COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY
U.S. HOUSE OF REPRESENTATIVES
HEARING CHARTER

Biological research at the Department of Energy: Leveraging DOE's unique capabilities to respond to the COVID-19 pandemic
Friday, September 11, 2020
1:30 PM EST
Cisco Webex

PURPOSE

The purpose of the hearing is to examine the biological research and development activities within the U.S. Department of Energy Office of Science's Biological and Environmental Research (BER) program. The hearing will examine the historic reasons for why the Department has bioscience research capabilities; how this expertise and BER's advanced research tools are being leveraged to respond to the COVID-19 pandemic; and future directions for the Department's biological research activities. The hearing will also inform the development of legislation that will guide the DOE Office of Science's activities in these and other areas.

WITNESSES

- **Dr. Mary Maxon**, Associate Laboratory Director for Biosciences, Department of Energy, Lawrence Berkeley National Laboratory
- **Dr. Debra Mohnen**, Professor, Department of Biochemistry and Molecular Biology, University of Georgia
- **Dr. Glenn C. Randall**, Chair, Committee on Microbiology, The University of Chicago
- **Dr. Kelly C. Wrighton**, Associate Professor, Department of Soil and Crop Science, Colorado State University

BACKGROUND

In response to the COVID-19 pandemic, the U.S. Department of Energy has leveraged its expertise in biological and virology research to address the global health crisis. Activities range from deploying supercomputers to screen thousands of potential drug components to determining viral protein structures and drug targets using high intensity x-rays. Additionally, the department has employed its user facility capabilities in molecular structural determination, genomic sequencing, clinical and non-clinical sample testing, computational modeling and simulation, and epidemiological and logistics support to respond to the pandemic. This research is made possible by leveraging the expertise of facilities such as the Joint Genome Institute, which is

capable of sequencing large quantities of patient samples, and comparing the COVID-19 disease with other genomes (an organism's complete set of DNA, including all of its genes) to identify promising options for immuno-targeting, and constructing models of individual susceptibility.[1]

To synergize the biological and advanced computing expertise of its national laboratory network, DOE launched the *National Virtual Biotechnology Laboratory (NVBL)*.[2] Considered the US Department of Energy's COVID-19 consortium, NVBL strives to mobilize the resources of the department's seventeen national laboratories to engage in COVID-19 research. Projects within the consortium are focused on molecular design for medical therapeutics, COVID-19 testing R&D, epidemiological modeling, and manufacturing.[3] One such project involves designing potential inhibitor molecules to inactivate the main SARS-CoV-2 enzyme in viral replication. These potential inhibitors will be experimentally biochemically tested and validated, then improved upon with computational algorithms.[4]

The NVBL consortium is also leveraging the capabilities of bioinformatics platforms, such as the Empowering the Development of Genomics Expertise (EDGE) platform, hosted by Los Alamos National Laboratory, to tailor COVID-19 analytics and allow public health labs to report SARS-CoV-2 genome sequencing data, validate diagnostic assays, and track case counts and genomic data.[5] NVBL is establishing a data platform to enable the widespread collection and use of reported data attributes that influence public health response outcomes. The platform will include more than 1,200 attributes and process 600,000 data records weekly, while also potentially laying the foundation for a national data infrastructure to support future epidemiological and pandemic modeling.[6]

The hearing will provide an in-depth discussion of why the Department of Energy's biological research capabilities uniquely position the Department to respond to the unprecedented nature of the COVID-19 pandemic, and how leveraging these capabilities may enable DOE to proactively respond to future pandemics, as well as enable continued advancements to our nation's energy security.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH (BER) PROGRAM

The Biological and Environmental Research (BER) program is one of the six interdisciplinary science program offices within the Department of Energy's (DOE) Office of Science. BER's mission is to advance fundamental research and scientific user facilities to "achieve predictive understanding of complex biological, earth, and environmental systems for energy and infrastructure security, independence, and prosperity." [7] BER's programs are divided between two divisions, the Biological Systems Science Division (BSSD) and the Earth and

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[1] https://science.osti.gov/nvbl
[2] Ibid.
[3] https://science.osti.gov/nvbl/NVBL-Projects
[4] https://science.osti.gov/nvbl/NVBL-Projects/Molecular-Design-Highlights/2020-06-a
[5] https://science.osti.gov/nvbl/NVBL-Projects/COVID-19-Testing-RD-Highlights/2020-06-a
https://science.osti.gov/nvbl/NVBL-Projects/COVID-19-Testing-RD-Highlights/2020-06-b
[6] https://science.osti.gov/nvbl/NVBL-Projects/Epidemiological-Modeling-Highlights/2020-06-b
[7] https://www.energy.gov/sites/prod/files/2020/06/f75/fy-2021-sc-ber-cong-budget.pdf

Environmental Systems Sciences Division. In support of its research agenda, BER operates and manages three user facilities, the Atmospheric Radiation Measurement (ARM), the Environmental Molecular Sciences Laboratory (EMSL), and the Joint Genome Institute (JGI).[8]

BER is credited for its transformative impact on science. In 1990, BER initiated the Human Genome Project, which helped map the human genome (the complete set of human DNA, including all genes), and initiated the era of modern biotechnology and genomics-based systems biology.[9] Today, BER's research seeks to understand and uncover "nature's mysteries involving the processes and interdependencies among genomics, plants, ecosystems, watersheds, regional climate, and the earth system." By studying the fundamental properties encoded in an organism's genome, DOE scientists are trying to understand the principles that dictate the translation of the genetic code into functional proteins and metabolic/regulatory networks underlying the systems biology of plants and microbes (microscopic organism, which may exist in its single-celled form or a colony of cells) as they respond to and modify their environments. This understanding will enable the design and reengineering of microbes and plants supporting an extensive clean energy portfolio, including improved bioproduct and biofuels, as well as controlled biological transformation of materials such as nutrients and contaminants in the environment.[10]

Biological Systems Science Division

The hearing will focus on the capabilities of the Biological Systems Science Division (BSSD) of BER. BSSD's research focuses on integrating discovery and hypothesis driven sciences with technology development to study plant and microbial systems relevant to national priorities in energy security and resilience. BSSD defines systems biology as the "multidisciplinary study of complex interactions specifying the function of entire biological systems—from single cells to multicellular organisms—rather than the study of individual isolated components."[11] Research areas within the division include genome sequencing, proteomics, metabolomics, structural biology, computational models, and high-resolution imaging and characterization.

BSSD supports the Genomic Science program, considered a leading program in systems biology research, which uses genome sequences as the blueprint for understanding the common principles that govern living systems. The program supports single-investigator and team projects in research areas related to bioenergy, environmental microbiome science, and computational biology;[12] and also supports four distinct Bioenergy Research Centers to accelerate research pathways to improve and scale advanced biofuel and bioproduct production processes.

Bioenergy Research Centers

[8] https://science.osti.gov/ber/Research
[9] the BER's FY 2021 proposal has the year as 1990, other sources site DOE establishing BER in either 1986 or 1987.
[10] https://www.energy.gov/sites/prod/files/2020/06/f75/fy-2021-sc-ber-cong-budget.pdf
[11] https://science.osti.gov/ber/Research/bssd
[12] https://science.osti.gov/ber/Research/bssd/Genomic-Science
https://genomicscience.energy.gov/pubs/GenomicScienceOverview.pdf
https://genomicscience.energy.gov/index.shtml

- **Center for Advanced Bioenergy and Bioproducts Innovation (CABBI)**, led by the University of Illinois at Urbana-Champaign. CABBI integrates recent advances in agronomics, genomics, biosystems design, and computational biology to increase the value of energy crops, using a "plants as factories" approach to grow fuels and chemicals in plant stems and an automated foundry to convert biomass into valuable chemicals that are ecologically and economically sustainable.
- **Center for Bioenergy Innovation (CBI)**, led by Oak Ridge National Laboratory. CBI conducts research to accelerate the domestication of bioenergy-relevant plants and microbes to enable high-impact, value-added coproduct development at multiple points in the bioenergy supply chain.
- **Great Lakes Bioenergy Research Center (GLBRC)**, led by the University of Wisconsin—Madison in partnership with Michigan State University. GLBRC is developing the science and technological advances to ensure sustainability at each step in the process of creating biofuels and bioproducts from lignocellulose.
- **Joint BioEnergy Institute (JBEI)**, led by DOE's Lawrence Berkeley National Laboratory. JBEI deploys advanced tools in molecular biology, chemical engineering, and computational and robotics technologies to transform biomass into biofuels and bioproducts.

Joint Genome Institute

The BSSD subprogram also supports the Joint Genome Institute (JGI), established in 1997 to connect expertise and resources in genome mapping, DNA sequencing, technology development, and information sciences. JGI serves as the central source for genome sequence production capabilities for plants, microbes, and microbial communities. JGI's capabilities are instrumental to several BER programs, such as the BRCs, and the Institute's resources are available to the larger research community. JGI is currently engaged in enhancing its expertise to further support microbiome research, and production of complex plant, fungal, and microbial genomes supporting systems biology research within the BRCs and the BER portfolio.

Bioimaging Research

BSSD also supports the Bioimaging Research program, which advances research to develop novel approaches for multifunctional imaging and integrative analysis of the principles guiding gene expression and regulation.[13] The program supports the development of new imaging, characterization, and sensor techniques, with an emphasis on improvements in quantifying nutrient and metabolite flows in situ in field environments.

[13] https://science.osti.gov/ber/bioimaging-research