Division of Molecular of Cellular Biosciences
Committee of Visitors 2008

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DIVERSITY DOCUMENT

Committee of Visitors for the
Division of Molecular and Cellular Biosciences
Directorate for Biological Sciences
National Science Foundation

June 11-13, 2008

This document describes the diversity, independence, and balance represented by members of the COV, and the resolution of real or apparent conflicts of interest.

The 2008 Committee of Visitors for the Division of Molecular and Cellular Biosciences (see attached list) was composed of fifteen members, including Dr. Richard McCombie, who represented the BIO Advisory Committee. Eight of the members are female and four members are from an underrepresented minority. Members currently work in eleven different states (California, Georgia, Iowa, Maryland, Massachusetts, Montana, New Jersey, New York, Tennessee, Texas, and Wisconsin) and District of Columbia. Thirteen members are from academic institutions; one is from industry, and one from government.

All files presented to the committee were first scrutinized for possible conflicts with committee members. All conflicts were identified so that committee members would be aware of which files they could not review. Committee members were advised about confidentiality and conflicts of interest both prior to arriving at NSF and at the inception of the meeting. Conflicts issues during the meeting were considered and adjudicated by the division conflicts official.

James Collins
Assistant Director
Biological Sciences

Committee of Visitors Report on the Molecular and Cellular Biosciences Division of the BIO Directorate
June 11-13, 2008
Executive Summary

The Division of Molecular and Cellular Biosciences (MCB) continues to play a critical role in the BIO directorate supporting excellent research and researchers with the goal of understanding biological processes at the cellular, subcellular, and molecular levels and how they impact the global, community, and organismal levels. The Committee of Visitors (COV) found MCB's performance in pursuit of its basic mission to be exemplary. During the review period (2005 to 2007), MCB continued to successfully identify and support outstanding research and education initiatives. In addition, MCB has successfully formulated research portfolios that appropriately address a broad range of NSF and national objectives. MCB is promoting innovative/transformative and emerging research areas, encouraging multidisciplinary research, developing new investigators, supporting research at undergraduate institutions, improving the research enterprise across the United States, disseminating information to scientists and to the public at large, and incorporating underrepresented groups in science. In addition, the COV commends MCB for its efforts to cooperate with other NSF Divisions and public and private agencies outside of NSF.

The most important challenge facing MCB is how to maintain and improve this level of excellence given flat budgets, an increasing number of submitted proposals, and the emergence of new fields of research. Only a small percentage of the proposals judged to be Outstanding can be supported. This, along with other issues identified by the COV and presented in this report, affect the ability of MCB to continue with and enhance its critical mission. Increased resources are clearly required to support a greater number of outstanding research and education proposals and to assist MCB staff in handling the increased workload.

The COV identified the following issues that require careful scrutiny by MCB staff and administration. These issues, along with specific suggestions for improvement, are presented here in brief form and detailed in the body of the report.

1. ***Proposal Review***. While the COV felt that most of the reviews and panel summaries were substantive, the COV believes that the consistency and quality of reviews could be improved if better orientation and training were provided for reviewers and panel members, particularly those who have not previously served as reviewers or panel members. This should include posting of examples of both substantive and deficient reviews for reviewer training.
2. ***Broader Impact***. The COV noted that Broader Impacts need to be addressed more consistently by all panels. It would be helpful if MCB posted actual examples of excellent Broader Impact activities on its website.
3. ***Enhancing Innovative/Transformative Research***. The COV felt that NSF needs to communicate to the scientific community its strong interest in expanding the portfolio of new and innovative research. Applicants should be required to specifically address innovative/transformative aspects of their applications, and reviewers should have a separate section for comments on this criterion. In addition, exceptionally innovative/transformative proposals may require a separate

mechanism for review.

4. ***Support for Early Career Stage Investigators***. MCB has done an outstanding job of supporting PIs early in their careers. However, concerns were raised about the high proportion of investigators who had completed their first NSF grant but failed to obtain a subsequent NSF grant for continuation of the project. The COV suggests that early career investigators be given the option of requesting supplementary funds at 50% of the annual award rate for a fourth year to provide bridge funding if more time is needed before applying for renewal.
5. ***Portfolio Enhancement***. While maintaining support for earlier career stage investigators, the COV also believes that MCB should actively recruit prominent researchers to apply for NSF grants in innovative areas.
6. ***Support for Discovery-Based Research***. The COV felt that MCB should continue to support discovery-based research in addition to the more traditional hypothesis-driven research, and that this commitment should be effectively communicated to investigators and reviewers.
7. ***Transition of Focused Programs***. The COV is impressed by the success of the Microbial Observatories and Microbial Interactions and Processes (MO/MIP) program and concerned about the fate of the innovative science supported by this program (and other successful focused programs). The COV strongly recommends that MCB provide a specific plan for "mainstreaming" such research programs, which will ensure continuation of the science supported by successful focused programs.
8. ***New Scientific Opportunities***. The COV is impressed with the breadth of research areas supported by MCB. It recommends additionally that the following emerging research areas be given serious consideration as having the potential to produce innovative, transformative knowledge and technology.

    - Systems/network biology
    - Metagenomics
    - Synthetic biology at the molecular/cellular level
    - Protein disorder and RNA structural plasticity in the control of biological functions
    - Microbial mediated processes from cellular to community to global scales
    - Epigenetics in eukaryotes, archaea, and bacteria
    - Exploiting unusual or novel model systems
    - Molecular processes in a crowded cellular environment
    - Continuing the emphasis on developing cutting-edge technology (e.g., subcellular imaging)

9. ***Better Tracking of Trainees and Development of Metrics for Scientific Progress.*** The MCB should look for ways to obtain follow-up information on past funded projects and previous trainees without placing an undue burden on PIs or trainees.
10. ***Maintaining Open Lines of Communication***. Effective communication between organizational levels is critical to the continued success of MCB. Although communication between PDs and MCB upper-level administrators has recently improved, communication continues to be problematic at other levels.
11. ***Administrative Staff***. The COV felt that there were significant morale problems

among support staff, who feel that their talents were not being fully utilized by the scientific and supervisory staff. The COV urges MCB to address these problems to enhance productivity at all levels.

This COV report is the result of two and one-half days of discussions by 15 scientists from diverse fields and institutions throughout the United States following the review of records provided by MCB staff and interviews of administrators and staff. All aspects of the report received input from all COV members prior to completion of the final document.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

A.1 Questions about the quality and effectiveness of the program's use of merit review process.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? **Comments:** Frequency of panel reviews is appropriate (2 per year). Panels meeting less frequently should be evaluated to see if two per year is more appropriate.	Yes
2. Are both merit review criteria addressed **a) In individual reviews?** **b) In panel summaries?** **c) In Program Officer review analyses?** **Comments:** Level of detail varied and transposition from proposal to review to panel summary to PD summary was not always accurate.	Most did, but not all (ad hocs) Yes Yes

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals?	

[1] If "Not Applicable" please explain why in the "Comments" section.

Comments: About 15-25% of the reviews were not sufficiently substantive. Some reviews did not expand beyond qualitative statements that were not focused on specific points. More reviews need to address how the proposal can be strengthened. If it does not already occur, the COV suggests that the PDs keep track of reviewers who consistently provide less informative reviews. It was not clear from most reviews how much weight was given to the two criteria, and if broader impact was also judged as excellent/very good/good or fair. (For specific recommendations, see ***C.1)***	Variable
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? **Comments:** It was not clear if this variability was panel specific. All summaries should point out the key strengths and weaknesses and, if it is known, which reviews were most influential. The rationale should be very clear when the panel summary is substantively different from the general tone of the reviews. There should be more communication about whether, if the PI addresses all the issues, this proposal would ever be competitive for funding.	Variable
5. Does the documentation in the jacket provide the rationale for the award/decline decision? **Comments: (see comments above in *A.1.4*)**	Yes

6. Does the documentation to PI provide the rationale for the award/decline decision? **Comments:** When the PD makes a decision that is not consistent with the reviews/panel summary, it is not clear how this is communicated to the PI.	Not always
7. Is the time to decision appropriate? **Comments:** The MCB should be commended that time to decision was further reduced during this three-year period.	Yes

8. Additional comments on the quality and effectiveness of the program's use of merit review process: Please see comments under ***C.1***

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE**[2]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? **Comments:** The COV was concerned that some international reviewers were used when experts in this country might have been available. Differences in the review process in foreign countries could affect the outcome. This could be improved by providing more explicit instructions and examples to all reviewers, particularly foreign reviewers.	Mostly but not always.
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? **Comments:** Although demographic representation is important, the most important consideration should be the scientific expertise of the reviewer. The reviewers for the majority of the eJackets analyzed by the COV were excellent, and the COV commends NSF for enlisting excellent reviewers who were diverse in all dimensions.	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? **Comments:**	Yes

[2] If "Not Applicable" please explain why in the "Comments" section.

4. Additional comments on reviewer selection: None

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. **Comments:** The information provided to the COV, however, was felt to be anecdotal. The COV agreed that tracking the success of trainees and faculty members (especially young faculty with first or CAREER awards) is important. The MCB should look for ways to obtain follow-up information on past funded projects and recent trainees without placing an undue burden on PIs or trainees (please see additional suggestions under ***C.8***).	Appropriate
2. Does the program portfolio promote the integration of research and education? **Comments:**	Yes
3. Are awards appropriate in size and duration for the scope of the projects? **Comments:** (please see comments for early career investigators under ***C.4***)	Yes
4. Does the program portfolio have an appropriate balance of: • **Innovative/potentially transformative projects?**	Not known/cannot be determined

[3] If "Not Appropriate" please explain why in the "Comments" section.

Comments: The COV noticed a decrease in the number of awards given to research projects considered "innovative/transformative". MCB needs to make it clearer to the community that these types of proposals are encouraged. All applicants and reviewers should be requested to address potentially innovative or transformative aspects of their proposal. The COV suggests that a special panel be convened specifically for proposals that are considered highly innovative. (Please see additional comments under ***C.3***)	
5. Does the program portfolio have an appropriate balance of: • **Inter- and multi- disciplinary projects?** **Comments:** The COV commends the PDs' collaboration with other Divisions in the review process. With the increasing amount of research that interfaces between traditional disciplines, cooperation in funding these efforts is essential. The coordination of Biomolecular Systems with Chemistry and Theoretical Biophysics are long-standing efforts. In the period of 2005-2007, the creation of a program officer jointly between Biomolecular Systems and Chemistry is highly commendable. PDs should generally be encouraged to participate in such efforts and ways to remove barriers to these efforts should continue to be addressed.	Yes

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? **Comments:**	Yes
7. Does the program portfolio have an appropriate balance of: • **Awards to new investigators?** **Comments:** NSF is to be commended for being an incubator for new investigators and new areas of research. However, the COV notes in Table 25 of the Self-Study report that the funding rate was lower for new investigators than for "all investigator types". It recommends that the "new" investigator category should be redefined as early career investigators and that NSF should proactively support this group of investigators. (Please see additional comments under ***C.4***)	Yes
8. Does the program portfolio have an appropriate balance of: • **Geographical distribution of Principal Investigators?**	

Comments:	Yes
9. Does the program portfolio have an appropriate balance of: • **Institutional types?** **Comments:** The COV notes that the proportion of awards to Baccalaureate/Master's level colleges is decreasing and hopes that this is not a trend, since these funds support good research and good educational opportunities. The COV also commends the outreach of MCB to Native-serving Institutions	Yes
10. Does the program portfolio have an appropriate balance: • **Across disciplines and sub disciplines of the activity?** **Comments:** The COV believes that the PDs are doing a very good job of ensuring an appropriate balance.	Yes
11. Does the program portfolio have appropriate participation of underrepresented groups? **Comments:** The COV noted that in 2007, the Cellular cluster received more applications and funded a far lower percentage of RIG-CAA awards than the other clusters. The COV recommends that the PD determine if a trend is developing (poor reviews, poor grantsmanship, etc) and report these findings to the next COV.	Mainly Yes
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. **Comments:** The COV finds that MCB has been very attentive to national priorities and NSF's mission by encouraging high quality fundamental science (both discovery-based and hypothesis-driven), strengthening the scientific infrastructure (student/postgraduate training, methods development, and equipment acquisition), strengthening scientific education from kindergarten to Ph.D., helping inform the public about science, responding to global challenges that require scientific research for a solution (such as the National Plant Genome Initiative, harnessing nature's microbial diversity for environmental remediation, biofuels, drug/antibiotics discovery), identifying and supporting high quality research that is often innovative	Yes

and transformative (such as the National Nanotechnology Initiative, single molecule analysis, systems biology), supporting networking and information technology R&D, internationalizing scientific activities (supporting field research and collaborations across the globe, as exemplified by the Microbial Observatory Program), understanding complex biological systems (metagenomics, genomics, pathway analysis, systems biology, epigenetics, etc.), and supporting environmental initiatives. The COV commends the Directorate of Biological Sciences' efforts to support "the vitality of the biological sciences at US colleges and universities, especially in those areas where NSF has major responsibilities such as supporting young investigators, underrepresented groups and a diverse array of institutional types," as stated in their 2008 self-study document, and identifying new priorities through National Research Council reports combined with "community" workshops and planning activities. The COV commends the efforts made by MCB to meet national priorities, its own missions, and to identify emerging areas of research.	
13. Additional comments on the quality of the projects or the balance of the portfolio:	

A.4 Management of the program under review.

1. Management of the program.

Comments: The COV heard from staff and scientific officers that communications within MCB and BIO have improved since the last COV report, but the workload continues to increase for both PDs and administrative staff. Much of this problem has arisen from shifting responsibilities for managing electronic resources from administrative staff to PDs. Both groups felt that this is not the best use of their time.

The staff identified persistent limitations in computer program capabilities and low priorities of addressing them as adding significantly to their workload. The priorities for fixing these problems were perceived as being low due to budget limitations. There also appears to be significant morale problems among the support staff, including the feeling that there is a lack of respect from the scientific and managerial staff for their talents and dedication to the MCB mission, and that their input into decisions that affect their working lives is not valued. Staff should be allowed to participate in training opportunities to enhance their job effectiveness and career development. We recommend that an independent evaluator be brought in to evaluate the issues and suggest reforms.

Although initially skeptical, the COV supports the idea that the Division Director (DD) be a rotating scientist. This recommendation is based on the expectation that the Deputy

Division Director (DDD) position be held by a permanent employee to ensure administrative continuity and retention of "institutional memory". Concerns were raised about whether a 3-year tenure for the DD is sufficient to implement substantive programs. While the COV is cognizant of the limitations of the IPA mechanism, the DD position should ideally have the option of a second 3-year term. The COV also suggests that different Divisions should not be on the same cycle for the rotation of DD or change of DDD.

The ratio of rotator to permanent PD during the period reviewed was considered inappropriately high. The COV agrees with the current DD and DDD that a ratio of at least 1:1 is optimal so that each rotator is paired with a permanent PD. Staffing should be at full levels at all times, and every effort should be made to eliminate gaps between outgoing and incoming rotators. These measures should significantly decrease the workloads of individual PDs. The COV was pleased to learn that the measures described here are now being implemented and commends the efforts of the current DD and DDD to develop a cache of potential future PDs.

Formal training/mentoring should also be established to get rotators up to speed as soon as possible. A standard operating procedure for each position should be established as a baseline to guide new rotators.

2. Responsiveness of the program to emerging research and education opportunities.

Comments: The existing portfolio represents exciting research at the cutting edge of a number of emerging areas of biology. The existence and use of SGER grants is a useful mechanism for testing new or timely initiatives at little cost with rapid turnaround.

The COV was enthusiastic to learn that all members of the Division are invited to bring emerging areas into conversations held at annual "leading edge" retreats. The Assistant Director (AD), DDs, and DDDs also recently participated in a very successful brainstorming workshop to promote thinking across disciplines and to consider new directions in the context of theoretical biology. Although this was a special workshop, other meetings also occur that allow feedback to the AD. The AD asks the DDs to identify new emerging areas and has recently found a mechanism to promote emerging areas by creating a fund of "venture capital" to which DDs could apply to fund particular proposals that fit within these areas. These activities were considered to be innovative means for encouraging interactions among the Divisions to identify and encourage new and emerging areas.

The COV believes that efforts to free PDs' time for reading, visiting labs, and attending conferences would also ensure that new developments and research/educational directions are identified in a timely manner.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments: The COV had little information in the provided documents about planning and prioritization except the evidence in the portfolio itself, which (as is noted in more detail elsewhere) appears to fulfill the mandates of excellent science combined with various other

considerations to enhance the scientific infrastructure across the nation.

Conversations with AD Dr. James Collins identified the following additional sources of information leading to changes in scientific priorities:

- Suggestions from the scientific community.
- Suggestions from Congress.
- Ideas generated from Leading Edge documents and retreats.
- Workshops generated in response to the scientific community or NSF personnel.
- Travel of PDs to conferences and site visits.
- Reading widely in the scientific literature.

4. Responsiveness of program to previous COV comments and recommendations.

Comments: The COV recognizes that MCB has made significant progress toward addressing the recommendations submitted by the previous COV (see Table below). For example, panel summaries show an increased consistency in addressing both review criteria, in providing negative and positive feedback for each criterion, and in capturing the essence of the panel discussion. The COV noted that despite the increase in the number of proposals submitted, PDs and administrative staff have improved the turn-around time for the submission-to-decision process, with most decisions reported to the PIs within six months of submission. Finally, the COV acknowledges that there is a general feeling among the PDs that quality and effectiveness of communication with the DD and DDD have improved. On the other hand, the COV is concerned that the following recommendations were not sufficiently addressed during 2005-2007 period under review:

1. This COV is disappointed with the lack of tracking information which would allow a substantive assessment of the ability of MCB to meet its mandates. Better tracking (of students and trainees previously funded by NSF) has been a recommendation of two previous COV reports, which suggests that there has been a 6-year period of unresponsiveness. The most recent response has been that such data are not easily available, and that attempts are in place to develop computer software that will allow tracking. This COV feels that, by now, NSF should either have such a system in place or should be able to demonstrate sincere efforts to address this recommendation.

2. MCB did not sufficiently address the previous COV recommendations on workload during 2005-2007.
    a. Like the previous committee, this COV is concerned that the current workload is compromising the effectiveness of PDs, by limiting their ability to seek opportunities for continuing education and public outreach, to initiate new programs, and promote visibility of their successes in funding cutting edge research. The COV understands that MCB was restricted by the unavailability of funds for increased permanent PD slots, and that additional

positions have since become available.

b. It appears that software modifications were made, but that these modifications did not enable administrative staff to handle some of the more routine aspects of the review process. It also appears that these modifications were put into place without the much needed additional training and support for the administrative staff and rotating PDs. The COV recommends that MCB reevaluate its current system of how the administrative tasks are handled and implement beneficial changes as soon as possible. Implementation of changes that significantly reduce the PD and administrative staff workload should be strongly considered.

3. Like the previous committee, this COV also recognizes that maintaining a balanced portfolio is difficult with current restrictions on funding and with the hesitancy of PIs to submit truly transformative proposals. Nevertheless, the COV recommends that NSF remain diligent in its efforts to maintain a diverse portfolio while simultaneously monitoring the effects of these efforts on single-investigator proposals.

4. This COV commends the efforts of MCB (and the BIO Directorate) to increase the number of applicants from, and awards to, underrepresented minority scientists. Outreach efforts by NSF staff resulted in an increase in minority PI grant submissions, and these efforts should be consistently implemented.

The following table summarizes the COV's opinion of whether MCB has met each of the 26 recommendations of the previous COV:

	2005 COV Recommendations	**2008 COV Evaluation**
1	Improve panel summaries	**These have been improved**
2	Document rationale for high risk designation	**Now defined as transformative**
3	Reduce turnaround time	**Turnaround time has decreased**
4	Track training in grants	**Need improvement and database implementation**
5	Inform COV of the center, group and individual PI projects	**Information has now been provided**
6	Identify and address success rates for minority PIs	**Actions taken have increased submission by minority PIs as awards modestly increased during 2005-2007**
7	Reduce proposal review workload: improve eJ and increase permanent PD	**Workload actually increased as a result of loss of PDs due to retirements. Plans are in place to replace 4 PDs**
8	Improve communication within MCB and with OAD	**Communication has significantly improved**
9	Involve PDs in decision-related conversations	**Conditions have improved**
10	Improve NSF website	**Website has been updated and re-**

		designed
11	Provide information about trainees in the projects	**This information was not provided, and a database has not been implemented**
12	Scrutinize productivity of the large grants	**Response was appropriate**
13	Improve the efficiency of the merit review system	**Response was appropriate**
14	Improve the eJ work environment	**Work environment did not improve and may have become more problematic**
15	Provide information accessible in all computer formats	**Appears to have been adequately addressed**
16	Address the effect of workload on other PD responsibilities	**PD workload did not decrease and in fact increased**
17	Assess management structure (clusters)	**This area still needs improvement**
18	The Cluster system needs to be more transparent to the community.	**Response was appropriate**
19	MO belongs in EF but the program has thrived under the MCB umbrella.	**This program was moved to another division and may be dismantled in the future**
20	Proposals should be required to document their training and outreach activities.	**No significant improvement in data collection was implemented since last COV**
21	Expand postdoctoral program	**No specific information on expansion of postdoctoral positions was provided**
22	eJ and electronic workload burden was high	**Clerical problems continue and have been compounded by implementation of Grants.gov, according to staff**
23	Implementation of new programs at the expense of established one should be carefully considered	**Improvement in this area was noted**
24	Provide materials well in advance of COV meeting	**This was done in a timely manner**
25	We find the report template to be repetitive and constraining.	**COV template was improved**
26	Time to decision, duration and amount of awards have not changed significantly.	**Time to decision has improved. Other issues could not be determined**

5. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.*"

Comments: MCB has been at the cutting edge in funding research activities leading to new scientific discoveries, both through traditional hypothesis-driven research programs and through targeted discovery-based research programs. Particularly noteworthy are the results that have come from the Microbial Observatory (MO) program, which has played a major role in laying the foundations for the emerging field of metagenomics. The Arabidopsis 2010 program has also been critical in transforming our understanding of plants and promoting research throughout the plant science community. The promotion of innovative research by single investigators is also noteworthy such as research on intrinsically disordered proteins, which has led to new paradigms in protein structure-function relationships. As another example, MCB has been at the forefront in supporting development of new methods, such as methods for single-molecule spectroscopy. NMR methods for characterizing internal dynamics of proteins, which have been extensively funded by MCB during the evaluation period, have created new insights into the role of allosteric changes and concerted motions in regulating enzyme kinetics and the thermodynamics of molecular recognition. These new methods have allowed the discovery of new aspects of nature, such as the critical and extensive role of microRNAs in regulating gene expression.

Recommendations: The high success in scientific discovery by MCB-supported research programs has been driven in part by the high quality of the scientific review process and vetting of proposals, ensuring efficient use of limited funding. The PDs do an outstanding job of recruiting panel members and ad hoc reviewers, and in communicating to the scientific community the cutting-edge scientific priorities of the MCB program. However, as discovery-based research programs like the MO/MIP and Arabidopsis 2010 are mainstreamed into core panels, challenges will include how to educate panel members to the special value of genomic-scale, discovery-based research. These panels have traditionally focused on specific and carefully considered hypothesis-driven research questions, rather than discovery-based research paradigms. Consequently, the Foundation will need to consider carefully how projects like MO/MIP and other discovery-based research programs will be assessed by these panels (see further comments under ***C.6*** and ***C.7)***.

The following are examples of successful projects:

Providing support to advance the frontier of knowledge:

Horizontal Gene Transfer and its Impact on Ocean Microbes
NSF Award Number: 0348001 and 0509923
Award Title: A Genomics-enabled Microbial Observatory in the Monterey Bay National Marine Sanctuary

Award Title: Microbial Genome Sequencing: The Cenarchaeum Symbiosum Genome Project: Genome Sequence from a Psychrophilic Archaeon, the Ocean's Single-most Abundant Microbes
PI Name: Edward DeLong

Elimination of Canonical Amino Acid from *Escherichia coli* by Experimental Evolution
NSF Award Numbers: 0128901 and 0455148
Award Title: Elimination of Canonical Amino Acid from Escherichia coli by Experimental Evolution
PI Name: Valerie de Crecy-Lagard

Providing support for transformative research:

Function of the Arabidopsis Small RNAs
NSF Award Numbers: 0209836
Award Title: Arabidopsis 2010: Function of the Arabidopsis Small RNAs
PI Name: James Carrington

International Collaboration Reveals Slow Motions in Proteins
NSF Award Number: 0211512
Award Title: New Methods and Applications for the Dynamic Characterization of Proteins by the Combination of NMR Spectroscopy and Computer Simulations
PI Name: Rafael Bruschweiler

A New View of the Initial Events in Photosynthesis
NSF Award Numbers: 0642260 and 0131776
Award Title: Protein Control of Electron Transfer Pathways in Photosynthesis
Award Title: Controlling the Pathway of Electron Transfer in Bacterial Reaction Centers
PI Name: Neal Woodbury

A New Paradigm for Cell Biology: Putting Some Muscle Into RNA Transcription
*NSF Award Numbers:*0079298, 9724168, 9631833
Award Title: US-Czech Collaborative Research on Nuclear Myosin I
Award Title: U.S.-Czech Cell Biology Research on Nuclear Myosin I
Award Title: Microsequencing of a Putatve Myosin I Isoform
PI Name: Primal de Lanerolle

Molecule Fluorescence Methods and Myosin V
*NSF Award Numbers:*9984841 and 0215869
Award Title: CAREER: Conformational Changes in Voltage-Controlled Ion Channels Measured by Advanced
Fluorescence Techniques
Award Title: Instrument Development for Imaging and Manipulation of Single Biomolecules
PI Name: Paul Selvin

B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

Comments: NSF continues to impact the scientific workforce substantially by providing support for the training of undergraduate and graduate students, as well as postdoctoral fellows. Training is provided directly and indirectly through diverse programs including regular grants, REUs, STEM grants, and postdoctoral fellowships, the combination of which has been highly successful. Education of young students (e.g., K-12) and expanding the public understanding of science are also critical components of creating scientifically literate citizens. Training and community outreach are also encouraged by Criterion II of the NSF research grant assessment priorities.

Recommendation: Although the COV is highly impressed with the extent to which MCB has pursued the training and educational component of the NSF mission, tracking the results of training those students is important to assess the long-term impact of this important aspect of the NSF mission. Metrics, or appropriate measures of success, need to be developed for assessing the impact of the educational aspects of the MCB grant portfolio. This may require input from education experts.

Awarded grants that address these training and educational goals:

Increasing the participation of underrepresented groups in science:

The Biochemistry of Template Switching
NSF Award Number: 0315762
Award Title: RUI: The Biochemistry of Template Switching
PI Name: Angel Islas

Providing training of undergraduate and graduate students as well as high school teachers:

Understanding the Enzymology and Biochemistry of Lignan Formation in Plants
NSF Award Number: 0417291
Award Title: Molecular Definition of the Unique Phenylpropanoid Radical Coupling Mechanisms of Dirigent
Proteins, Their Homologues, and Associated Metabolism: A Discovery-Based Approach
PI Name: Norman Lewis

Providing interdisciplinary training of undergraduate and graduate students:

Expanding the Scope of Nucleic Acid and Protein Evolution
NSF Award Number: 0094128
Award Title: CAREER: Expanding the Scope of Nucleic and Protein Evolution
PI Name: David Liu

Providing support for the application of new experimental tools in the cross-disciplinary training of undergraduate and graduate students:

Unraveling How Molecular Motors Really Work
NSF Award Number: 9984841

Award Title: CAREER: Conformational Changes in Voltage-Controlled Ion Channels Measured by Advanced Fluorescence Techniques
PI Name: Paul Selvin

Providing support to help students at small schools prepare for graduate-level research or the job market:

Sharing Biotech Tools with Smaller Schools
NSF Award Number: 0348028
Award Title: Functional Genomics of the Protein Disulfide Isomerase Family: Unraveling Protein Folding and Redox-Regulatory Networks
PI Name: David Christopher

Providing support to give young students an opportunity to experience a higher level of science :

Plant Science Summer Camp for 4th to 8th Graders
NSF Award Number: 0209694
Award Title: Collaborative Research: Arabidopsis 2010: In Vivo Genomics: Visualizing G Protein Interactions in Arabidopsis
PI Name: Sarah Assmann

Providing support to expand public understanding of science:

sLowlife: A Traveling Exhibit of Plant Science and Art
NSF Award Number: 0531641
Award Title: SlowLife: A Traveling Exhibit of Plant Science and Art
PI Name: Larry DeBuhr

Innovative training in molecular biology for students in the arts and humanities:
NSF Award Number: 0343821
Award Title: Intercellular Signaling in Vibrio Harveyi
PI Name: Bonnie Bassler

Providing K-12 students a chance to learn about cutting edge science and careers in research:

NSF Award Number: 0238407
Award Title: Microbial Observatories: Collaborative Research: Kamchatka, a Geothermal Microbial Observatory
PI Name: Juergen Wiegel

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

Comments: MCB contributes importantly to the development of the research infrastructure

of the biological community, including new methods for studying biology, advanced instrumentation, and databases. These activities are also supported, to some degree, through Criterion II of the grant assessment priorities.

Notable examples of research infrastructure provided by the MCB self-study:

a. **Important knowledge base for further research by the plant research community:**

NSF Award Number: 0520140
Award Title: Arabidopsis 2010: Metabolomics: A Functional Genomics Tool for Deciphering Functions of Arabidopsis Genes in the Context of Metabolic and Regulatory Networks
PI Name: Nikolau

b. **Development and application of new and powerful methods combining X-ray crystallography and electron microscopy data:**

Breakthrough Structural Information on Viruses through Combination Techniques and Methods
NSF Award Number: 9986266
Award Title: : X-ray Determination of Proteins and Viruses
PI Name: Michael Rossmann

c. **Development of Cyberinfrastructure:**

Behavioral Prediction of Biological Molecules and Supramolecular Assemblies through Theoretical and Computational Methods
NSF Award Number: 0071429
Award Title: Theory of Biomolecular Structure and Dynamics
PI Name: James McCammon

d. **Development of methods for new discovery:**

Small RNAs: Small Molecules with a Big Responsibility
NSF Award Number: 0439186
Award Title: SGER: Development of Methods for Analysis of Small Non-coding Transcripts By MPSS
PI Name: Pamela Green

e. **Building the nation's research capability through the development and application of experimental tools:**

NSF Award Number: 0516547
Award Title: Protein Biophysics in Cells
PI Name: Gary Pielak

f. Application of new instrumentation for the analysis to biological materials:

Phase Separation of Lipid Membranes Analyzed with High-Resolution Secondary-Ion Mass Spectrometry
NSF Award Numbers: 0416623 and 0110400
Award Title: Mechanism and Macromolecular Organization in Photosynthetic Reaction Centers
Award Title: Mechanism and Macromolecular Organization in Photosynthetic Reaction Centers and Membranes
PI Name: Steven Boxer

PART C. OTHER TOPICS

The following are areas that the COV believes require special attention and includes COV consensus ideas for how MCB can address these concerns. This section also includes questions that the COV was requested to address as part of its charge.

C.1 Proposal Review.

One area that the COV identified as needing improvement is the quality of reviews. The COV noted that many reviews were not substantive, especially in evaluation of broader impact. Too many of the reviews simply restated what the proposer wrote and discussed broader impact mainly in terms of intellectual merit.

The COV has two suggestions to help ad-hoc reviewers and panelists in the preparation of reviews: It believes that PDs should provide examples of substantive and not substantive reviews (for both intellectual merit and broader impact), and make these examples available for access by all reviewers (much like what was provided to the COV in the Self-Study Report). These reviews could be real or fabricated and should include explanations as to why the reviews are judged as excellent and informative or why they are not sufficiently substantive. The COV suggests a minimum of two sample reviews from each category, representing proposals judged as “excellent” and “good/fair”. It also suggests that PDs contact new panelists (perhaps by phone conference) and explain the panel process and general past panel results, to help ensure that proposals entrusted to new panelists are not at any advantage or disadvantage.

C.2 Broader Impact.

Criterion II on the broader impact of a research proposal is not well-defined and is inconsistently interpreted by both applicants and reviewers. There are two general types of broader impact of research proposals: broad scientific impact and broad societal impact. Broad scientific impact refers to how the research will enable work on scientific problems beyond the scope of the specific research plan outlined in the proposal. This would include, for example, new methods of data analysis, widely disseminated databases, seminal ideas, or technological infrastructure. Expectations for what constitutes appropriate social impact are

less clear, but would generally include training of diverse students as scientists, community outreach and education, and the development of public awareness of the value of science. The COV felt that both types of broader impact are important to the mission of MCB, and that a successful proposal would generally have excellence in Criterion I and excellence in at least one, but not necessarily both, of these areas of Criterion II. Reviewers should not require proposals to excel in both kinds of "broader impact." Both proposers and reviewers appear to be confused about this point, and it is critical and urgent to better educate both groups regarding what NSF seeks in terms of broader impact. The COV suggests that NSF make available to proposers and reviewers examples of excellent broader impact summaries from their portfolio.

Concerns were raised in cases where Criterion II is a major component of the proposal assessment. The COV believes that measurable outcomes of such "broader impacts" must be carefully defined and evaluated during and after the funded grant period. In the case of broader impact based on community outreach and/or training programs, it may be necessary to include as a panel member an expert who can specifically address such impact. The assessment of societal impact plans should be supported by appropriate preliminary results or by the progress report of a renewal proposal.

The NSF effectively fosters collaborations and supports shared facilities in order to promote the best possible research. Likewise, the agency can and should play a prominent role in helping PIs make connections that will allow them to achieve effective education and outreach, where appropriate. For example, MCB could provide contact information regarding NSF-funded educational programs with which MCB-funded investigators might establish connections to enhance their broader impact activities.

In addition to considering the potential broad impact of research grant proposals, NSF should particularly encourage proactive community outreach and/or public education for institutional type grants, such as MRI and training grants

C.3 Enhancing Innovative/Transformative Research.

The COV commends NSF for changing the terminology of "high risk" to "innovative/transformative" research. The COV believes that every proposal should address what, if anything, is innovative or transformative about the science and that reviewers should be asked to comment on this specific aspect of proposals. One mechanism for this would be to add this query to both the application form and the review template.

To further stimulate highly innovative/transformative project applications (other than SGERs), the COV suggests the use of a separate panel to review a collection of such proposals. This may encourage PIs to propose innovative/transformative research knowing that the panel will be evaluating only proposals in this category. Where the research is time-critical, the current mechanism of SGER review should be retained.

MCB should communicate to investigators, by whatever means are most effective (Dear Colleague letters; at meetings; on the web site), their strong interest in receiving such proposals, and they should publicize the fact that in recent years these proposals have, on average, achieved a higher rate of funding than less innovative proposals.

C.4 Support for Early Career Stage Investigators.

One of the key missions of MCB is to foster new scientific initiatives. In this regard, MCB makes an important and valuable impact by supporting early career investigators by nurturing the creation of new laboratories involved in high quality basic research. Support of early career investigators has seeded important new areas of science, and helped in the development of new techniques and basic fundamental research that have provided the groundwork for some of the top research laboratories in the nation.

Historically (including the period 2005-2007), MCB has done an outstanding job in supporting PIs early in their careers by devoting a substantial portion of their portfolio to the first awards granted to these individuals. While the funding rates for early stage investigators obtaining their first awards appear to be good relative to other priorities, it is critical that support of early stage researchers continue to be a major component of the MCB portfolio, and that the success of this early stage research support by NSF be made known to the scientific community.

Concerns were raised that many early career stage PIs who are doing good work still fail to succeed in attracting subsequent NSF funding. Approximately 60% of new investigators, which includes a large proportion of early career investigators, failed to obtain subsequent NSF funding. However, the COV recognized that an unknown number of these investigators obtained funding from other sources. To optimize success rates of these burgeoning laboratories and projects, the COV suggests that funding for early career investigators should generally be for three years, with an option for supplementary funding at 50% of the annual award rate for the 4th year, to provide a bridge for PIs who are close to, but not quite ready, to apply for renewals.

C.5 Portfolio Enhancement.

MCB should also promote new and innovative science by the best researchers in the nation. These researchers have already demonstrated their abilities and have sufficient infrastructure in place to complete challenging projects. Eminent researchers should be actively recruited by MCB to apply for NSF grants, particularly for support of transformative and innovative ideas in basic biological research that cannot be funded by other agencies. This would ensure that investments in transformative and innovative research projects are made with a high likelihood of success, and actively involve researchers who are not currently contributing to the legacy of the NSF.

C.6 Support for Discovery-Based Research.

The COV concurs that, in addition to hypothesis-driven research, discovery-based research provides substantial benefit to the scientific community and often leads to the emergence of new fields of study and baseline data for hypothesis-driven investigations. The COV commends current efforts to balance PD portfolios with both innovative/transformative proposals as well as discovery-based research, which are often intertwined. The COV applauds MCB for recognizing the value of discovery-based research and hopes that PDs will not only continue to emphasize the importance of such studies during panel review, but also

will include panelists equipped to evaluate proposals that have a discovery-based component or emphasis. The COV further suggests that MCB enhance its efforts to: (i) inform the community that NSF welcomes innovative discovery-based research and, (ii) help the applicant-PI to identify the most suitable panel for his/her proposal. Because discovery-based proposals must be evaluated using review criteria that differ significantly from those used in reviewing hypothesis-driven proposals, the COV recommends that specific guidance be provided (e.g., in the review instructions) to panel members and ad-hoc reviewers to ensure appropriate and consistent reviews for discovery-based research proposals.

C.7 Transition of Successful Focus Programs.

MCB does an excellent job soliciting proposals for special projects, such as MO/MIP, that nurture emerging fields and support innovative and transformative science. However, the COV is concerned that some successful solicited programs are not easily "mainstreamed" because they do not fit into core portfolios for various reasons, including, but not limited to (i) a discovery-based, rather than hypothesis-driven emphasis; (ii) experimental work that requires resources larger than the standard budget; (iii) the absence of a PD or panel members with the appropriate expertise. Moreover, "taxon-neutral" funding can disadvantage the study of emerging and new model systems that have yet to develop the tools available in classic systems, such as genetics, biochemistry, and genomics.

The COV recommends that MCB develop specific transition plans for such initiatives that do not easily transfer into its core programs. If the choice of the transition plan is to "mainstream" a successful focus program, four key elements should be considered: (i) provide core programs with sufficient funds that are specifically designated for the subject of the transferred focused program (e.g., in the case of MO/MIP, for microbial biology); (ii) enlist PDs with expertise in the focused program area; (iii) include specialists from the focused area on review panels; (iv) alert the community of the evolution of these programs by disseminating letters of solicitation for proposals in the focused area and by helping PIs to identify the appropriate cluster for their proposals.

With regard to the MO/MIP program, the COV was very impressed by its exemplary success, where advances have been made that broadly impact the life sciences (genomics, molecular biology, structural biology, biogeochemistry, biophysics, cell biology, computational biology, community ecology, biotechnology). The MO/MIP program put NSF at the forefront of science linking several levels of organization, from the genome and cell to complex communities that influence planetary mechanisms and global climate change, and spawned novel fields of study (e.g., metagenomics and community profiling). In addition to scientific merit, many MO/MIP projects have exceptionally strong broader impacts, particularly in community outreach, international collaborations, and minority science education.

Given this success, we are very concerned that MCB is considering "phasing out" MO/MIP as an independent program. The COV recommends that a concrete plan be developed that specifically addresses how MO/MIP will be incorporated into core programs without jeopardizing the science. We suggest that this plan should include the four key elements above to ensure not only the survival but also the enhancement of fields currently supported by MO/MIP.

C.8 Tracking of trainees.

A specific recommendation by the previous COV was to improve tracking of the research training activities of NSF-funded projects. In particular, there has been a historical lack of tracking of REU undergraduate trainees. As mentioned in the response to this recommendation, "…the NSF report system does not deposit information submitted by the PIs in a searchable database." The response also mentions that "NSF is currently developing a new reporting system …. to evaluate the impacts of training. However, this system is not yet fully functional." A report of total number of trainees per year was provided by the MCB, but this report was not deemed sufficiently detailed to allow for an in-depth analysis of participant gender and ethnicity or the impact of their training (continuation in the Ph.D./scientific pipeline). The COV recommends that the NSF find a means of tracking their former trainees by a procedure that is designed to be of low burden to PI and trainee. One possibility is that the NSF could annually ask PIs for email addresses of all current trainees and to feed this information into an address list for an annual survey of the trainees in which they are asked simply to reply to confirm or change their current email address and job/student status. This process could be programmed to run automatically to periodically update an NSF-or MCB-maintained database. The request of a limited response should increase compliance because it requires little time of the responder and keeps email addresses updated. A bounce of an email from this mailing could trigger an email request to the PI for an update in contact information for the trainee, if available. The MCB could occasionally use this maintained list of email addresses of former trainees to gather more detailed information relevant to its mission.

C.9 New Scientific Opportunities.

The COV is impressed with the breadth of research areas supported by MCB. It recommends, in addition, that the following emerging research areas be given serious consideration as having the potential for producing innovative, transformative knowledge and technology.

- Systems/network biology
- Metagenomics
- Synthetic biology at the molecular/cellular level
- Protein disorder and RNA structural plasticity in the control of biological functions
- Microbial mediated processes from cellular to community to global scales
- Epigenetics in eukaryotes, archaea, and bacteria
- Exploiting unusual or novel model systems
- Molecular processes in a crowded cellular environment
- Continuing the emphasis on developing cutting-edge technology (e.g., subcellular imaging)

The COV also commends MCB for fostering the study of intrinsically unfolded proteins. MCB is now poised to support studies of the roles of intrinsically disordered proteins in systems/network biology.

C.10 Mechanisms the Division Should Use to Identify Priority Areas in MCB.

In addition to the current methods, which the COV agrees have been very effective, it encourages PDs attending, supporting, and organizing workshops on new and transformative ideas. Likewise, they should be encouraged to continue attending cutting edge meetings (such as Gordon Conferences), and the Directorate should ensure that the PDs have sufficient time for such activities.

C.11 Effective Approaches for Fostering Interdisciplinary and Integrative Research in MCB.

To encourage applications for these types of projects, PDs may find it helpful to be more proactive by identifying potential collaborative investigators within their portfolio and encouraging them to develop interdisciplinary areas. One useful way of bringing together diverse individuals together is to fund workshops that foster interdisciplinary research interactions.

The COV also feels that an important component is the training of more scientists whose knowledge bridges multiple areas of research. While the IGERT program is one good model of training, the COV recommends that MCB invest in a new postdoctoral program, where top postdoctoral scientists who have identified mentors in at least two different research domains would be eligible to apply.

C.12 Improving the COV Review Process, Format and Report Template.

The COV recommends that the chair of the COV be chosen from a recent COV. COV members who are local but who live more than one hour from Ballston, should be reimbursed for staying in the Ballston area because of the lengthy agenda. The COV suggests that, in the future, materials be made available as far in advance of the meeting as possible and that more guidance be provided about which documents to read before the meeting. The COV suggests that a few key documents be provided several weeks in advance: the previous COV report and responses, the self-study report, the IPAMM report, the charge to the committee, and the membership list. Also, suggestions on the most critical aspects of the e-Jackets to evaluate should be provided.

It is also suggested that future COVs include members from the previous committee who are available to consult with the chair prior to the meeting. The chair should also be given other recent COV reports prior to the meeting.

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SIGNATURE BLOCK:

_____	_____
For the MCB COV Anne Simon, Chair	Date
_____	_____
Renato Aguilera	Terrance Johnson
_____	_____
Michael Ceballos	Casonya Johnson
_____	_____
Joseph Ecker	Mary Lee Ledbetter
_____	_____
Daniel Gallie	Gaetano Montelione
_____	_____
Judith Greenberg	Marit Nilsen-Hamilton
_____	_____
Toshiko Ichiye	Francine Perler
_____	_____
Terrance Johnson	Jennifer Wernegreen

As the designated representative to this COV and on behalf of the BIO Advisory Committee, I submit this report to the Assistant Director of the Directorate for Biological Sciences.

_____
W. Richard McCombie
Designated Representative of the BIO Advisory Committee