion focused on whether learning outcomes can be defined so they can be used as metrics in assessing student learning, and if so, whether a process can be developed for assessing how well students meet learning goals. It was suggested that larger institutions particularly may need guidance in assessing how students learn. A question was raised about the effectiveness of team teaching, especially when teachers teach together; i.e., in the same classroom at the same time.

Teaching faculty. The discussion focused on shared resources, training and professional rewards. Shared resources are needed, to enable faculty members to learn from each other about what works. It was suggested for example that successful models could be drawn from physics education. Another approach could be the creation of a central repository of data where educators could see the outcomes of their colleagues' educational approaches. Seeing the outcome of others' efforts would encourage faculty buy-in and experimentation with alternative teaching methods. Graduate students and postdoctoral fellows (who are currently teaching less) also could be trained in new teaching methods and given teaching experiences. Research Collaboration Networks were discussed as a mechanism for sharing best practices; it was suggested that they should be ambitious and large-scale, like the Large Scale Active Middleware (LSAM) model. Finally, it was noted the academic reward culture often undervalues the education of students when faculty are considered for promotion. A more direct reward system for educators is needed. It was suggested that Deans could set aside some promotions for faculty who focus on being educators and innovators, and that embedding science education faculty into research departments might also help.

Undergraduate Education in Biology. The discussion turned to questions and issues regarding how we educate undergraduate students in biology:

- Who are we educating and what for?
- What do we want non-biology majors to get out of biology courses? It is important to recognize different audiences.
- There is a cultural problem when the community is encouraged (or required) to develop new ways of teaching but then judged negatively for adopting what someone else is doing.
- Howard Hughes funds a program in which instructors teach modern methods of teaching.
- What is the proper foundation for thinking for biologists and non-biologists?
- We should scale-up approaches that work and make them available to the teachers.
- How do we take advantage of the window in time when agencies try to take this to the national level?

Discussion 2 – Scientific Research Collections (Michael Donoghue, discussion leader, with Sue Bryant, Michael Mares and Judy Skog, BIO liaison)

The discussion began with a short review of the status of biological collections in the US. There are about 0.5 billion scientific research collections in the United States many of which represent untapped resources for science education. It was noted that museums use collections for informal science education, and that there is a large international component to the collections.

The discussion then turned to the problems and challenges of managing biological collections. Scientific research collections are underfunded and understaffed. Many collections have unfunded mandates; they are generated from projects and the collection community does not have the funding needed to manage these collections. We do not know how fast the community is losing collections. We need to

start broadening the user base for collections by: 1) creating and maintaining new types of collections, and 2) geo-referencing specimens with regard to exact geographical location and description of the point of collection. We also need to determine how to deal with redundancy and stewardship of collections. (One suggestion regarding stewardship was to house some collections at undergraduate institutions to provide students with experience in using and maintaining collections.)

It was pointed out that not enough collections are available digitally. While DBI/BRC is correct to emphasize digitization projects, it was suggested that the program stop making 5-6 smaller awards a year for digitization projects, and instead, to create one big project that spans 5-10 years. In this regard, an effort should be made to prioritize the items that need to be digitized and the collections that are most important to be digitized, and to determine the appropriate research uses of each digitized specimen. Advisory Groups could prioritize projects. In addition, we could look at what other countries are doing and learn from them. Mexico sent teams of researchers to database extant collections; biodiversity maps were a byproduct of this effort. It was pointed out that the Assembling the Tree of Life (AToL) program generates lots of new types of specimens – tissues and DNAs.

The following questions arose:

- How is the digitization going to track the DNA?
- Should there be report requirements for potential funding?
- What are other agencies doing regarding collections?

Discussion 3 - Broadening Participation (Juliette Bell, discussion leader, with Muriel Poston, Michael Mares, Barbara Wakimoto and Parag Chitnis, BIO liaison)

The discussion began with some background information and went on to highlight some of the more compelling issues.

NSF measurements of the percentage of underrepresented PIs that are funded and percentage of proposals that are submitted by underrepresented PIs indicate that members of underrepresented groups were more likely to get awards than members of a non-underrepresented group, but that the numbers of awards and the dollar amounts were lower. It was noted that assessment was confounded by the fact that PIs (and reviewers) often do not report their ethnicity.

It was pointed out that not everyone in science is doing research that is appropriate to NSF. Other federal agencies historically have funded more applied research that is typically being done in minority serving institutions. Still there are gaps within BIO that are not attracting underrepresented groups.

A primary concern was how to collect better data on broadening participation. There are currently no data on how well NSF is doing in bringing in more underrepresented groups or which programs are successful. Indeed, success needs to be defined. For example, what are the distributions among incoming applications of URMs and women? Can these numbers determine the problem and suggest potential solutions. Can we look beyond the surface data and find other useful corollary data. The Research Initiation Grant (RIG) program was recognized as an important BP investment; however, there were several questions. How many applicants are there? What is the trend over time? What can be done encourage applications?

Some possible measures include improved recruitment of underrepresented groups to NSF; use of outside contractors to asses BIO programs targeting underrepresented groups; and increasing the number of underrepresented groups getting doctorates (data that show that most students come out of HBCUs). Another suggestion is to start sooner in children's education, K-12. BIO is partnering with the EHR directorate to reach out to K-12 students.

Discussion 4 – International Activities (Barbara Schaal, lead, with Michael Donoghue, Daniel Wubah, Chris Comer, David Stern and Peter Arzberger, BIO liaison)

The discussion began with the observation that the health of US science increasingly depends on interactions between the US and other countries, and that we must find mechanisms that facilitate these interactions as simply as possible. It was suggested that there is a bifurcation between science as a diplomatic tool and science for research. The diplomatic avenue provides a different set of problems and outcomes.

Expanding peer review: Can NSF partner with other countries to increase the pool of reviewers by tapping the resource of international reviewers?

Research team infrastructure: The US Group on Earth Observations was cited as an example of international partnering.

Which guidelines should be considered for BIO international activity?

- Basic sciences
- Form partnerships that mitigate unnecessary competition
- Projects that are too big for BIO alone, e.g., tomato genome
- Should we consider partnerships with private corporations?
- Graduate training (e.g., Singapore has strong graduate training.)

According to the National Academy of Sciences, the US has an important international role to play.

- What is the community's view of the utility paying dues for US membership in international scientific unions (e.g., ICSU)?
- What are the roles of these unions
- Does NSF query the attendees to meetings of these unions? (There are 5 unions with different answers to offer.)

High Risk Projects – Examples from the BIO Portfolio presented by BIO Program Directors

- Nily Dan – Developing an axiomatic theory of evolution; constructing a general mathematical theory of evolution that allows deriving special cases

- Matt Kane - Multi-scale modeling of non-linear biosphere-atmosphere-hydrosphere interactions; data model assimilation

- Jim Deschler – What is the genetic basis of morphological diversity between species?

- Mary Chamberlin – Aggregations of organisms

- Karen Cone – Single molecule tools for evaluating histone modifications in single living cells

- Elizabeth Vierling – Elucidating the central pathway of microbial electron transport systems in complex consortia

- Steve Ellis – Flat sheet microscopy and photothermal flow cytometry

- George Gilchrist - EAGERs: The Mechanism of Induction of Plant Galls; and Atmospheric Transport Barriers and the Biological Invasion of Toxigenic Fungi in the Genus *Fusarium*

Friday, September 11

BIO Short News Presentations

Jane Silverthorne presented on Basic Research to Enable Agricultural Development (BREAD), a 5-year program funded jointly by NSF and Bill & Melinda Gates Foundation, with the goal of funding science-based solutions to problems of smallholder agriculture in developing countries.

Joanne Tornow presented a synthetic biology "Sandpit" update. Awards for projects were made by both NSF and the Engineering and Physical Sciences Research Council (EPSRC) with start dates of Sept 1, 2009. Projects are: 1) Cyberplasm: An autonomous micro-robot constructed using synthetic biology; 2) Programmable Rhizosphere; 3) Engineering Genetically Augmented Polymers; 4) Synthetic Integrons for Continuous Directed Evolution of Complex Genetic Ensembles; and 5) Synthetic Aesthetics.

Liz Blood presented a NEON project update. She discussed the NEON Environmental Assessment and the Preliminary Design Review, which was completed in two stages: Stage I was the NEON Science and Observatory Design Review; Stage 2 was the Project Scope, Cost, and Schedule. The next steps are the Final Design Review and Final Design and Development Stage.

Penny Firth presented an update on the LTER 30-year Review. The goal: Documenting, analyzing, and understanding ecological processes, patterns and phenomena, which vary along temporal scales.

Judy Verbeke presented a Synthesis Centers update. BIO funds 4 synthesis centers: 1) National Center for Ecological Analysis and Synthesis (NCEAS); 2) National Evolutionary Synthesis Center (NESCent); 3) iPlant Collaborative; and 4) National Institute for Mathematical and Biological Synthesis (NIMBioS).

Discussion 5 - Environmental Research and Education Advisory Committee's "Green Report" (Joe Travis, discussion leader, with Michael Mares and Penny Firth, BIO liaison)

Discussion comments and questions included the following:

Response to NSF Dear Colleague Letters is not as good as expected. Dear Colleague Letters often don't elicit the number and kinds of proposals as hoped. There has to be an effort made to inform education policy makers about topics. One idea is to use synthesis centers to target issues raised by Green Report, but there are still many gaps.

The ERE-AC is advocating for the NSF to lead a major initiative in the research of coupled natural and human systems among several agencies. AC members are in full support of NSF being a player in

research, political and education aspects. How does this effort coordinate with other agencies? Is there duplication? There are other agencies sponsoring some of these types of research. NSF is not talking about another LTER style project.

What is NSF's role in influencing skeptics of climate change and other human-driven economic changes? Educating the citizens on these topics is very important. It is important to find solutions to problems, and to understand the full extent of the problems so that solutions don't in fact make things worse. Without a better understanding of the systems we are just guessing at solutions. NSF would do best to provide the clearest possible evidence and then hand it off.

How do the results of scientific research plus big questions get communicated to the public? OLPA

How about collaborations with the private sector? BREAD

Lunch Meeting with Drs. Arden Bement and Cora Marrett

Dr. Bement announced that the FY 2010 budget had been approved on the floor of the House and at the committee level in the Senate. He further noted that NSF put in an ambitious 2011 budget request; however, the deficit concern could be a factor.

The following topics were discussed:

Undergraduate biology education. What can NSF do as an agency to take advantage of the excitement generated by the Vision and Change Meeting? One of the ideas was assessment. Many are teaching courses but not adept at assessing how students are learning.

> *Assessment practices have changed. Many programs used to wait until end of program and then assessed the effectiveness of the program. Now the emphasis is on self assessment and third party assessment. Assessment has become much more quantitative in performance goals, with more emphasis on how we evaluate at different stages throughout the program.*
>
> *The Senior Management team completed a report about what should be done and where the needs are in STEM education. There will be emphasis on hands-on learning, peer-on-peer learning, self-directed learning, and much greater emphasis and use of cybertools.*

Research Collections. There are many valuable collections around the country containing specimens that are in danger of decay. Discussion followed on digitizing as many specimens as possible.

> *Dr. Bement said that NSF has been working with Smithsonian and other private organizations. There are many issues involved with digitization, e.g., copyright, intellectual property. NSF will invest in the areas where the Foundation can be helpful.*

Broadening Participation: Assessment questions included: How do we know what is working, what are the baseline data, what are the tools in place to see which of the programs we should continue and which ones we need to modify? Given that we have the framework, where do you see the next steps in dealing with the issue of BP, and has any consideration been given on how to assess success with the programs currently in place.

Drs. Marrett and Bement responded that they are starting to think of assessment as what the community has to be responsible for and what NSF has to be responsible for. Talks on what exactly NSF is trying to do and how well are they doing it are very much on the top of the agenda. The willingness or unwillingness of the community to identify themselves really limits the Foundation in assessing success of broadening participation activities. NSF has been successful in the ADVANCE program: success is shown in all education levels of women and underrepresented groups, but this is linear with a small slope.

BIO AD search. Dr. Bement reported that the search for a new BIO AD was started early and covered a lot of ground and will stay open until the right candidate is found.

New NSF obligations include:

- Climate change effect on ecology
- National cyberinfrascture to deal with problems at a higher level of complexity

Dr. Bement noted that all these climate issues sooner or later involve policy issues

New Building. Internal working group and contractors are developing plans for space. If NSF stays in Ballston, additional space will be required.

Award structure. What metric is used in trying to create a balanced portfolio?

Dr. Bement replied that it should be reflective of what is going on at the universities and that science is going to more open interactions. There is a political problem with people expecting science to return results quickly.

Dr. Bement also said that supporting universities distributes money throughout congressional districts. These are long-term re-investments because you get a recurring return. It was noted that NSF helped NIH find additional reviewers for their grants and worked with NIST on some of their centers

New Campaign - Penny Firth presented a new campaign in DEB called Dimensions of Biodiversity, a 10-year campaign to characterize the dimensions of biodiversity on Earth.

The Fall Advisory Committee was adjourned at 2:00pm.