Meeting of the BIO Advisory Committee
Summary Minutes
April 22-23, 1999

THURSDAY, APRIL 22 - MORNING SESSION

Welcome & Introduction of New Members, Dr. Mary Clutter
Dr. Mary Clutter, Assistant Director for the Biological Sciences (BIO), welcomed the new members in attendance, Dr. Kerri-Ann Jones and Dr. Leonard Krishtalka, and noted that Dr. Larry Vanderhoef was also joining the committee but could not attend this meeting. She announced that Dr. Gwen Jacobs will be the new chair of the committee in FY 2000. Dr. Clutter then extended a welcome to the new ex officio member from EPA, Dr. Norine Noonan, and announced that the new liaison from CEOSE, Dr. Joe Martinez, also could not attend this meeting. She then announced that later in the meeting Dr. Stephanie Pfirman, Chair of the Polar Program AC, would join the meeting in a liaison capacity.

Dr. Machi Dilworth introduced a visiting scholar from Japan, Dr. Miki Ohba, spending her developmental leave in the United States studying the US system for support of scientific research.

Remarks and Approval of Minutes, Dr. Frank Harris
The minutes of the October 22-23, 1998, meeting were unanimously approved. Dr. Harris welcomed Dr. Jacobs as the next chair and stressed the importance of interactions with other AC chairs and Director's office. He then gave a brief summary of the March 1999 meeting of AC Chairs with Dr. Colwell. He noted that many of the issues discussed at that meeting were embodied in their agenda and that Dr. Colwell asked the ACs to discuss these issues and provide feedback, especially in the following areas:

- cost sharing;
- broadening participation in NSF programs, particularly in increasing the diversity of institutional participation. A real opportunity exists to achieve integration of education and research as increasing numbers of graduate students enter academia outside of the top 100 research institutions. Dr. Harris expressed the opinion that BIO could be a

strong player.
- information technology and the tie between its development and application;
- Biocomplexity and the role of biology in the environment;
- international science-the role of NSF and BIO; he noted the establishment of an NSB Task Force on International Collaboration and Partnerships;
- the evolution of GPRA-the first "real" report is due March 2000-in preparation for this, directorates (including BIO) and NSF have been generating mock reports.

These are some of the questions and issues that will be addressed throughout this BIOAC meeting.

Discussion of FY 2000 Budget Request and BIO Initiatives, Dr. Mary Clutter
Dr. Clutter conveyed Dr. Colwell's budget planning perspective to the group. Instead of looking at outyear budgets as a dismal picture, Dr. Colwell is looking at what we need to accomplish our goals in the outyears - a very liberating perspective. As to the FY 2000 budget request, Congress must take into account many issues and it is likely that there would not be any feedback until late September.

Dr.Clutter went on to outline some of the Administration initiatives included in the NSF FY 2000 budget request: IT2 - a $366M investment for FY2000. There is $146 million in NSF's FY 2000 budget request that would fund a grid of machines and software forming a terascale computing system ($36M), with the remaining $110M to be spent on research, including ethical, social and workforce issues.

Another big initiative deals with the environment -- Integrated Science for Ecosystem Challenges -- $90M is requested for this area in the President's budget request. Within NSF's request, Biocomplexity in the Environment gets $50M for Phase 2 in FY 2000. Dr. Goldberg asked if Biocomplexity is limited to ecology and ecosystems. Dr. Clutter replied that it is not and that input from the BIOAC will help to shape the Biocomplexity initiative.

In the area of plant biology, the sequencing of Arabidopsis will be completed by the end of CY 2000 providing an excellent resource for plant functional genomics. In the first year of the Plant Genome Program, NSF funded 12 virtual centers and convened a meeting of the plant genome PIs that turned into an exciting and interesting exchange.

In the area of Education for the Future (EFF), BIO has requested $51.39 million for FY 2000, an increase of $2.8 million. This includes REU, IGERT, CAREER and microbial postocs.

Dr. Quatrano asked if the decrease in number of proposals over the last couple of years coincides with BIO's decision to no longer fund duplicate submissions to another agency. Dr. Clutter clarified that the BIO policy is "no simultaneous review." BIO will still accept duplicate proposals but will only review them at the same time as another Federal agency if they meet one of two exceptions-(1) prior agreement by both agencies to joint review with possible joint funding or (2) proposals from beginning investigators (as defined in the Grant Proposal Guide). She went on to say she does not think this policy is the reason for the recent decline in proposal submissions. Dr. Horsch reported that a recent committee of visitors concluded that even if the NSF budget were quadrupled, the agency would still have plenty of high-caliber reviewed awards to fund that are normally forced to be left on the table. Dr. Noonan speculated

that perhaps new investigators are easily discouraged after a couple declines. Dr. Villa-Komaroff agreed that young faculty are very easily discouraged. Dr. Wake suggested that in the time it takes to write a good grant you could write two research publications. She asked where is the time investment best applied?

Dr. Chuck Liarakos pointed out that the problem in MCB is not with funding rates but with award size.

Dr. Clutter briefly discussed FY 2001 in terms of opportunities and unmet needs. Each Assistant Director was asked to provide examples of unmet needs that could be met by a substantial increase in the NSF budget.

The BIOAC responded:

- strengthen discipline research by (1) increasing success rate to 35%, (2) increasing award size to $200,000, and (3) incorporating genomics technologies more broadly;
- establish a National Ecological Observatory Network, consisting of 20 observatories from pole to pole to enable the study of biocomplexity (molecular to ecosystem level), in a consortium approach. The Network would be able to predict dynamics of species distribution and abundance, lead toward global climate understanding, link universities, involve K-12 participation, and provide outreach to the public;
- establish a total plant genomics project. By 2010, we could determine the functions of the 25,000 genes of the Arabidopsis genome.

Dr. Fraser commented on current approaches to functional genomics and the need to develop technology on a genomics-wide scale. She asked how NSF can help develop this technology. Dr. Quatrano said that by expanding plant genomics to include a wider range of plants, beyond crop plants, with today's technology we will get more function. Dr. Jacobs said that partnering with the CISE directorate for the IT2 component is a necessity to tackle these goals.

In summary, the cost of these unmet needs in BIO alone is over $1 billion. Several "speed bumps", such as sharing of information will have to be resolved. There is some duplication of federal and private sector funding in genomics, but this is necessary because government focuses on the long-term while the private sector generally focuses on the short-term. Dr. Noonan reemphasized this, and added that confidentiality agreements are becoming more commonplace and that universities need to be prepared to stand up to industry and private sector contacts and agreements. There is a tremendous benefit from private sector collaboration, but the pitfalls need to be identified and worked through. Education of industry and of academia is needed.

Information Technology for the 21st Century
BIOAC Discussants: Dr. Ellen goldberg (lead), Dr. Ralph Quatrano, Dr. Leonard Krishtalka, Dr. Gwen Jacobs
NSF Staff: Dr. Maryanna Henkart (Lead), Dr. Machi Dilworth, Dr. Bruce Hayden

Dr. Maryanna Henkart opened with a quote by Michael Levitt: "Computers have changed biology forever, even if most biologists don't know it yet." She presented the PITAC (President's Information Technology Advisory Committee) report recommendations -

development of enhanced, robust software; development of scalable (internet-like) information infrastructure; development of high-end computing; and socioeconomic impacts and needs for training and education. She then summarized BIO's IT2 needs including: robust software, electronic networking, wireless technologies, high-end computing, and education and training.

Dr. Gwen Jacobs served on an NIH panel looking at these issues and presented a brief report. The group was charged with identifying the challenges and opportunities in biomedical computing. In this arena, NSF is way ahead of NIH. Two major areas where there are needs and challenges are: (1) work-force issues, including the lack of trained personnel in the labs and lack of student interest in this arena; and (2) access to resources. She talked about the need for access to supercomputers to conduct research. Resource access including computer clusters and reliable software is needed at home institutions.

The NIH panel report is due out in the first week of June. It will include stories and descriptions of what the centers will do. Two solutions are to establish two levels of resources at a total funding level of $200 million - $250 million; (1) training centers driven by a scientific question, where students will receive bioinformatics training, solving shortage of trained personnel; and, (2) providing more equipment at the institutions in the forms of computer clusters, access to supercomputers, and software development. Questions NIH will need to consider are: Is there a review mechanism for handling such proposals? Would panels be willing to fund a programmer as a member of a laboratory? How are physicians going to be trained to use these resources (i.e. immersion training at the centers)? She also asked what the money for these centers will actually do. Will it drive institutional change to hire faculty members in bioinformatics? Institutions need to embrace this new area and be prepared to bend departmental boundaries. She said that the only way that this can happen is to require biology students to take more math and more computer science.

In the panel discussion, bioinformatics was defined as the computer-assisted acquisition and integration of data within and across disciplines in a research context. The panel said that there is a need to encourage cross-training between biological and mathematics/computer science disciplines. Such cross-training should start at the undergraduate level while also including faculty so that they may develop adequate skills to teach students. The panel's concerns regarding IT in bioinformatics included the fact that biologists often consider it to be a "service industry," involving the curation of databases, software, etc. We need the inclusion of hypothesis-driven bioinformatics to maintain research-driven bioinformatics. There are not enough people to meet both the service and research needs of informatics, which leads to rapid burnout of creative people. Integrating biology and computer science would require the presence of theory-, modeling-, and hypothesis-driven research across the two disciplines.

Opportunities for future biology/computer science informatics research include considering research on some aspects of biocomplexity as potential models for complex behavior of computers and computer networks since computer networks are themselves complex systems. Thus, NSF could take the lead on developing software that will make complexity tractable. NSF should serve as facilitator for cross-discipline research. Possibilities include developing initiatives to encourage biology and computer science graduate students to work together, with graduate students work in teams involving biologists, computer, political, and social scientists.

The steps we need to take now: (1) develop a white paper regarding what bioinformatics is and what NSF (BIO and CISE) can do to help it develop in ways useful to biologists; (2) what type of initiative and activities NSF can then do to encourage this type of research; and, (3) more advisory committee cross-talk. The current and incoming BIO chair were encouraged to facilitate cross-AC collaboration.

LUNCH -- "What's Happening at EPA Overview", Norine Noonan, EPA
Dr. Norine Noonan, presented a brief synopsis on EPA. The EPA was created 30 years ago from pieces of other agencies and doesn't have any organic statute. EPA's major responsibility is regulatory. Fully half of EPA's portfolio is the protection of human life. The EPA has strong, active collaboration with NSF and other federal agencies, international bodies, industry, as well as state, local and tribal governments. Dr. Noonan gave a summary of EPA's current funding plan. She then gave examples of ongoing ecological research and collaboration with NSF and other agencies (SBER, Water and Watersheds, etc.). The EPA awards around $100 million in competitive grants each year. There are no unsolicited competitions; requests for proposals are only in specific areas. Dr. Noonan gave a summary of the EPA GPRA plan. Monies are allocated by goal in accordance with GPRA. EPA is relying on its Science Advisory Board, NAS, and ORD committees to develop goal reporting on such questions as: How can they demonstrate that goals are being met? Smaller applications of pesticides would be an output. How that affects human health would be an outcome. That is difficult to get a handle on.

Dr. Clutter took this opportunity to announce that in the week to follow, Dr. Robert Horsch would be awarded the National Medal of Technology for his work on recombinant DNA, plant tissues, and somatic cell genetics. The committee members took great pleasure in this and congratulated Dr. Horsch on his accomplishments.

THURSDAY, APRIL 22 - AFTERNOON SESSION

Biocomplexity in the Environment
BIOAC Discussants: Dr. James Collins (Lead), Dr. Claire Fraser, Dr. George Jones
NSF Staff: Dr. Joann Roskoski (LEAD), Dr. Bruce Umminger, Dr. Charles Liarakos

Dr. Joanne Roskoski presented summary slides of biocomplexity-like research at NSF over the last 10 years (though it was not called biocomplexity at the time). Dr. Roskoski summarized the Biocomplexity Phase I competition. This competition focused on micro-organisms in biological, chemical, geological, physical and social environments to keep the first competition small. There were 113 pre-proposals, which involved 525 involved researchers and requested a total of $325 million; 34 pre-proposers were requested to submit full proposals. The full proposal panel is August 5-6. A total of $11 million is available for the Phase I competition.

The working group for the Phase II competition, representing all of NSF, was charged by Dr. Colwell to come up with a scope and plan for Phase II implementation. They are looking to publish an announcement for Phase II later this year. Advice for planning the Biocomplexity Phase II Program Announcement suggested that consideration be given to (1) requiring inclusion of a specific model, and (2) focusing on properties of complexity (such as emergent properties, feedback, hierarchies, sensitivity to initial conditions, etc.) that could be illustrated

and understood in biological systems in conjunction with other disciplines. There was concern that there be focus so that not every area of science could apply.

Question 1: Why do biological systems afford a special opportunity, offer special challenges, and serve as special models for understanding complexity?

- Unlike physical or chemical systems, each biological system has some unique properties.
- Biological systems are self-replicating and self-sustaining, whereas other systems are not.
- Biological systems are scalable and hierarchical in space and time whereas other systems are not scalable the same way; multidimensional across all levels of hierarchy whereas other fields are not.
- Components of biological systems are individuals.
- We have the conceptual framework along with the computational tools to examine complex biological systems and explore the field of biocomplexity.
- Cautionary note: In order to address biocomplexity adequately, model building must transcend to all areas of biology.

Question 2: What are the special opportunities at the interface of biology and other disciplines for studying complexity?

- Opportunity for understanding the mechanisms by which connections between the different levels of biology occur - i.e. signal transduction at cellular level and its impact on other levels, social sciences impact at the biome level, etc.
- Biology lies at the interface of order and chaos. By investigating complexity, we may discover that a narrow focus and lack of understanding led to the classification of some systems as chaotic.
- Opportunity for biologists to learn from other disciplines, i.e. physicists who believe there is always an answer while biologists do not. Other disciplines develop analysis tools that can be adapted to and applied to biology.

Question 3: Does our approach to doing science and the nature of the research effort change for complex systems? How can we foster research in biocomplexity?

- Encourage working in groups and overcoming the "language" barrier between disciplines; this needs to be fostered in the institutions.
- Shift focus from hypothesis-driven proposals to proposals that are a combination of hypotheses and also built around a working model of the system.
- Concerns:
    - Will limited budgets discourage groups of people from pulling together to submit proposals?
    - Will focus fall towards larger institutions with more resources already in place?
- Ways to address concerns:
    - Tools of the computer and internet may allow collaboration at individual institutions to spread to multi-institutions.
    - Groups and conferences can facilitate discussion between institutions and across disciplines. It may be important to bring modelers and experimentalists together in

groups to talk before reaching the large STC-scale grants.
    - Don't overlook virtual centers in favor of STC centers. Value that could be added from any institution would be lost going with an STC-type organization versus a virtual center-type structure.

Partnerships: International/Industrial
BIOAC Discussants: Dr. Marvalee Wake (Lead), Dr. Kerri-Ann Jones, Dr. Robert Horsch
NSF Staff: Dr. Machi Dilworth (Lead)

Dr. Wake remarked that although relatively few US scientists are involved in international/industrial partnerships, overall interest is increasing. Many scientists do not know how to set up or look for such partnerships. Possible ways or avenues to encourage partnerships:

- Hold meetings, symposia, etc. to bring industry and researchers together. Encourage industry involvement in editing journals, reviews, etc. to expose industry to research and influence the way they think.
- Opportunities for partnerships in bioinformatics are probably much wider spread in industry than other educational institutions.

Partnerships with industry are important in order to reduce the tremendous duplication of effort in scientific areas such as genomics. The issues surrounding intellectual property values would have to be addressed. It was suggested that since industrial partnership is such a complex topic, it may be helpful to focus future discussion on a single issue within this topic.

Foreign countries tend to view NSF as unwilling to fund broadly international science and also view US scientists as relative isolationists. How can NSF shake this misperception?

- Facilitate new types of collaboration, posing a question on a grant that would lend itself to international or industry collaboration. Research that contributes to biomedicine and agriculture can be easily used to forge industrial partnerships although other areas need to find ties with industry. Set up areas for matching support.
- Biology is gaining more interest worldwide, and foreign agencies will be looking at what NSF and BIO can do. NSF needs to spend time developing a program, understanding the players, and understanding the "rules" of the partnership design. Complexity is a global issue, and centers, virtual or realized, will be important to establish worldwide and need international cooperation.
- NSF could set aside a sum of money earmarked for international projects. The new European community now has a European pot of money for research, which could provide an avenue for NSF to get involved in international funding.

NSF can and should play a unique role in fostering science-based (not politics-based) international partnerships. The value of these partnerships include realization of the political and social issues of the other parts of the world.

New Approaches to Undergraduate Biology
BIOAC Discussants: Dr. Laura Hoopes (Lead)
NSF Staff: Dr. Grace Wyngaard (Lead)

Dr. Hoopes led the panel discussion which can be summarized by the following:

- Undergraduate education must incorporate the needs of the biocomplexity scientist by incorporating problem-solving coupled with writing, collaboration with humanities and sciences, as well as more mathematics, statistics, and computer science coursework. CISE and BIO directorates may be able to facilitate this effort.
- The institutional barriers for reforming curricula and providing interdisiciplinary education for students are considerable. Universities should avail themselves of 'renegade faculty' who cross traditional departmental and disciplinary boundaries to develop IGERT-like activities for undergraduates. The BIO Directorate should explore modifying the current IGERT competition to accomplish this.
- Team-teaching classes and problem-solving sessions with other departments could serve to challenge students across disciplines. We could provide funding for faculty to develop and implement new curriculum changes.

FRIDAY, APRIL 23 - MORNING SESSION

Remarks, Dr. Rita Colwell, Director, NSF
Dr. Colwell said that we need to increase NSF's budget to reflect the importance of basic research and education. Current success rates (low) do not reflect the quality and caliber of the proposals. NSF should make a case to Congress that insufficient funds prevent NSF from supporting and doing important projects.

Biocomplexity is an important issue in that it brings together the complexity that has been fermenting in all disciplines. Building prediction models will help reach decision making goals in environmental policy. Dr. Colwell also said that BIO and CISE need to work together on the IT2 project to develop a white paper initiative. In addition, EHR and BIO AC should work together to develop initiatives with undergraduates to encourage bioinformatics and that perhaps an undergraduate IGERT could foster this development.

She also said that STCs and similar ways of increasing the quality of science and building infrastructure provide important ways to change communities. STC's need to be strongly encouraged to strengthen the education and diversity of their own institution in addition to reaching out to other institutions. Also, more minority post-docs and graduate fellowships are needed to increase PI diversity.

NSF Issue Discussion: Proposed Cost Sharing Policy
BIOAC Discussant: Dr. Lydia Villa-Komaroff
NSF Staff: Dr. Thomas Quarles (Lead)

Dr. Clutter noted that the NSB has not yet passed the cost-sharing policy. Dr. Villa-Komaroff said that cost sharing hasn't been much of a problem in BIO much, but in other directorates it is an issue. Some BIO programs, like instrumentation, require 30% to 50% cost-sharing, written up front. However, sometimes a cost-sharing requirement is not written in the

announcement and not mentioned in the proposal, and then at panel such a lack may hurt a proposal with no mention of cost sharing. Program Officers sometimes impose cost sharing as a way to spread small budgets across a larger number of awards. She then summarized the new cost-sharing draft policy. When applicable, cost-sharing must be mentioned in announcements. No bargaining on cost-sharing is allowed after awarding a proposal. Differential cost sharing for different size programs can occur.

In the panel discussion, Dr. Collins pointed out that with some larger grants, such as LTERs, cost-sharing may be an issue, and that cost-sharing is also required on IGERTs. Dr. Jacobs asked if there could be any hope of a cost-sharing sliding scale? Dr. Villa-Komaroff said that there is a problem with enforcing the cost-sharing policy in the review process. Dr. Edwards said that program officers must play a role here. Dr. Harris said that we must eliminate perception that increasing cost-sharing above required amounts will give proposals advantage, and eliminate games institutions can play games with overhead. Dr. Ensley suggested that the cost sharing component could be submitted separately so it isn't an issue at review. He pointed out that institutions with the largest overhead can play the most games with cost-sharing. Several examples were mentioned regarding institution cost-sharing and overhead policies and STC cost-sharing where the larger lead institutions assumed more of the cost-sharing. Dr. Harris asked if the GPG language would change? Dr. Quarles replied yes, when the NSB votes it into policy. Dr. Lydia Villa-Komaroff suggested we make cost-sharing issues clear to review panels before they begin looking at proposals.

Dr. Edwards asked for input on last paragraph of the draft. After discussion on this issue, there was a motion to reword the last paragraph to the effect that, with a reduction in budget, the PO, PI and SRO will work together to determine the effect and any reduction in scope. Dr. Lydia Villa-Komaroff provided the following rewording:

> "In budget negotiations, reductions of 10% or more in proposed budget should be accompanied by an assessment of the scope of the proposal such that the scope of the proposal reflects the work that can be carried out with no expectation of uncompensated institutional contribution beyond those formally reflected as cost sharing. In the event that the scope is modified, the modified scope should be provided along with the modified budget."

Additional Discussion

Dr. Chuck Liarakos talked about the NSF CAREER workshop, giving snapshot views of some of the break-out discussions. This meeting of CAREER awardees was held in January 1999, with one day focussing on all of NSF, and one day directorate-specific. The workshop was attended mostly by 1st or 2nd year awardees, along with some 4th year individuals. The overall consensus was that the awards allowed them to do what they would otherwise not be able to do. Some indicated that if CAREER was their only support, then publications and research would suffer, which will have impacts at tenure time. But, overall, they felt that the awards were good for their career. There were some discussions on the future of the program. CAREERs aren't renewable, but should that change? Should eligible PI's be expanded to include mid-career folks, etc.? All participants were asked to comment on the effect of

CAREER awards on their careers. This was also asked of non-CAREER awardee control groups. Questionnaires also went to department heads. The resulting report is due out sometime this summer. The biggest benefit of the meeting was the opportunity for networking, sharing ideas and experiences and problems of education and research integration. Enthusiasm was high for continuing CAREERs.

Dr. Joann Roskoski said administrators see curricular reform and modernization as a big plus, and some CAREER awardees have been hired for that. Dr. Jacobs asked if there was any mechanism for long-term tracking of CAREER awardees? Dr. Liarakos said that NSF is starting to ask for that type of information. Dr. Edwards said that one of the GPRA performance indicators relevant to education and research integration is that at least 25% of the research grant proposals will specifically address said integration, and at least 25% of proposal reviews will address said integration.

GPRA Discussion, BIO FY 1998 Mock GPRA Report
BIOAC Discussant: Dr. Burt Ensley
NSF Staff: Dr. James Edwards (Lead), Ms. Sonya Mallinoff

Dr. Edwards started by saying that NSF's budget is not specifically oriented towards GPRA goals, rather GPRA goals permeate what we do. In the case of NSF, outputs include numbers of awards, personnel supported, publications produced, etc. NSF is going to try and focus on outcomes, where committees of visitors and ACs come into play. He then presented a summary of the GPRA process. COV templates have been modified to address GPRA goals. Only 1/3 of NSF's programs are reviewed every year, so there will be a lot of material needed to bring to bear GPRA results for the other 2/3 - program annual reports for example. BIO will present FY 1999 data at the December 1999 AC meeting, and the AC will evaluate BIO on the GPRA criteria. The AC's report will then go through AD, OD, NSB and then the Congress.

Ms. Sonya Malinoff presented a Directorate Annual Self-Assessment Report, a mock report for FY 1998. The COV process is probably the most important component, program annual reports cover the rest. Only one BIO COV to date was specifically structured to address GPRA. This year COV and annual reports have very structured templates to address GPRA requirements. This implementation for 1999 will make the GPRA reporting process easier.

Dr. Ensley said that no one likes generating or assessing reviews, but they can be very valuable and give a lot of information. There are three areas of performance evaluation:

1. Performance - what have you done well?
2. What have you done that you could have done better, or done better with outside contribution?
3. Goals should be specific, measurable, achievable and challenging (SMAC).

He asked what are the NSF BIO goals and are they SMAC?

Dr. Horsch said that the two benefits of reporting include: reporting to get a grade to be able to keep going, and secondly improve internal performance; i.e. developing best science and high-risk portfolios, use of and improving peer review system, increasing and promoting diversity

Dr. Ensley said that we have expressed the need for a diverse, globally-oriented science and engineering workforce. NSF takes this very seriously, and has done a tremendous job, however, this is difficult to evaluate objectively. Dr. Ensley doesn't think that NSF has identified the factors affecting performance over which NSF has no control.

Dr. George Jones asked what happens to a minority PI after a decline? Does he or she resubmit? Is there any help or encouragement provided to encourage resubmission? We need to look at successful programs in other agencies to help increase minority success rates at NSF.

Dr. Ensley said that improved mathematics and science skills are needed by all Americans. The rating of N/A for this area in the BIO Mock Report suggests BIO did nothing and does not care. This is a shared responsibility of all NSF directorates, and some reporting needs to be included in the BIO report. Dr. Jacobs said that PI's need to report both on the number of personnel receiving training by working under a grant, and on how knowledge from a grant is being shared in classroom experiences. Dr. Liarakos replied that CAREER reporting will address some of Dr. Jacob's points.

During the panel discussion, Dr. Ensley asked if, as written, the NSF GPRA goals are appropriate. Dr. Horsch said that we could include indicators as to what the connections and discoveries are. Dr. Pfirman said that questions that are asked in PI annual and final reports should be aligned with the GPRA goals. Also mentioned was the danger in that the agencies that will gain the most and need to gain the most from GPRA will do the worst job in reporting and give themselves the highest grade.

Dr. Edwards said that the new project reporting system allows PIs to add future results to their final project reports. He asked how we can encourage PI's to continually submit updates, and then how would NSF get at and report on this information.

BIOAC will form a GPRA subcommittee to review, in detail, the yearly GPRA report and come to the December meetings and give a report card report to the full committee for discussion.

WORKING LUNCH, Report on BIOAC Workship, "Computing in Life Sciences", Pomona College, April 25, 1998, Dr. Laura Hoopes

Dr. Clutter briefly described a series of workshops developed and organized by AC members around the theme "integration of research and education." There have been nine workshops to date each addressing an area or topic of interest to the AC member's community and/or region. Dr. Clutter invited other members who might be interested in organizing a workshop to contact her. Each workshop must produce a report that the AC member can present at a subsequent meeting. BIO can provide limited funds for incidental expenses such as conference space and limited travel expenses if necessary. Reports of the workshops are available on the BIOAC web site.

Dr. Hoopes said that two main questions were asked at the workshop she organized:

1. Is computing in the life sciences bringing teaching and research closer together? She summarized the speakers comments. There was a general discussion on whether or not

research and teaching are brought together via computer resources in the life sciences. The problem of support was addressed. For example, computers must be reliable, personnel able to troubleshoot, to keep the systems running, and to train users, must be made available. Virtual versus real lab experiences were discussed - some real lab experience must be there, but the two could work together. It was asked what could be measured to determine if computers are bringing education and research together. Biology alumni at Harvey Mudd were asked what was most important aspect of undergraduate education. They responded that writing experience and real life research experience were the most important.

2. What concerns are there about computer infrastructure in biology? Dr. Hoopes summarized the discussions of infrastructure needs that arise from the increase in use of computing in the life sciences. Students need to have more knowledge of the techniques that students are using. Too many undergraduate students have weak chemistry and physics backgrounds from high school. Concerns were raised about the expense of replacing and upgrading infrastructure. The consensus feeling was that institutions are not stepping up and keeping infrastructure current. Other discussions included Internet 2 and its importance to institutions.

During the panel discussion, Dr. Collins expressed concern with improving infrastructure in universities. Dr. Clutter addressed the previous suggestion that NSF could establish regional state-of-the-art computing and instrumentation centers that are kept cutting edge, and asked if that would make sense. Dr. Hoopes said yes, but several logistics would need to be worked out, such as staffing, training, and ability of people to travel to the centers. Dr. George Jones indicated that that is how science works in Europe. He asked how you determine at the end if the students have learned more biology, or if they have learned the same biology just in a different way. Dr. Wake strongly supported the idea of shared technology centers - both to benefit smaller schools that have no other means of acquiring such resources, and to foster more interaction between large and small institutions.

FRIDAY, APRIL 23 - AFTERNOON SESSION

Role of Advisory Committee in the 21st Century, Dr. Frank Harris, Chair

Dr. Harris started by saying that the caliber of people attracted to the BIOAC means that the AC could be of greater assistance and have greater influence on NSF. He pointed out that similar committees at other agencies look at 3 budget cycles at a time, and therefore have more flexibility to platform back and forth as needed. He suggested that thinking in these broader time frames would be useful, but take more time. Some augmentation and activity in-between current meetings would be needed. Dr. Harris cited the following areas as ripe ones for the AC to consider developing short whitepapers: technology development for functional genomics; bioinformatics and IT2 and development of new software; education; research integration with examples of how to increase undergraduate participation and diversity; and the GPRA process and planning. He asked for committee input as to taking on more and longer term goals.

During the panel discussion, Dr. Hoopes said that she felt that the rewards of putting more time would be worthwhile. Dr. Harris gave a model example of how BIOAC members would form outreach committees to investigate some of the cited examples. Dr. Jacobs asked to get more reporting on the "new exciting programs" from previous years so investment and impact can be better evaluated. She emphasized BIO's position to be ready to take a lead in NSF regarding biocomplexity and biotechnology.

Dr. Kerri-Ann Jones addressed the need of the AC to develop short, concise whitepapers addressing the topics discussed, and the need to move quickly but also questioned what influence said whitepapers would have. Short papers could have an impact on future budgets. Two roles for the AC to take up are (1) more intensive internal follow-up, and (2) being external voice for the community, increasing community awareness. Dr. Harris said that he would like to see the AC whitepapers written up in Science/Science News. Dr. Clutter said that it would be extremely beneficial to have a subset of the AC committee working with BIO and the community to develop strategic plans for the next 10 years.

Dr. Harris said that the AC needs to be more proactive and proposed areas with which to start: (1) BIO and CISE connection, (2) beyond plant genomics, (3) educational component, and (4) biocomplexity in the environment. Dr. Hoopes mentioned enthusiasm for an undergraduate IGERT. Dr. Clutter commented that the educational initiatives are important, and are an important part of Dr. Colwell's agenda. Between now and December we need to take a hard look at all of the educational programs and what the extent of the education actually is. Dr. Clutter said that we will look strategically at issues and come up with a charge to AC committee members.

Future Business

Meeting Dates:
Fall -- December 2-3, 1999
Spring -- April 24 -25, 2000 (tentative)

Hardcopy minutes approved by W. Franklin Harris for Gwen A. Jacobs, Chair

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