

**Biological and Environmental Research Advisory Committee (BERAC)  
Meeting Minutes  
April 25-26, 2019  
Gaithersburg Marriott Washingtonian Center  
9751 Washingtonian Blvd, Gaithersburg, MD 20878**

**BERAC Members Present**

Bruce Hungate, Chair	Himadri Pakrasi	Michael Burkart
Julie Biteen	James Randerson	Frazier Benya
Amy Brunner	Patrick Reed	Joel Rowland
Leo Donner	Philip Robertson	Lara Kueppers
Robert Fischetti	Daniel Segré	James Stegen
Amy Fridlind	Jeremy Schmutz	Caroline Ajo-Frnaklin
James Hack	Matthew Shupe	
Krista Jones Prather	David Stahl	<b>Designated Federal Officer</b>
L. Ruby Leung	John Weyant	Tristram West
Maureen McCann	Huimin Zhao	
Gerald Meehl		
Jerry Melillo	<b>Guest Speakers</b>	
Gloria Muday	C. Robin Buell	

**Others**

Tiffani R. Conner, Science Writer

Approximately 80 others attended during the course of the two-day meeting.

**Thursday, April 25, 2019  
Morning Session**

All presentations are posted to the BERAC internet site:

<https://science.osti.gov/ber/berac/Meetings>

BERAC Chair Bruce Hungate called the meeting to order at 9:00 a.m. Eastern Time (ET). At his request, BERAC members introduced themselves and provided updates on current research activities.

**News from the Office of Science** – Dr. Steve Binkley, Deputy Director, Office of Science (SC), Department of Energy (DOE)  
[Presentation posted]

Following the posted presentation slides, Binkley discussed two policy memoranda on sensitive technologies and on foreign talent programs. DOE has adopted policies ensuring key aspects of accelerator technologies and high performance computing (HPC) that are monitored and controlled. Quantum information sciences (QIS), gene editing technologies (i.e. CRISPR Cas9), artificial intelligence (AI), and machine learning (ML) may require the same scrutiny. DOE is working across national labs with Chief Research Officers (CRO), to identify key

aspects of technologies that need to be controlled. The U.S. has identified countries of concern relative to these technologies. Discussions with universities and professional organizations will address these sensitive technologies in the academic environment. As a matter of policy, DOE will not provide funding to individuals being supported by a foreign talent program. Identification of foreign talent programs and implementation of this policy will initially be done within the national labs, and eventually through universities.

## **Discussion**

Melillo inquired if informal international collaborations with students and faculty will begin to focus on intellectual property (IP) issues. Binkley responded to be mindful of IP issues and stated some will be affected. For example, there are certain accelerator technologies and techniques that can and should be protected.

Pakrasi asked if the foreign talent memorandum specifies U.S. government or DOE funding. Binkley said it specifies only DOE funding. Federal agencies are sharing their approaches; Office of Science and Technology Policy (OSTP) will consider these types of questions as well.

Randerson expressed concern for the foreign talent program memorandum and asked what DOE is doing to improve retention of talented scientists. Binkley confirmed there is global competition for talent. SC programs need to identify and determine how to keep these scientists. Foreign talent programs are intended to identify people of such talent and pull them back to one country or another. After World War II, the U.S. took the approach of attracting people through the opportunities that exist here.

Fischetti sought clarification on allowing foreign scientists and students into facilities. Binkley said many of the concerns that stimulated these policies came out of activities that happened at the Advanced Photon Source (APS).

Schmutz asked why CRISPR Cas9 is in the same category as enrichment for nuclear weapons. Weatherwax explained that specific biological technologies have not been considered as being misused at a large scale. DOE released the National Biodefense Strategy at the end of 2018, part of that was consideration of the types of threats that exist from intentional or unintentional misuse. The federal government as a whole is determining strategies to understand new and emerging technologies and define the threat level. There is no intent to impede basic research or scientific exchange.

A break was called at 10:34 a.m. and the meeting reconvened at 10:50 a.m.

**News from BER** – Dr. Sharlene Weatherwax, Associate Director, Office of Biological & Environmental Research (BER)  
[Presentation posted]

## **Discussion**

Donner referred to a possible widespread government shutdown in October 2019 and asked about DOE's preparations to maintain national labs' functions. Weatherwax said there are a series of high level planning maneuvers to ensure contingency funds are available for a short-term shutdown or to implement a longer-term shutdown in an orderly fashion.

Meehl asked if there is a sense that Congress will allocate more funding than the President's Budget Request (PBR). Weatherwax noted 2018 was the first time both the House and Senate

wanted to mark DOE higher than the PBR. Congress is supportive of basic research, the programs, and early briefings have been positive towards the BER portfolio.

Reed expressed concern that even suggestions of a budget cut could have negative structural effects and asked how to mediate the risk of a loss of trust among scientific staff. Weatherwax explained the strategy for young people interested in a scientific career is to keep science interesting. Current practitioners are the ones in danger of becoming demoralized. BER, and SC, try to avoid any abrupt changes or irrevocable actions. Those who have worked in the federal system have become used to tough budgets. The PBR is a request; it is the beginning of dialog with Congress. Congress has indicated they are displeased with the low number.

Robertson asked how the user facilities report might be employed by BER. Weatherwax said the reports reinforce the value of the facilities and give BER opportunities to think about future capabilities. The report is influencing BER's thinking and will play out over the next four years.

Shupe wondered how high-level decisions are made, describing the cuts as asymmetrical. Weatherwax explained the emphasis on user facilities and creating enabling capabilities obligates much of the SC money in construction. Programs that receive more funding have huge construction projects. BER does not currently have any big construction projects. All funding requests cite the OSTP and Office of Management and Budget (OMB) memorandum for research and development (R&D) priorities.

**News from Biological Systems Science Division (BSSD)** – Dr. Todd Anderson, Director  
[Presentation posted]

**News from Climate & Environmental Sciences Division (CESD)** – Dr. Gary Geernaert, Director  
[Presentation posted]

### **Discussion on BSSD and CESD Presentations**

Randerson inquired about the greenhouse gas bias during the 1950s and 1960s stating model temperatures appear low compared to observations. Geerneart confirmed there is no explanation; he said there are a number of issues with many of the models.

McCann asked if ML tools are being integrated into the DOE Systems Biology Knowledgebase (KBase). Anderson said ML is being considered, but is not yet in KBase.

The meeting was adjourned for lunch at 12:16 p.m. ET.

### **Thursday, April 25, 2019 Afternoon Session**

Hungate reconvened the meeting at 1:33 p.m. ET.

**BERAC Science Talk: *Functional Genomics of Populus Growth and Development*** – Dr. Amy Brunner (Virginia Tech)  
[Presentation posted]

### **Discussion**

Stahl asked if chitin controls a regulatory system and what signals plant growth. Brunner explained chitin is a general rather than a plant-specific category. Chitin response can be related to metabolism or other events. Muday added the redistribution of auxin, a plant hormone that promotes growth, to the lower side drives most tropism responses in plants.

Randerson wondered how gene expression regulation changes as a function of plant age and what causes a plant to stop growing. Brunner said comparisons are difficult because plant development is so different. For example, certain trees have long lives and very little growth, while others grow rapidly but have short lives.

A break was called at 2:31 p.m. and the meeting reconvened at 2:44 p.m.

**NAS Report: Gaseous Carbon Waste Streams Utilization** – Dr. Michael Burkart (University of California, San Diego) [remote]  
[Presentation posted]

### **Discussion**

Pakrasi inquired about the status of green algae. Burkart explained green algae's genetic tools are 20-25 years behind cyanobacteria's genetic tools. Fundamental information about such things as reporters and resistance markers is lacking for green algae and the ability to manipulate the genome is significantly more challenging. The studies on green algae focus on fundamental biology rather than metabolic engineering. Green algae tends to be more suitable for large-scale biofuel production because of rapid growth and innate resistance to predation.

Robertson stated cement production is usually assumed to release CO<sub>2</sub>, not to sequester it. He asked if the sequestration comes from the substitution of enriched CO<sub>2</sub> streams. Burkart explained cement and concrete production are huge sources of waste CO<sub>2</sub>; involving CO<sub>2</sub> when cement is curing results in stronger materials with better properties. Entities are injecting CO<sub>2</sub> into the curing process to create better concrete structures and use it as a sequestration device.

**NAS Report: Sexual Harassment of Women** – Dr. Frazier Benya (NAS)  
[Presentation posted]

### **Discussion**

Biteen stated that funding agencies and professional societies are responsible for increasing the stakes and having effective penalties for sexual harassment. Benya explained there are a number of practices being led by the American Geological Union (AGU). AGU has a strict code of conduct that includes sexual harassment as research misconduct and can remove Fellow status for sexual harassment. The National Institutes of Health and National Science Foundation want to know when a funded researcher is found guilty of violating sexual harassment policies. The committee recognized as the stakes are increased, there is an amplified risk of retaliation.

Weyant was concerned that perpetrators can freely move from one location to another. Benya admitted "pass-the-harasser" is a problem. The University of California, Davis (UCD) is pilot testing a hiring process for tenure track positions. Applicants must sign a waiver allowing UCD access to their existing institution's human resources (HR) records. An unsigned waiver means the application is incomplete. The University of Wisconsin System, along with the State of Wisconsin, have set policy to share HR records between the two. Professional societies are discussing how to ensure they are informed about investigations at higher education institutions.

A recommendation is to ban confidentiality agreements, especially the confidentiality of the perpetrator; California and New York have taken this action.

Melillo asked how changes are being tracked. Benya explained the Action Collaborative on Preventing Sexual Harassment in Higher Education and a consortium of scientific and technical societies will provide a mechanism to track changes. Current legislation in Congress will create an interagency committee to address federal agencies' standard responses with their grantees. NAS will follow this for the next four years through the Action Collaborative.

Randerson was interested in steps to protect against retaliations, especially those that occur outside the institution. Benya said the report is a call out to the community to think creatively and out of the box. Addressing retaliation is tied to the recommendation to diffuse the power differential between advisors and trainees, doing so removes the ability to retaliate. For example, a specific department at Massachusetts Institute of Technology (MIT) will give one semester of independent funding to any graduate student who needs to change advisors, for any reason. Students have the financial means with which to leave if necessary. Since the funding can be for any reason, the student is not known to have been sexually harassed. The committee also spoke about committee-based advising, similar to dissertation committees in the U.S. In Europe, the concept of an advisor is split into two parts, one for career recommendations, and one for guidance and feedback, someone to listen and support a student.

McCann asked about the scale of the bystander effect. Benya did not know how common it is to report bystander experiences, but said committee members could be more specific. Work teams feel the burden because the target withdraws from the environment and their work.

Fischetti stated if a bystander witnesses harassment, simply walking up and saying "I am lost can you help me", or "do you know the time", is a way to stop the harassment. Benya relayed that experimental social science helps convey the power of the environment. Researchers created an artificial setting with sexually harassing images on the walls and actors making lewd comments. Distinguishing between those who are more or less apt to harass in the first place they found that both groups engaged in sexual harassment behavior in the tolerant environment. The researchers hypothesized if they created an environment that does not tolerate sexual harassment, even those who held sexist beliefs would stop sexually harassing.

Muday requested recommendations for bystanders to be preventers. Benya explained, thus far bystander interventions have been developed to address street harassment issues or assault cases in settings with an equal power differential. In workplace environments, the power differential can be drastically different. More of the work has focused on how faculty and staff interact with each other to create bystander interventions.

Hungate expressed interest in model environments where these issues have declined. Benya noted climate surveys have shown that organizational tolerance is associated with lower rates of sexual harassment in workplaces and education settings. Two examples found were a novel alternative method to report the experience of sexual harassment and a novel way to address the pass-the-harasser problem.

Jones Prather asked if DOE has talked about sexual harassment. Weatherwax said SC formed a diversity and inclusion group who created a policy statement that explicitly says how SC defines harassment, articulates SC's view, and explains how to report issues. Benya has briefed two other advisory committees for DOE. She spoke with the DOE lab directors and their diversity and inclusion staff this past fall.

**Workshop Report: Breaking the Bottleneck of Genomes: Understanding Gene Function across Taxa** – Dr. C. Robin Buell, Michigan State University  
[Presentation posted]

### **Discussion**

Schmutz inquired how the plants for this project were selected. Buell responded while the mission of BER drove the decision, there were considerations of the expanse of plant species being used for biofuel feedstocks and resource availability. *Poplar* was selected as a C3 perennial woody tree, *sorghum* because it is genetically abundant, an annual, and has multiple funding sources, *switchgrass* is related to sorghum and is a perennial grass, and *camelina* was the chosen because it is not a food fuel. Developing model species is also important; *arabidopsis* and *chlamydomonas* were considered to have a central role to play. Schmutz asked about a diploid dicot producing oil-based seeds. Buell explained using soybean or canola would generate a food fuel issue; a diploid dicot can be transformed with a floral dip, it is desirable to make transgenic plants easily to focus on gene function.

McCann asked about minimal chassis organisms in plants. Buell said the point was to strip away redundancy to have a chassis, to get the bare minimum necessary to make a reasonably healthy plant to use as a functional testbed for gene function. The experiment is to design something minimal to remove background noise.

Fischetti sought clarification on the interest in structural determination and atomic resolution. Buell stated the interest is in current technologies that cannot be completed on a larger scale, widely (number of samples), or inexpensively. Discussions on miniaturizing led to questions about obtaining the same kind of information using droplet based activities or Nuclear Magnetic Resonance (NMR) on a single cell. Fischetti shared this was similar to the results from the structural biology workshop in August 2018. There were many problems close to needing structural biology to enable atomic resolution structures.

Segré expressed curiosity about high quality data and the practical challenge of having a gold standard database. Buell replied that data quality was discussed in the Computation and the Database sections. Quality values on incoming data to be used to advance our knowledge is necessary. The biggest limitation is the expense of data curators.

Pakrasi mentioned microbes other than those geared for a gene or protein. Buell reinforced that the report is focused on protein coding function; the call for proposals addresses the genome.

Muday asked if there are additional calls for proposal that address the problems mentioned. Buell was not aware of other calls for proposal outside of DOE. The funding opportunity announcement (FOA) “Genomics-Enabled Plant Biology or Determination of Gene Function” (DE-FOA-0002060) covers more elements than are in the workshop report but is still aimed at understanding the genome and gene function. The report condenses what was considered logical. Buell suggested the community rethink databases and having curators. The aim should be platinum standards for annotation.

Schmutz described this as a plant science problem and lamented that funding entities have not worked together to create a comprehensive and coherent plan. Buell cautioned that such coordination is logistically difficult and expensive. The plants are big; microbes’ advantage is their genomes are more compact.

## **Discussion BERAC**

Hungate opened the floor for BERAC discussions. He mentioned a topic might be what BERAC could do to respond or act upon what was learned from the NAS report on sexual harassment. Weyant suggested pulling information from individual institutions.

Leong recommended discussions, across SC, about the use of ML and AI. McCann added ML and tools for end users in KBase; user tools that encourage individual researchers to play with ML and consider how to make validations experimentally.

Randerson was interested in when ML and AI affect the computing resources strategy and who will host the data from ML. Weatherwax responded that Advanced Scientific Computing Research (ASCR) could provide a briefing on AI and ML activities. SC is holding a number of discussions about managing the data. The intent is to have a data ecosystem for funded federal research. SC programs have, or will have, large data issues to address.

Weyant asked about developing a use strategy for AI and ML. He suggested inviting Eric Horvitz, head of Microsoft Research Labs, who is using decision theory to examine what would be most valuable. Weatherwax stated there is a federal strategy for AI and there is some overlap with the DOE community. SC has developed a strategy, but it is not yet publicly available. Hack recommended inviting a speaker from ASCR, with expertise in ML, to talk about use cases and tackling the data problem. Randerson lamented there is no environment to access all data and do ML in situ; sources available are data archiving oriented. Hack said the problems are not trivial particularly from a cybersecurity perspective. ASCR, SC, and the national labs are all considering what to do. Schmutz suggested plant phenotyping as a use case.

Randerson was excited to uncover BER's big challenges for ML. Weyant noted the need to combine those interested in use cases with out-of-the-box thinkers sooner rather than later.

Pakrasi recommended having a discussion on the data management plan requirement in federal grant proposals; defining the phrase "data management plan," explaining the requirements, suggesting good practices, and indicating what an applicant should address.

Weyant asked if there were upcoming BERAC assignments. Weatherwax said there might be new assignments at the next BERAC meeting.

## **Public Comments**

Daniel Pham read the following ASBMB statement, "To members of the Biological and Environmental Research Advisory Committee,

"We are the American Society for Biochemistry and Molecular Biology, a scientific society that represents over 12,000 biochemists and molecular biologists worldwide, a number of whom receive funding and utilize the resources from the Department of Energy Office of Science. Thank you for giving us the time to introduce ourselves and provide feedback to BERAC's activities. We would also like to thank Dr. Todd Anderson for participating in our webinar to discuss opportunities and resources from the Biological Systems Science Division of the DOE that our members can utilize.

"We have been closely monitoring the increased oversight on U.S. labs with foreign ties and new policies to deter foreign influence and espionage. We would first like to thank Dr. Steve Binkley for discussing this topic earlier this morning. We recognize the dangers of these threats, but we also believe that science is inherently collaborative, and these collaborations have historically crossed borders. We have been concerned by the detrimental effect that these new

policies have on fostering international collaborations vital to scientific progress. These changes would inhibit important scientific advances, and impact the important role of the U.S. as a leader in these discoveries.

“We would like some clarification especially on the new policies released by the Department of Energy restricting collaborations. While Undersecretary Paul Dabbar mentioned that the new policies would only affect an extremely narrow segment of the overall science community, as published in a February Science magazine article, has BERAC considered the impact beyond the direct effect of these policies? We are concerned that while these policies may indeed affect a small number of researchers from specific countries, future countries may soon be targeted and impact more scientists. According to a recent Nature news article published on April 18, conference travel, research visas, security clearances, and science funding to foreign scientists working with the U.S. in different capacities have already been affected by these new policies. If this continues, the U.S. will no longer be able to recruit the brightest minds from around the world, and drive the best talents to other countries, possibly impacting the economy, scientific training, and job availability in science.

“We also would like to understand how the DOE plans to administer this new policy. How will university labs that receive extramural grants or private labs that coordinate with the National Labs, which may not have as much oversight as these national labs, be asked to comply with these changes? What are some criteria that will be used to determine whether certain research requires additional protections? What does the oversight entail, and what are consequences when a researcher or group of researchers is found in violation of these new policies?

“As Dr. Binkley acknowledged that the DOE is working with other federal science agencies, will there be pan-agency policies developed to streamline these policies to combat foreign influence and espionage? We are concerned that scientists receiving grants from multiple agencies must adhere to disparate policies, depending on the agency. Furthermore, how does the DOE plan to disseminate new policies that ensure transparency of these changes, along with an assessment of possible consequences from these policies?

“Foreign influence and espionage must be prevented, and U.S. science is vital to national security of the nation. We also hope that in our quest to protect ourselves from foreign threats, that we do not lose our ability to be the leaders in scientific discoveries. Thank you for your time.”

Nigel Mouncey, Joint Genome Institute (JGI) at Lawrence Berkeley National Laboratory, stated “the cross-cutting nature of microbiome research and the increased velocity of the generation of microbiome data including genomic, proteomic, metabolomic, environmental, imaging data necessitates the need for an integrated community-centric framework to make this data findable, accessible, interoperable and reusable to the broad scientific community. The National Microbiome Data Collaborative (NMDC) will empower the research community to harness microbiome data exploration and discovery through a collaborative and integrative data science ecosystem that will leverage existing DOE assets such as the JGI, KBase, Environmental Molecular Sciences Laboratory (EMSL) and HPC systems within the DOE complex. The first Phase of the NMDC will focus on the design and deployment of NMDC compliant metadata standards and workflows, data facilitation and integration and the user interface and community engagement. For NMDC to be a success, we need your ideas and input on how we can best engage the community and build the NMDC userbase.”

Hungate dismissed BERAC at 5:10 p.m.

**Friday, April 26, 2019**

Hungate reconvened the BERAC meeting at 9:00 a.m. ET.

**Early Career Science Talk: *River-floodplain Dynamics: The Role of Structure, Function, and Evolution in Earth System Science*** – Dr. Joel Rowland (LANL)

[Presentation posted]

### **Discussion**

Weyant inquired if human activity was a factor in Rowland's results. Rowland stated that human activity is critical; humans cannot be separated from rivers. Getting accurate maps will include population density, agricultural usage, and the presence of dams and will help determine if there is a direct correlation between erosion rates and human activity.

Randerson asked how sea level rise propagates through river reorganization and how far it spreads upstream. Rowland explained the upstream effect of sea level rise is relatively limited; it is controlled by the backwater effect.

Reed wondered about land use, transportation, thawing, and new flows in terms of the landscape changing. Rowland indicated Next Generation Exosystem Experiments (NGEE) will be identifying disturbance integration and propagation to the extent an effect can be felt in the channels, and at what point they reinitiate and the effect is gone. Based on historical data, there is fundamental reorganization of the landscape, with new drainage networks and massive fluxes of sediment. The expectation is a huge cumulative effect going down the system. However, there is evidence of built-in resilience and natural oscillation in the system.

Robertson asked about nitrogen export to create oxysomes in the Arctic. Rowland said work has been done on permafrost thaw and nitrogen fluxes from hillslopes. When investigating the age of fluxes entering the river, the sources of materials in the river must be considered.

**Workshop Report: Disturbance and Vegetation Dynamics (VDM) in Earth System Models (ESM)**– Dr. Lara Kueppers (LBNL)

[Presentation posted]

### **Discussion**

Donner was curious about the improvements VDM will provide to ESM and the computational expense. Kueppers said VDM's are capturing the ecological dynamics that give rise to non-linear responses. The models are more expensive. The challenge will be to find computational efficiencies and resist the urge to implement every detailed process to determine which ones are most essential to capture explicitly or capture implicitly. Donner asked about the discrepancy between the fates predicting fires and fires in the observations. Kueppers' colleagues are actively doing parameterizations in testing to understand the dynamics in different parts of the Amazon and South America. The NGEE-Tropics project is funding development of the fates; thus far focusing on observational testbeds. NGEE-Tropics is benchmarking processes with the model. There is a need to expand the local scale information to landscape and regional scales and assemble datasets to inform why the model might be missing something.

Reed inquired if a deterministic repressed model is capable of producing multiple fugue-like predictions. Kueppers explained the fire model is trying to capture fractions of a pixel that is likely to burn given meteorological conditions and state of the vegetation. It is not currently

designed to capture idiosyncrasies, local topographic effects, or even the gustiness of winds. The question is at the earth systems scale, how much stochastic behavior we need to capture versus keeping the focus on productive things, with large-scale associations, that are robust at scale.

Fridlind sought additional information on leading observational gaps to get to VDM. Kuepper noted two types of observational gaps, synthesis supporting robust development of algorithms within the model and testing, and observations at the intersection of disturbance, climate, and vegetation. There is an opportunity to develop benchmarks and demographic processes from observations and experiments by the plant community ecology. Another opportunity is considering how changes in the climate system affects vegetation and the incidence of disturbance, both independently and jointly.

Robertson mentioned VDM's focus on trees stating grasslands are vegetation. Kuepper explained the focus on trees is a consequence of history; these models came out of the gap model or the individual-based forest models. A number of projects are underway to extend the concepts to shrublands, which are a critical global ecosystem. Grasses are represented in these models but are handled similarly to the big leaf approach rather than the demographic approach.

## **Workshop Report: Leveraging Distributed Research Networks to Understand Watershed Systems – Dr. James Stegen (PNNL)**

### **Discussion**

Stahl asked about the management structure of the research networks. Stegen said the management structure is a key piece of the report in terms of governance.

Schmutz inquired how biological experimental data is feeding into the models. Stegen explained generating metagenomic and metatranscriptomic data across biological systems will be coupled with the reaction network models. Using regulation based processes, thermodynamic data is combined with the microbiologic data, and that is fed into a broader reaction network model. This provides a core foundation to put into an effective transport model, bringing in physical processes to join fundamental biology, chemistry, and transport.

Donner commented the intellectual structure and problems are strikingly similar to the approach Atmospheric System Research and Atmospheric Radiation Measurement have taken with respect to the atmosphere. Stegen responded that inspiration has been taken from networks like Ameriflux; the data seems well structured and interoperable.

Fridlind asked if Stegen has seen a role for open science and open source. Stegen remarked that the open source piece of code and model, in terms of code to analyze or compile data or build process-based models, is essential. The cyber infrastructure is key to making this work.

A break was called at 10:42 a.m. and the meeting reconvened at 11:01 a.m.

## **Workshop Report: Genome Engineering for Material Synthesis (GEMS) – Dr. Caroline Ajo-Franklin (LBNL)** [Presentation posted]

### **Discussion**

Donner asked how close GEMS is to reaching a commercialization threshold. Ajo-Franklin said there are start-ups but no investment from large corporations. Two efforts are making bricks in a NCO<sub>2</sub>-neutral fashion, and using mycelium to make packing material from mushrooms.

Stahl inquired about discussions on new classes of biodegradable plastics. Ajo-Franklin said the focus was on the synthesis of inorganic material; plastics were out of scope.

McCann asked if particular materials were identified that would be closer to technology readiness level 3 (TRL3), such as a novel material for which there is a market pull. Ajo-Franklin said making concretes that are ready to self-repair might be a more tractable market. Concrete that can be deployed in inaccessible conditions, such as under water, is a novel material that does not currently exist but is close to development.

Muday expressed curiosity about bacteria that can live in concrete. Ajo-Franklin said there are bacillus bacteria embedded in the concrete. When the concrete cracks those are exposed to oxygen and come out of their spores. The bacteria become metabolically active and form calcium carbonate, which seals the crack. If a material contained an organic component that could make calcium silicate, it would yield the strength to match the original material.

### **BERAC general discussion**

Hungate asked BERAC for topics at future meetings. Weatherwax said the opportunity for BERAC to bring their own experience to the discussion was not previously built into the agenda. BERAC can get a briefing on AI, have time to think about it and then have informed discussions.

Donner stated NOAA publishes its budget in the Bluebook and asked if DOE has anything equivalent. Weatherwax shared the SC website has a granular budget document for download. Reed recommended discussion on aligning the strategic investments of BER with areas that are stable and growing into the future.

Reed and Shupe mentioned watershed science and the report, the approaches, and the potential for cross linkages. McCann was struck by the open watershed and VDM topics, as well as adaptive evolution versus phenotypic plasticity in response to disturbances.

Biteen requested discussions on incorporating QIS into BER research. Randerson was interested in building a nimble component of the BER research program to respond to emergencies or extreme events. Reed reinforced the cross-scale research topic.

Robertson was interested in how AI bears on the BER portfolio. Segré expressed curiosity in AI's replacement or merging with mechanistic models. Donner added BER being favorably positioned to take advantage of advanced computing. Reed and Pakrasi suggested bringing in external speakers from large corporations to discuss AI, automation, and physical analytics. Randerson asked for discussions on the ML ecosystem across biological systems and earth systems. Weyant requested the social science perspective on humans interacting with machines and the changes in job functions with AI and ML.

Fridlind, Brunner, and Muday expressed interest in the open source movement, making databases available and data accessible, and software to put capabilities in the hands of the user. Brunner added annotations of genome data, prioritizing what genes to study, and the bottleneck of studying gene function in the organism. Muday mentioned genomes, how organisms are affected by the environment, and how they define their growth and development.

Randerson suggested discussing ways to generate collaboration between the two components of BER that ties into the facilities report and grand challenges. Robertson mentioned cross-scale integration and the long-term vision. Segré recommended discussing how scientists might increase communication and exchange of data to help solve urgent problems. Shupe was interested in cross facility activities and Muday proposed interagency collaborations to develop methods to make genomic data more functionally interpretable.

Randerson, Robertson, and Segré expressed interest in additional discussions on sexual harassment. Randerson specifically asked how to promote a culture of inclusive excellence in the grant making process, and adopting recommendations from the NAS report on sexual harassment. Segré was curious whether grant policy can help with sexual harassment. Robertson suggested discussions on sexual harassment become part of the BERAC agenda.

**Public comment**

Julie Mitchell, ORNL, reminded attendees that isolated incidents of sexual harassment and other types of scientific misconduct can occur at any institution, with or without a poor climate. It is important to provide positive reinforcement to institutions that dismiss harassers and make their findings more public.

Hungate thanked attendees for their time and adjourned the meeting at 12:01 p.m.

Respectfully submitted,  
T. Reneau Conner, ORISE  
May 10, 2019