



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Biological and Environmental Research

**BER Advisory Committee (BERAC)
Spring Meeting
April 25-26, 2019**

*Sharlene Weatherwax
Associate Director*

BER Staff Changes



Dorothy Koch
Departed for NOAA



Boris Wawrick
Program Manager for
Environmental Genomics



David Lesmes
Departed for USGS



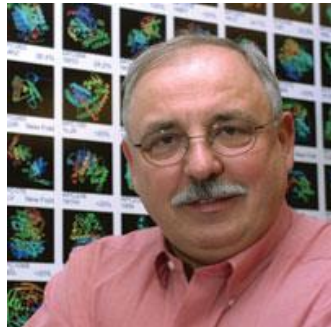
Corrine Hartin
Detaillee from PNNL
Earth System Modeling

Departing BERAC members

Thank you!



Gary Stacey
University of Missouri



Andrzej Joachimiak
Argonne National Laboratory

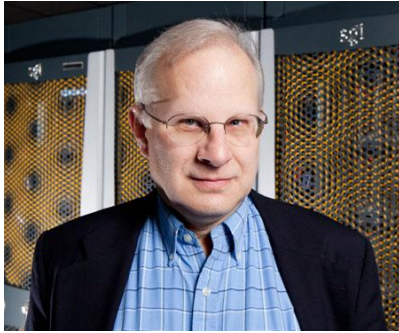


James Ehleringer
University of Utah



Karen Schlauch
Desert Research Institute

New BERAC Members



Leo Donner
NOAA Geophysical Fluid Dynamics Laboratory

Welcome!



Maureen McCann
Purdue University



Robert Fischetti
Argonne National Laboratory

New BERAC Members (cont'd)



Ann Fridlind

NASA Goddard Institute for Space Studies

Welcome!



Jeremy Schmutz

HudsonAlpha Institute for Biotechnology



Himadri Pakrasi

Washington University at St. Louis

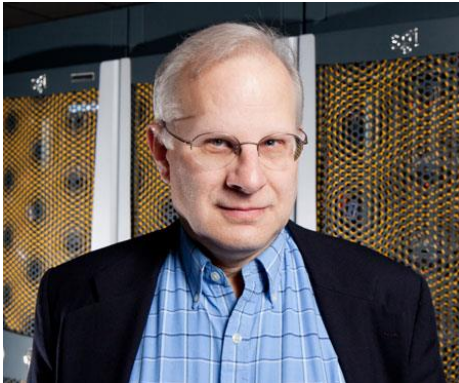
BERAC Members Recognized



Bruce Hungate

Northern Arizona University

2019 Fellow – Ecological Society of America



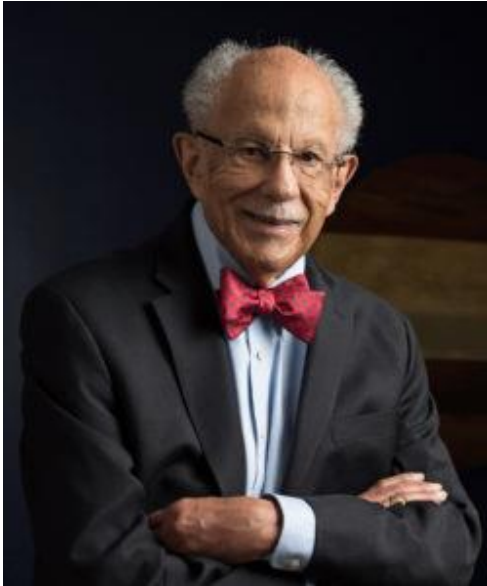
Leo Donner

NOAA Geophysical Fluid Dynamics Laboratory

2019 Fellow – American Meteorological Society



BER Researchers Recognized



Dr. Warren M. Washington
National Center for Atmospheric Research
2019 Tyler Prize Laureate



TYLER PRIZE
for Environmental Achievement



U.S. DEPARTMENT OF
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BER Researchers Recognized



Jizhong Zhou

University of Oklahoma

**2019 Award for Environmental Research –
American Society for Microbiology**



Paul Durack

Lawrence Livermore National Laboratory

2018 Data Prize -World Climate Research Programme



U.S. DEPARTMENT OF
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BER Researchers Recognized

2018 AAAS Fellows



Federica Brandizzi
Michigan State University



Manvendra Krishna Dubey
Los Alamos National Laboratory



Susannah G. Tringe
Joint Genome Institute,
Lawrence Berkeley National Laboratory



Kristala L.J. Prather
Massachusetts Institute of Technology

2019 Royal Society Fellow

Inez Fung
University of California, Berkeley

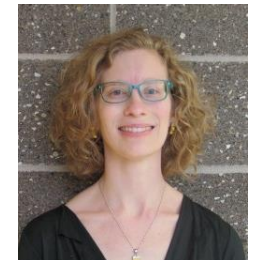


2019 ESA Fellows

Scott Saleska
University of Arizona

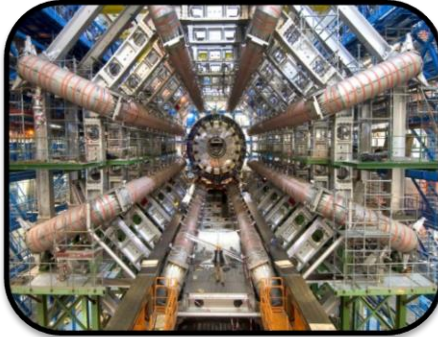


Ashley Shade
Michigan State University
(*Early Career Fellow*)

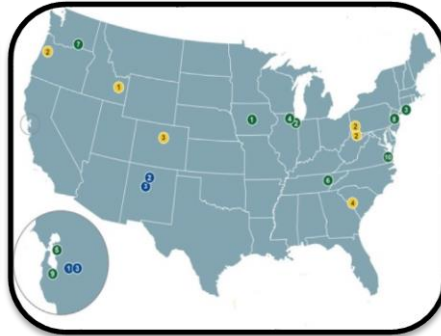


Office of Science at a Glance

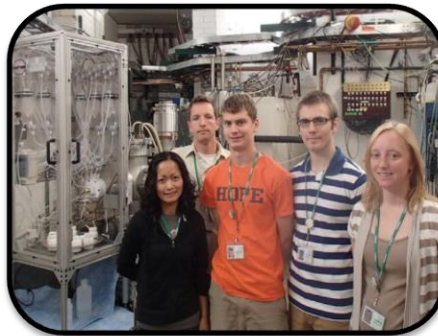
FY 2020 Request: \$5.55B



Largest Supporter of Physical Sciences in the U.S.



Funding at >300 Institutions, including 17 DOE Labs



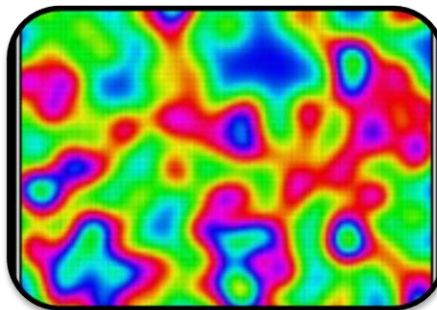
Over 22,000 Researchers Supported



Over 32,000 Users of 27 SC Scientific Facilities



~40% of Research to Universities



Research: 40.6%, \$2.25B



Facility Operations: 39.9%, \$2.21B



Projects/Other: 19.5%, \$1.09B

Major Programmatic Responsibilities

Support of Fundamental Research

SC funds programs in physics, chemistry, materials science, biology, environmental science, applied mathematics, computer science and computational science, and is the Federal steward for several disciplines within these fields such as: high energy physics and nuclear physics; fusion sciences; high performance computing science and technology; and accelerator and detector science and technology. SC is also the largest Federal supporter of fundamental research relevant to future solutions for clean energy.

Support of 21st Century Tools for Science

SC supports the planning, design, construction, and operation of state-of-the-art scientific user facilities considered the most advanced tools of modern science. **Over 32,000** investigators perform research at these open-access facilities each year. Large facilities can have costs in excess of \$1B and can be in design and construction for a decade. Most of our facilities are at DOE labs, but increasingly we engage in international cooperation due to the cost of some of the facilities.

Oversight of 10 DOE Laboratories

SC oversees the operation of 10 DOE national laboratories. It also conducts a formal laboratory strategic planning process annually with its labs to understand future directions, immediate and long-range challenges, and resource needs. As part of its oversight of the laboratories, SC conducts an annual evaluation of the scientific, technological, managerial, and operational performance of the Management & Operating (M&O) contractors of its labs. In addition, SC funds mission-ready infrastructure and investments that foster safe and environmentally responsible operations at the labs.

R&D coordination and integration

SC coordinates its activities with the DOE technology offices, the National Nuclear Security Administration, and other federal agencies. This occurs through multi-program teams led by the DOE Under Secretary for Science (S4), SC and DOE program manager-driven informal working groups, and interagency working groups. New areas have focused on advanced materials, exascale computing, cybersecurity, subsurface technology R&D, and quantum information science. On-going coordination occurs in areas such as biofuels, solar energy utilization, superconductivity for grid applications, and vehicle technologies.

The Office of Science Research Portfolio

Advanced Scientific Computing Research

- Delivering world leading computational and networking capabilities to extend the frontiers of science and technology

Basic Energy Sciences

- Understanding, predicting, and ultimately controlling matter and energy flow at the electronic, atomic, and molecular levels

Biological and Environmental Research

- Understanding complex biological, earth, and environmental systems

Fusion Energy Sciences

- Building the scientific foundations for a fusion energy source

High Energy Physics

- Understanding how the universe works at its most fundamental level

Nuclear Physics

- Discovering, exploring, and understanding all forms of nuclear matter



The DOE/SC Labs Today



BERKELEY LAB

\$858M in FY 2018



- Founded 1931
- 202 acres, 96 buildings
- 3,302 FTEs, including: 486 post-docs, 411 students, and 232 joint faculty
- 2,241 visiting scientists
- 11,403 facility users



Pacific Northwest NATIONAL LABORATORY

\$887M in FY 2018



- Founded 1965
- 781 acres, 71 buildings
- 4,238 FTEs, including: 256 post-docs, 745 students, and 64 joint faculty
- 302 visiting scientists
- 1,742 facility users



THE Ames Laboratory

\$56M in FY 2018



- Founded 1947 (1942)
- 10 acres, 13 buildings
- 307 FTEs, including: 46 post-docs, 174 students, and 43 joint faculty
- 321 visiting scientists



Fermilab

\$414M in FY 2018



Wilson Hall

- Founded 1967
- 6,800 acres, 366 buildings
- 1,783 FTEs, including: 88 post-docs, 94 students, and 13 joint faculty
- 9 visiting scientists
- 3,472 facility users



Argonne NATIONAL LABORATORY

\$782M in FY 2018



Advanced Photon Source

- Founded 1946 (1942)
- 1,517 acres, 154 buildings
- 3,225 FTEs, including: 273 post-docs, 569 students, and 274 joint faculty
- 1,107 visiting scientists
- 8,305 facility users



SLAC NATIONAL ACCELERATOR LABORATORY

\$593M in FY 2018



- Founded 1962
- 426 acres, 149 buildings
- 1,531 FTEs, including: 152 post-docs, 299 students, and 36 joint faculty
- 19 visiting scientists
- 2,692 facility users



OAK RIDGE National Laboratory

\$1,570M in FY 2018



Spallation Neutron Source

- Founded 1943
- 4,421 acres, 271 buildings
- 4,957 FTEs, including: 320 post-docs, 633 students, and 214 joint faculty
- 1,888 visiting scientists
- 3,248 facility users



Jefferson Lab

\$172M in FY 2018



- Founded 1962
- 169 acres, 69 buildings
- 1678 FTEs, including: 34 post-docs, 53 students, and 27 joint faculty
- 1,438 visiting scientists
- 1,597 facility users



PPPL PRINCETON PLASMA PHYSICS LABORATORY

\$100M in FY 2018



NSTX Spherical Tokamak

- Founded 1961 (1951)
- 91 acres, 30 buildings
- 495 FTEs, including: 21 post-docs, 48 students, and 6 joint faculty
- 50 visiting scientists
- 292 facility users



BROOKHAVEN NATIONAL LABORATORY

\$546M in FY 2018



Relativistic Heavy Ion Collider

- Founded 1947
- 5,322 acres, 315 buildings
- 2,527 FTEs, including: 116 post-docs, 395 students, and 123 joint faculty
- 2,313 visiting scientists
- 2,923 facility users

FY 2020 President's Budget Priorities

FY 2018 Enacted: \$6.260B

FY 2019 Enacted: \$6.585B

FY 2020 President's Request: \$5.546B

Priorities:

- Continue operations of all the national laboratories
- Focus on the development of foundational Artificial Intelligence (AI) and Machine Learning (ML) capabilities
- Continue exascale computing research for delivery in FY 2021
- Expand quantum computing and quantum information science efforts
- Focus on cutting edge, early stage research and development
- Ensure a sustained pipeline for the science, technology, engineering, and mathematics (STEM) workforce

FY 2020 SC President's Budget Request

(Dollars in Thousands)

	FY 2018		FY 2019	FY 2020 Request	
	Enacted Approp.	Current Approp.	Enacted Approp.	President's Request	Request vs. FY 2019 Enacted
Advanced Scientific Computing Research	810,000	788,224	935,500	920,888	-14,612 -1.6%
Basic Energy Sciences	2,090,000	2,028,719	2,166,000	1,858,285	-307,715 -14.2%
Biological and Environmental Research	673,000	648,600	705,000	494,434	-210,566 -29.9%
Fusion Energy Sciences	532,111	518,824	564,000	402,750	-161,250 -28.6%
High Energy Physics	908,000	883,573	980,000	768,038	-211,962 -21.6%
Nuclear Physics	684,000	664,694	690,000	624,854	-65,146 -9.4%
Workforce Development for Teachers and Scientists	19,500	19,500	22,500	19,500	-3,000 -13.3%
Science Laboratories Infrastructure	257,292	257,292	232,890	163,600	-69,290 -29.8%
Safeguards and Security	103,000	103,000	106,110	110,623	+4,513 +4.3%
Program Direction	183,000	183,000	183,000	183,000
SBIR/STTR (SC)	...	164,477
Subtotal, Office of Science	6,259,903	6,259,903	6,585,000	5,545,972	-1,039,028 -15.8%
SBIR/STTR (DOE)	...	116,972
Total, Office of Science	6,259,903	6,376,875	6,585,000	5,545,972	-1,039,028 -15.8%

BER FY 2020 President's Request

(Dollars in thousands)

	FY 2018		FY 2019	FY 2020 Request		
	Enacted Approp.	Current Approp.	Enacted Approp.	President's Request	Request vs. FY 2019 Enacted	
Biological Systems Science						
Genomic Science	239,199	239,247	249,695	230,000	-19,695	-7.9%
<i>Bioenergy Research Centers (non-add)</i>	<i>(90,000)</i>	<i>(90,000)</i>	<i>(100,000)</i>	<i>(100,000)</i>	<i>(...)</i>	<i>(...)</i>
Biomolecular Characterization and Imaging Science ^a	30,000	29,952	34,908	24,908	-10,000	-28.6%
Biological Systems Facilities and Infrastructure	69,401	69,401	70,000	60,000	-10,000	-14.3%
SBIR/STTR	12,789	...	13,194	11,892	-1,302	-9.9%
Total, Biological Systems Science	351,389	338,600	367,797	326,800	-40,997	-11.1%
Earth and Environmental System Sciences						
Atmospheric System Research	28,000	27,989	28,000	12,000	-16,000	-57.1%
Environmental System Science	67,000	67,150	62,143	19,000	-43,143	-69.4%
Earth and Environmental Systems Modeling ^b	92,000	91,861	97,000	37,643	-59,357	-61.2%
Earth and Environmental Systems Sciences Facilities and Infrastructure	123,000	123,000	138,500	93,000	-45,500	-32.9%
SBIR/STTR	11,611	...	11,560	5,991	-5,569	-48.2%
Total, Earth and Environmental Systems Sciences	321,611	310,000	337,203	167,634	-169,569	-50.3%
Total Biological and Environmental Research	673,000	648,600	705,000	494,434	-210,566	-29.9%

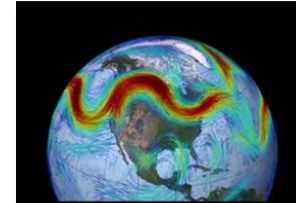
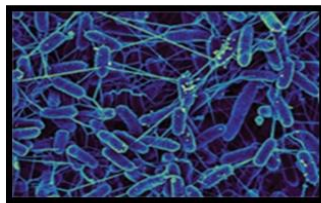
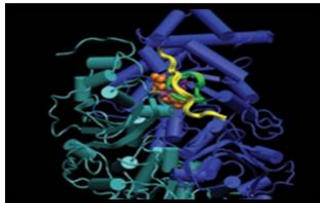
^a Biomolecular Characterization and Imaging Science contains previous Mesoscale to Molecules, and Structural Biology Infrastructure.

^b Earth and Environmental Systems Modeling reflects all previous Modeling activities (Regional and Global Model Analysis, Earth System Modeling, and Integrated Assessment).

Biological and Environmental Research

Understanding complex biological, earth, and environmental systems

- **Genomic sciences** supports the third year of full performance for the four Bioenergy Research Centers (BRCs), environmental genomics and microbiomes, and efforts in secure biosystems design for bioenergy and renewable bioproducts.
- **Biomolecular Characterization and Imaging Science** research supports the development of enabling technology to visualize key structural biomolecules and metabolic processes in plant and microbial cells, including new efforts to explore imaging, characterization and/or sensor techniques that take advantage of quantum information science (QIS)-enabled science concepts in environmental sensors in field environments.
- **Atmospheric System Research** supports research to advance the understanding of cloud-aerosol-precipitation interactions, and their influence on the earth's energy balance.
- **Earth and Environmental Systems Modeling** supports quantifying and reducing uncertainties in Earth System models based on more advanced process representations of Earth system observations and modeling components. The Energy Exascale Earth System Model will prioritize incorporation of studies of the water cycle.
- **Environmental System Science** prioritizes research on the ecology, biogeochemistry, and the water cycle, emphasizing Arctic regimes. Data analysis from the pilot terrestrial-aquatic interface projects continues, while modeling and experimental research involving subsurface fate and transport of radionuclides is terminated.
- **User facilities:** Atmospheric Radiation Measurement (ARM) prioritizes measurements at two fixed sites: North Slope, Alaska and Southern Great Plains, Oklahoma; funds support full deployment of one mobile facility to Norway and one mobile facility seasonal deployment at Oliktok, Alaska. Joint Genome Institute (JGI) provides genome sequence data, synthesis, and analysis. Environmental Molecular Sciences Laboratory (EMSL) focuses on molecular scale analysis for biological and environmental samples.



Biological Systems Science Research for FY2020

Foundational Genomics Research

- Biosystems design techniques to modify microbes and plants for bioenergy and bioproducts
- Genome-modification techniques to identify and predict biosecurity implications

Environmental Genomics

- Sustainable plant and microbial community interactions
- Plant and microbial physiology for bioenergy and ecosystems

Computational Bioscience

- Produce on open source, integrated computational platform for microbiome and bioenergy-related research

Bioenergy Research Centers

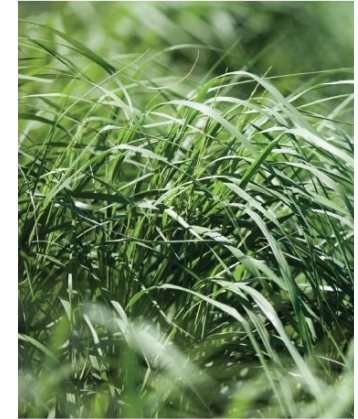
- Begin third year of operations to develop bioenergy crops with favorable physiological traits for environmental conditions

Biomolecular Characterization and Imaging Science

- New multi-modal imaging, visualization and structural characterization of biomolecular processes in plants and microbes; explore imaging that utilizes QIS concepts

Joint Genome Institute

- Serve as a central source for genome sequence production capabilities for plants, microbes and microbial communities
- Request includes reduction associated with moving the facility to the LBNL campus, during which JGI will reduce sequencing and analysis capabilities intermittently



Earth and Environmental Systems Sciences Research for FY2020

Atmospheric Sciences Research

- Cloud and aerosol science in regions that exhibit the greatest uncertainty in Earth models
- Analyze emerging data from the Norway field campaign

Environmental System Science

- Continue studies on permafrost ecosystems, boreal ecology, watershed hydrobiogeochemistry, and terrestrial-aquatic interfaces
- Terminate research on tropical ecology and fate and transport of radionuclides and mercury

Earth and Environmental Systems Modeling

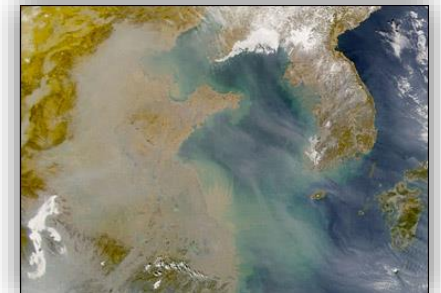
- Incorporate advanced software for deployment of the Earth system model onto exascale computing architectures.
- Continue research on extreme weather phenomena, biogeochemical cycling and water cycle, and model intercomparisons and diagnostics.

ARM User Facility

- Prioritize observations needed to improve the E3SM model.
- Deploy mobile facility to Norway; new aircraft testing and evaluation

EMSL User Facility

- Prioritize research on environmental biogeochemistry, microbial metabolomics, aerosol chemistry, and early applications of Dynamic Transmission Electron Microscope



FY 2020 Administration Priority Research Initiatives

- Machine Learning/Artificial Intelligence
- Bio (security, materials, manufacturing)
- Quantum Information Science - includes quantum sensing, computing, networking, and isotope production
- Exascale Computing
- Microelectronics Innovation
- National Isotopes Strategy
- U.S. Fusion Program Acceleration

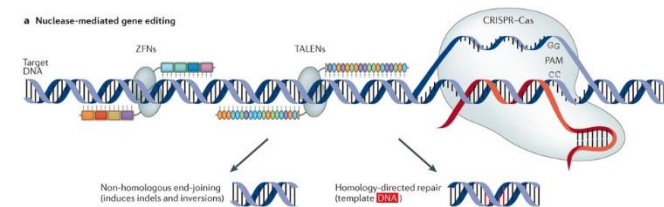
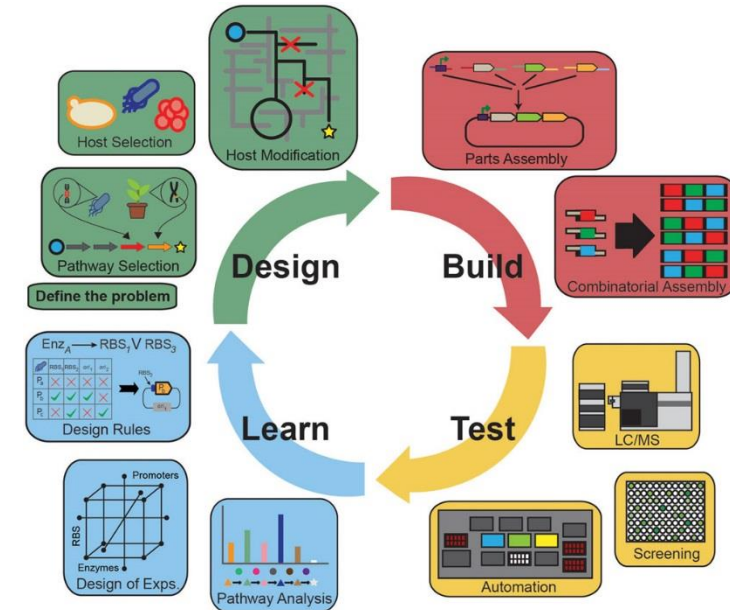
FY 2020 Priority #1 Research Initiatives

(Dollars in Thousands)

Research Initiative	ASCR	BES	BER	FES	HEP	NP	Total
Machine Learning / Artificial Intelligence	36,000	10,000	3,000	7,000	15,000		71,000
Biosecurity			20,000				20,000
Quantum Information Science	51,161	52,503	12,000	7,520	38,308	7,000	168,492
Exascale Computing	463,735	26,000	10,000				499,735
Microelectronics		25,000					25,000
Isotope Development and Production for Research and Applications						47,500	47,500
U.S. Fusion Program Acceleration				4,000			4,000
Total	550,896	113,503	45,000	18,520	53,308	54,500	835,727

Secure Biosystems Design

- Leverages the significant, historical DOE leadership in gene-based research over the last two decades
- Accelerates DOE progress in developing gene-based understanding and manipulation technologies in biological systems relevant to DOE missions by:
 - Systematizing the underlying biological design principles for beneficial redesign and optimization of plant and microbial pathways
 - Expanding systems biology research to a broader range of platform species (plants, microbes)
 - Extending bioenergy research beyond the production of fuels to higher value chemicals and bioproducts
 - Enable development of new secure gene-editing and multi-gene stacking techniques



Thank you!



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