National Science Foundation
Directorate for Biological Sciences

Advisory Committee Meeting
October 24-25, 2016
Room 1235

Summary Minutes

BIO Advisory Committee Members in Attendance:

Dr. Katherine L. Gross, Chair	Dr. May Berenbaum	Dr. Hannah V. Carey
Dr. Wilfredo Colón	Dr. Greg Florant	Dr. Steve A. N. Goldstein
Dr. Stephanie Hampton	Dr. Susan Marqusee (10/24)	Dr. Dominic Poccia
Dr. Randy J. Nelson (10/24)	Dr. Michael Purugganan	Dr. Paul E. Turner (10/24)
Dr. Brett Tyler		

BIO Advisory Committee Members attending via telephone:
Drs. Elizabeth A. Kellogg (10/25) and Margaret McFall-Ngai (10/24)

BIO AC Members not in attendance:
Drs. Stacia A. Sower, Richard McCombie and Joan E. Strassmann

Monday, October 24, 2016

Dr. Katherine L. Gross, Advisory Committee Chair, convened the meeting at 8:31AM by welcoming the Advisory Committee (AC) members, NSF staff and guests and requesting introductions.

The summary minutes from the April 2016 BIO AC meeting were approved.

Dr. Gross reviewed the meeting agenda. Dr. Brent Miller, Science Advisor of the Directorate for Biological Sciences (BIO), reviewed the Advisory Committee Charter and the Federal Advisory Committee Act. Dr. Gross announced one change in the agenda: Group 2 of the AC Leading Edge presentations will be presenting first.

AC Leading Edge Presentations

AC Leading Edge Group 2

- ***"Adaptation to Temporal Niches" – Drs. Randy J. Nelson and Gregory Florant***
- ***"Mapping Rules for Genomes" – Dr. Michael Purugganan***

Presenters covered research examples at the organismal scale, focusing on the roles that the physical environment and evolution play on emergent behavior.

AC Leading Edge Group 1

- ***"The Roles of Protein Structure-Stability-Function in the Rules of Life" - Wilfredo Colón***
- ***"Seeing, Predicting, and Orchestrating the molecules of Life" - Susan Marqusee***

Presenters covered research examples at the molecular level of biology, specifically the role that molecular structure and function play in emergent behaviors. Currently, research activity at this

level happens primarily in artificial environments. It seeks to understand the relationship between a molecule's structure and its function, and may touch on its role in cellular behavior.

Preparation for Visit with Dr. Córdova, Director, National Science Foundation (NSF)

Dr. James L. Olds, Assistant Director of BIO, provided an overview of NSF's Ten Big Ideas, including six Research Ideas and four Process Ideas. The Research Ideas are:

1. Navigating the New Arctic
2. Harnessing Data for the 21st Century Science and Engineering
3. Work at the Human-Technology Frontier: Shaping the Future
4. Understanding the Rules Of Life: Predicting Phenotype
5. The Quantum Leap: Leading the Next Quantum Revolution
6. Windows on the Universe: the Era of Multi-Messenger Astrophysics.

The Process Ideas are:

1. Growing Convergent Science
2. Enhancing Science And Engineering Through Diversity (INCLUDES)
3. Mid-Scale Research Infrastructure
4. NSF 2050: Seeding Innovation.

The Advisory Committee members discussed several topics to be shared with NSF Director Dr. France Córdova regarding the importance of BIO funded research to NSF goals:

- Why the AC had focused on "Leading Edge" presentations for this meeting
- Need for promoting convergence research by NSF
- Role of BIO in development and training of workforce in cross-disciplinary research
- Importance of increasing the public understanding and appreciation of science

Visit with Dr. France Córdova, Director, NSF

Dr. Gross welcomed the Director and the members introduced themselves.

Dr. Gross described why the AC meeting was focused on Leading Edge research this time and how the agenda and presentations had come together. AC members responded enthusiastically to the opportunity to present their views on leading edge research under BIO's Rules of Life theme. Dr. Gross explained that subsequent breakout groups will explore the fundamental questions raised in the presentations to inform the nature of the science that could be represented under the "Rules of Life" theme.

Dr. Córdova and the Advisory Committee discussed: the training and education of the new workforce in areas of convergence; Earth's role in dictating the rules of life; methods to educate the general public in science, including the use of social media; the need to increase awareness of convergence at universities and institutions; ways in which NSF can assist in increasing this awareness; and, how the BIO AC members can help in developing the mechanisms and areas of target in this endeavor.

AC Leading Edge Group 3

- ***"Rules of Microbial Ecology and Evolution; Understanding Earth's Majority and Their Applied Prospects" - Paul Turner***
- **"Scaling Up Ecology" –** ***Stephanie Hampton***

Presenters covered research examples at the ecological scale – the roles of microbes in the environment and their applied prospects, and the role of data in understanding ecology. The group's discussion focused on how rules might help explain emergent properties – or phenotypes.

AC Leading Edge Group 4

- **"Rules of Life: Phylogenomics and Nomenclature" –** ***May Berenbaum for Stacia Sower***
- **"Research on the Edges Towards Rules that Span Scales" –** ***Brett Tyler***

Presenters provided research examples that cross scales and disciplinary boundaries – the role of phylogenomics and nomenclature, microbial integration in the biosphere as a framework for research and education, and the cross-disciplinary research necessary to understand forest ecosystems.

Discussion Groups

The AC members divided into discussion groups that included BIO Senior Manager/Program Directors from 2:30 – 5:00PM. The charge was to follow up on the Leading Edge presentations and report out on these discussions on Tuesday.

Tuesday, October 25, 2016

Dr. Katherine L. Gross, Advisory Committee chair, reconvened the meeting at 8:31AM.

NSF's Strategic Planning Process - Dr. Stephen Meachum

Dr. Stephen Meachum informed the BIO AC that NSF's strategic planning process has begun and a final version of the plan will be published in February 2018. The strategic plan will identify broad, long-term objectives and values that will help NSF achieve its mission. Dr. Meachum asked the AC members and senior managers to review the current strategic plan and provide feedback for revisions and comments through the strategic planning website: www.nsf.gov/od/oia/strategicplan/feedback.jsp or email strategicplan@nsf.gov in the next 2-3 weeks.

Division of Biological Infrastructure Committee of Visitors Report – ***Elizabeth Kellogg***

Dr. Kellogg provided a summary of the Committee of Visitors (COV) review and report of the Division of Biological Infrastructure (DBI). She commended the group for being well prepared for this review, and the information they had provided to the COV that included a self-study and a response to the recommendations from the last COV. The COV was provided a master spreadsheet showing every action taken by the Division over the review period, which enhanced the COV's ability to investigate merit review and award processes and outcomes. The COV deemed the review process, including the methods in which panelists were selected and the ways in which panels were conducted, as excellent. Discussions with Program Directors from other divisions, made it clear that DBI's activities undergird those in BIO's other divisions and support all facets of the Directorate.

Dr. Kellogg reviewed each of the challenges, as outlined in the COV report, for DBI to address in the future.

Dr. Muriel Poston, Division Director of DBI, acknowledged the terrific work by DBI staff and stated she agreed with comments provided in the COV report. Dr. Poston stated that she was working with agents from across BIO to address communication challenges that were identified in the COV report. She is also working with the Office of the Assistant Director in BIO on program evaluation activities to enhance decisions through portfolio analyses.

The Advisory Committee unanimously approved the COV report.

NEON Update and Planning Activities Surrounding the 10 Big Ideas – *Dr. James L. Olds, Assistant Director*

Dr. Olds updated the AC on the status of NEON under the new management of Battelle Memorial Institute. He reviewed the availability of NEON data products, construction status of observatory sites, and FY2017 budget for NEON. Dr. Olds also described the evolution of BIO's contribution "Understanding the Rules of Life" (URoL) and how this has contributed to NSF-wide 10 Big Ideas. The AC discussed the interconnections between the science presentations given by AC members and URoL, and to the other Big Ideas.

Reports from BIO Senior Managers on Group Discussions

Group 1 – Paula Mabee, Division Director of Division of Environmental Biology (DEB) and Robert Miller, Deputy Division Director of Division of Integrative Organismal Systems (IOS)

The discussants suggested the idea that the Rule of Life (RoL) concept should seek to expand our view of the molecular structure and function in biology, and how rules at this level cross biological scales. Approaches could include understanding rules that govern molecules and molecular interactions in natural environments, rules of cellular scale (i.e., volume, and time) that influence a molecular population's behaviors and interactions, and how these rules may allow forecasting of emergent properties at the cellular and organismal scale, and potentially beyond.

Group 2 – Heinz Gert de Couet, Division Director of IOS, and Alan Tessier, Deputy Division Director of DEB

Discussants worked on the assumption that basic rules exist because regular patterns of emergent properties are observed across biology, and hence, some level of predictability is possible despite organisms' observed complexity. The group converged on a general theme that an organism's structure, function, and behavior (or that of its component parts) will be shaped by trade-offs and constraints based on history; biological diversity at all scales is necessary to protect against contingencies. This prompted discussion of discovering rules that govern the breadth of change and diversity possible, and rules that allow forecasting of form and function. Interdisciplinary approaches emerged as a necessary prerequisite for RoL research, as did a diversity of model organisms as the object of research, because comparative approaches and diversity of systems allow for addressing broader questions.

Group 3 – Linda Hyman, Division Director of Division of Molecular and Cellular Biosciences (MCB) and James Deshler, Deputy Division Director of DBI

The group's discussion focused on how rules might help explain emergent properties – or phenotypes. The discussion was influenced by earlier presentations that showed strong

connections between molecular level activity and cellular and organismal level phenotypes. Modularity, extreme conditions, community interactions, flexibility, plasticity, and individual variation were all themes considered ripe for rule discovery, and that these rules may allow forecasting at scales in ecology.

Group 4 – Muriel Poston, Division Director of DBI, and Theresa Good, Deputy Division Director of MCB

The group discussed the character and nature of "rules"; are rules for the same process different at different levels of organization or across different temporal scales? Are there scale-free rules? Could rules from physics be used to describe the biotic world beyond macromolecule assemblies and do we have the computational power to do this? The group discussed the research infrastructure necessary to discover the kinds of rules imagined and converged on: high-throughput instrumentation able to measure (chemical, physical or behavioral) change over ever faster timescales (e.g., 10^{-15} seconds); cyberinfrastructure that allows for data integration across platforms; traineeships and undergraduate research programs that facilitate interdisciplinary study; and programs that support skill building for mid-career scientists working across research domains.

Wrap-Up

Dr. Gross stated that the next Committee meeting is in April 2017. She thanked the organizers and the presenters involved in the Leading Edge presentations and summaries. Dr. Gross and Dr. Olds acknowledged May Berenbaum's and Brett Tyler's appointment to the BIO Advisory Committee end in October 2016 and thanked them for their service. Certificates of Appreciation were presented to both members by Dr. Olds.

The Chair adjourned the meeting at 11:14AM.