

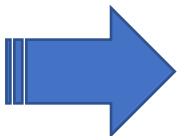
Biological Systems Science

Todd Anderson, Ph.D.
Acting Associate Director,
Office of Biological & Environmental Research
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Biological Systems Sciences Division: Program Goals and Objectives

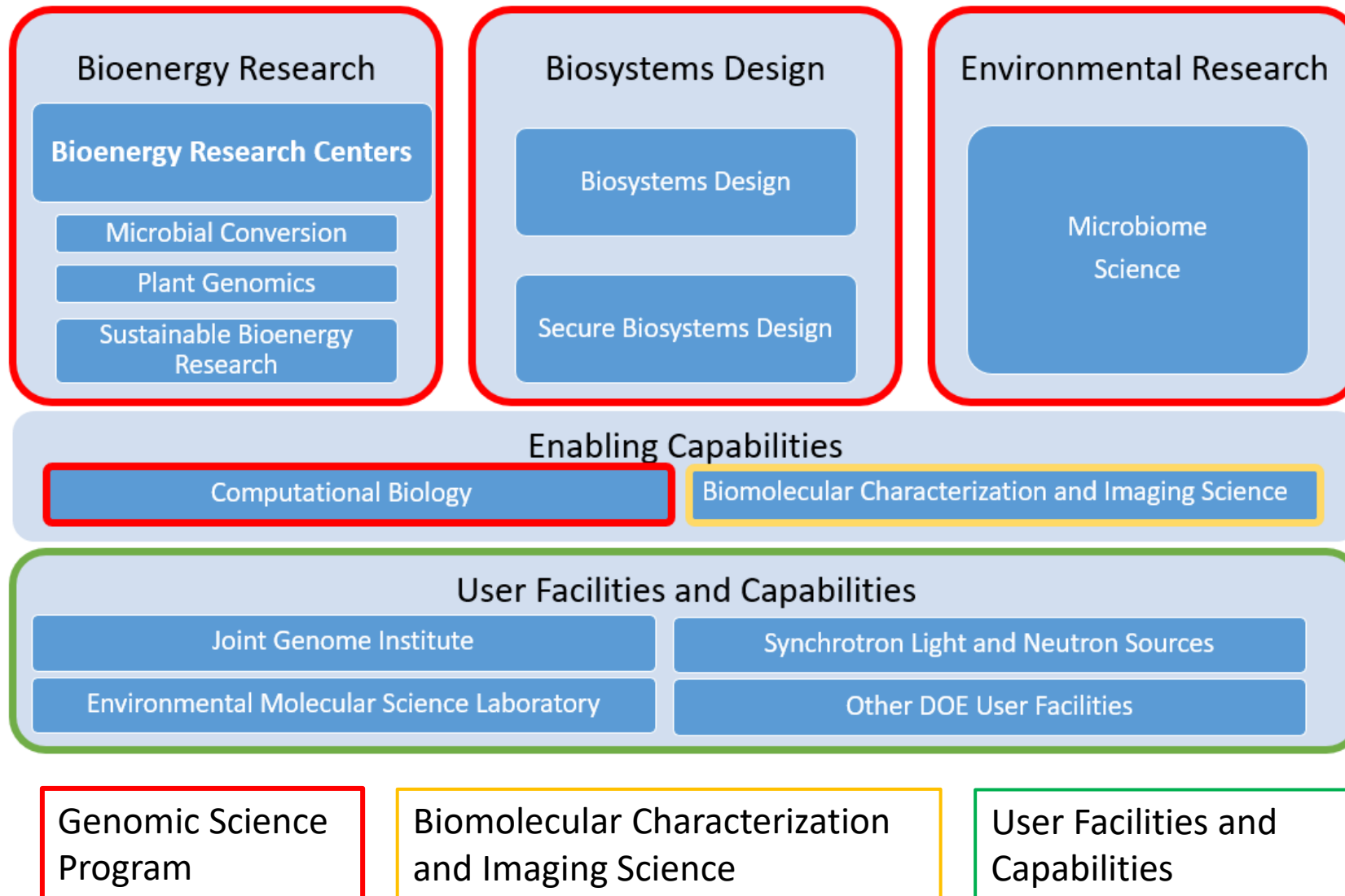
Provide the necessary fundamental science to understand, predict, manipulate, and design biological systems that underpin innovations for bioenergy and bioproduct production and enhance our understanding of natural, DOE-relevant environmental processes.

- 1. What information is encoded in a genome sequence, and how does this information direct the functional characteristics of cells, organisms, and whole biological systems?*
- 2. How do interactions among cells regulate the functional behavior of living systems, and how can these interactions be understood dynamically and predictively?*
- 3. How do plants, microbes, and communities of organisms adapt and respond to changing environmental conditions (e.g., temperature, water and nutrient availability, and ecological interactions), and how can their behavior be manipulated toward desired outcomes?*
- 4. What organizing biological principles need to be understood to facilitate the design and engineering of new biological systems for beneficial purposes?*



DOE Mission Areas in Bioenergy and Environmental Research

BSSD Research Portfolio



- Three main Research efforts:
 - Bioenergy
 - Biosystems Design
 - Environmental Research
- Range of large and small team projects and individual PI efforts.
- Supported by Enabling capabilities
- Access to JGI, EMSL and the DOE Light sources

Complemented by:

- Small Business Innovative Research (SBIR/STTR) awards
- Early Career awards
- SC Graduate Student Research
- EPSCoR (intermittent)

Bioenergy Research

Goal: Provide the basic science needed to convert renewable biomass to a range of fuels chemicals, and other bioproducts in support of a burgeoning bioeconomy.

- *Plant Genomics*

Subgoal: *Gain a genome-level understanding of plant metabolism, physiology, and growth to develop new bioenergy feedstocks with traits tailored for bioenergy and bioproduct production.*

- *Microbial Conversion*

Subgoal: *Develop an understanding of microbial and fungal metabolism necessary to design new strains, communities, or enzymes capable of converting plant biomass components into fuels, chemicals, and bioproducts.*

- *Sustainable Bioenergy*

Subgoal: *Understand the genomic properties of plants, microbes, and their interactions to enable the development of new approaches that improve the efficacy of bioenergy crop production on marginal lands with few or no agricultural inputs, while minimizing ecological impacts.*



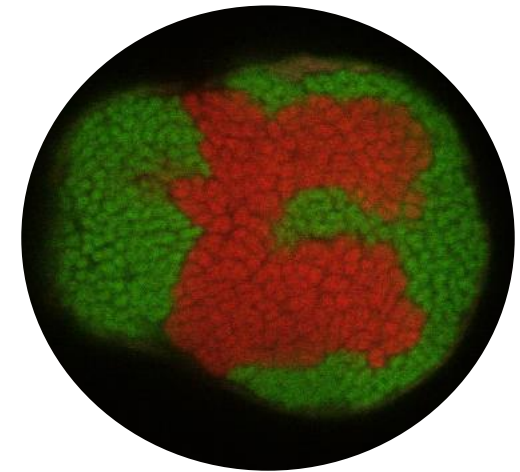
Biosystems Design Research

Goal: Advance fundamental understanding of genome biology and develop the genome-scale engineering technologies needed to design, build, and control plants and microbes for desired beneficial purposes.



Environmental Microbiome Research

Goal: Develop a process-level understanding of microbiome function and be able to predict ecosystem impacts on the cycling of materials (carbon, nutrients, and contaminants) in the environment.



Enabling Capabilities

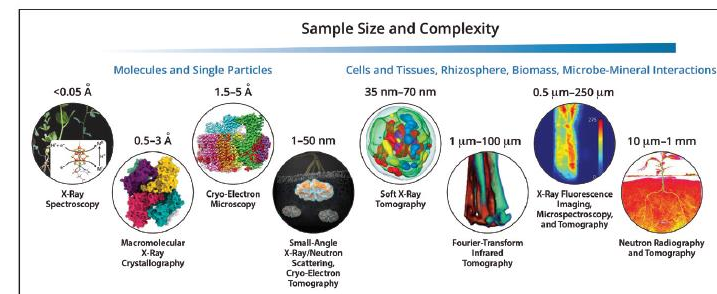
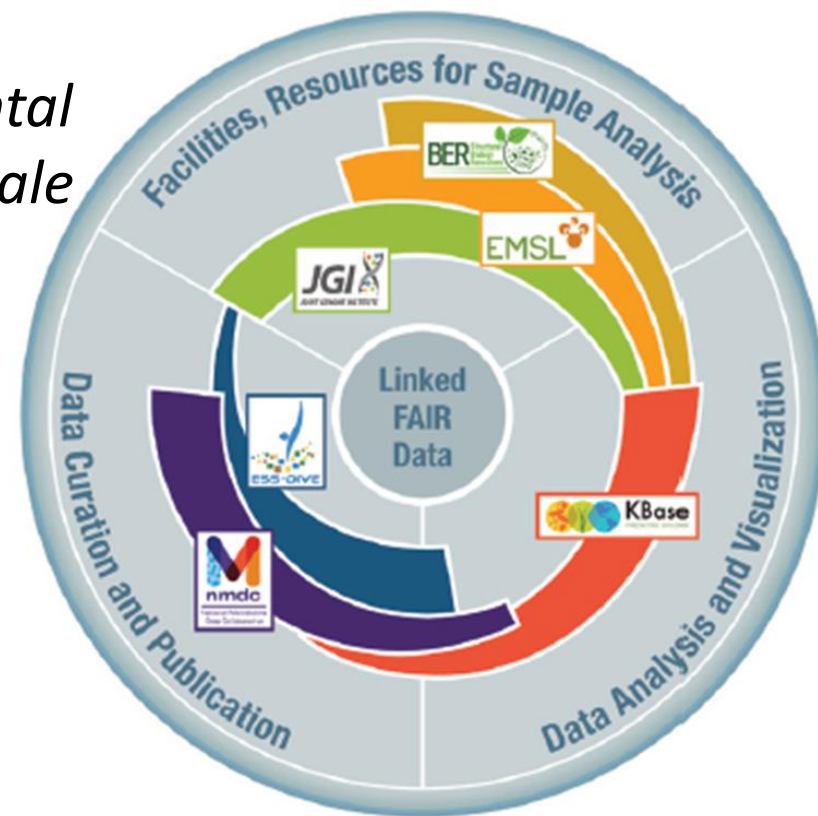
Goal: Support the development of computational and instrumental platforms to enable broader integration and analysis of large-scale complex data within BER's multidisciplinary research efforts.

Computational Biology: Integrated Computational Platforms

Subgoal: Create open-access and integrated computational capabilities tailored to large-scale data science investigations for molecular, structural, genomic, and omics-enabled research on plants and microorganisms for a range of DOE mission goals.

Biomolecular Characterization and Imaging Science

Subgoal: Improve or develop new multifunctional, multiscale imaging and measurement technologies that enable visualization of the spatiotemporal and functional relationships among biomolecules, cellular compartments, and higher-order organization of biological systems



User Facility Integration

Goal: Build unique, best-in-class capabilities within Office of Science user facilities (including JGI, EMSL, and DOE's light and neutron sources) to enhance the multidisciplinary Bioenergy Research, Biosystems Design, and Environmental Microbiome Research supported by the Division.

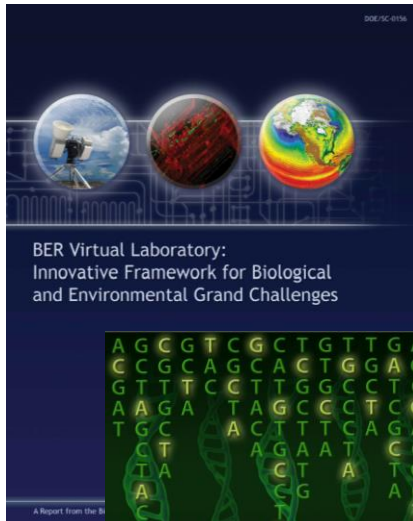
JGI Building on the LBNL Campus



Synchrotron Light and Neutron Sources
Nanoscience Centers
(operated by SC-BES)

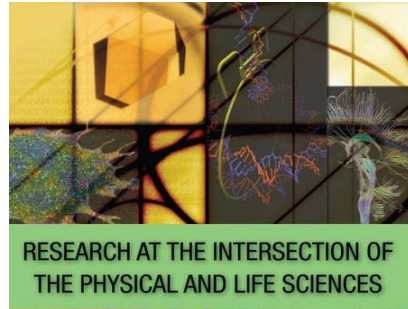
Supercomputing Center
(operated by SC-ASCR)

Strategic Planning and Workshops that Direct the Portfolio



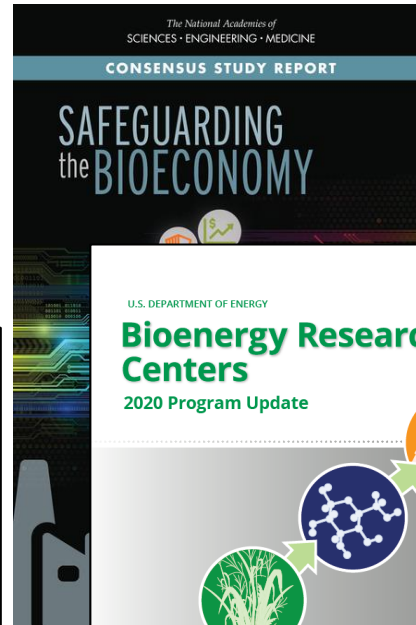
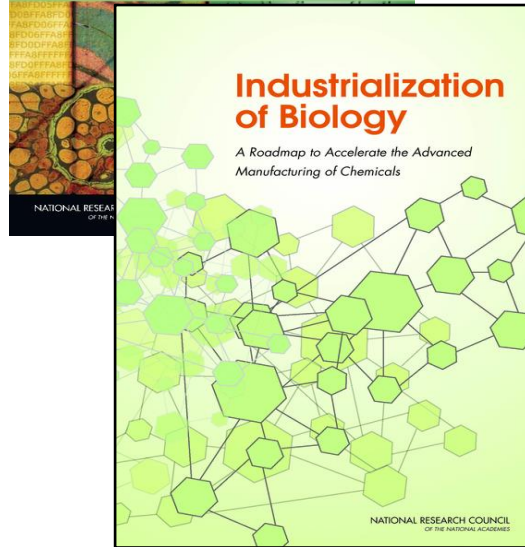
[BER Virtual Laboratory report - BERAC](#)

[BER Genome Eng. for Mat. Synthesis](#)



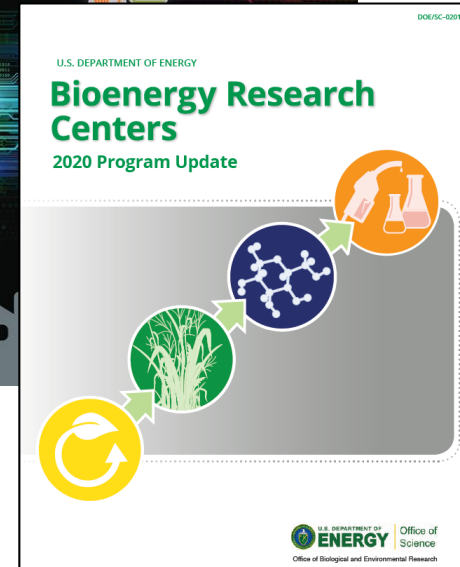
[NAS-Research at the Interface](#)

[NAS Study: Industrialization of Biology](#)



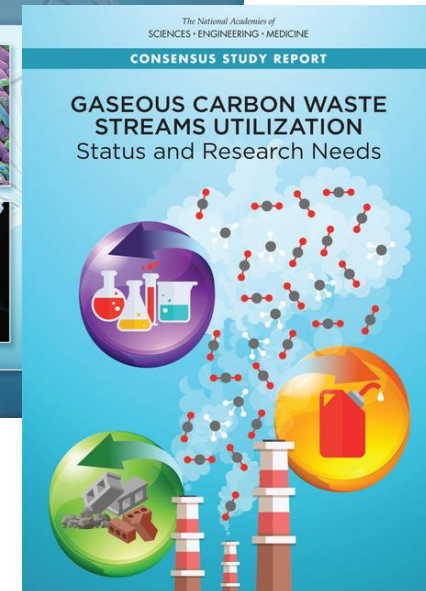
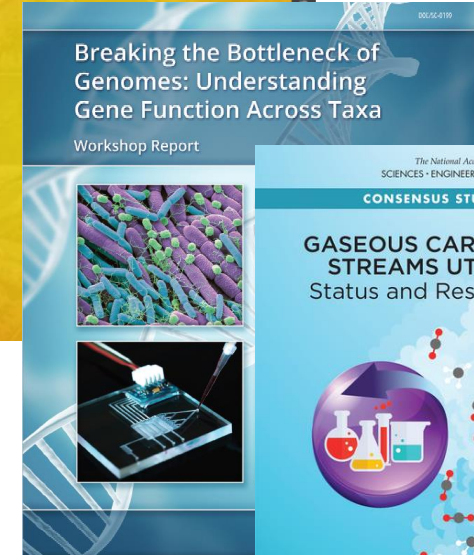
[NAS- Safeguarding the Bioeconomy](#)

[Bioenergy Research Brochure](#)



[Breaking the Bottleneck of Genomes](#)

[BES-Challenges at the Frontiers - BESAC](#)

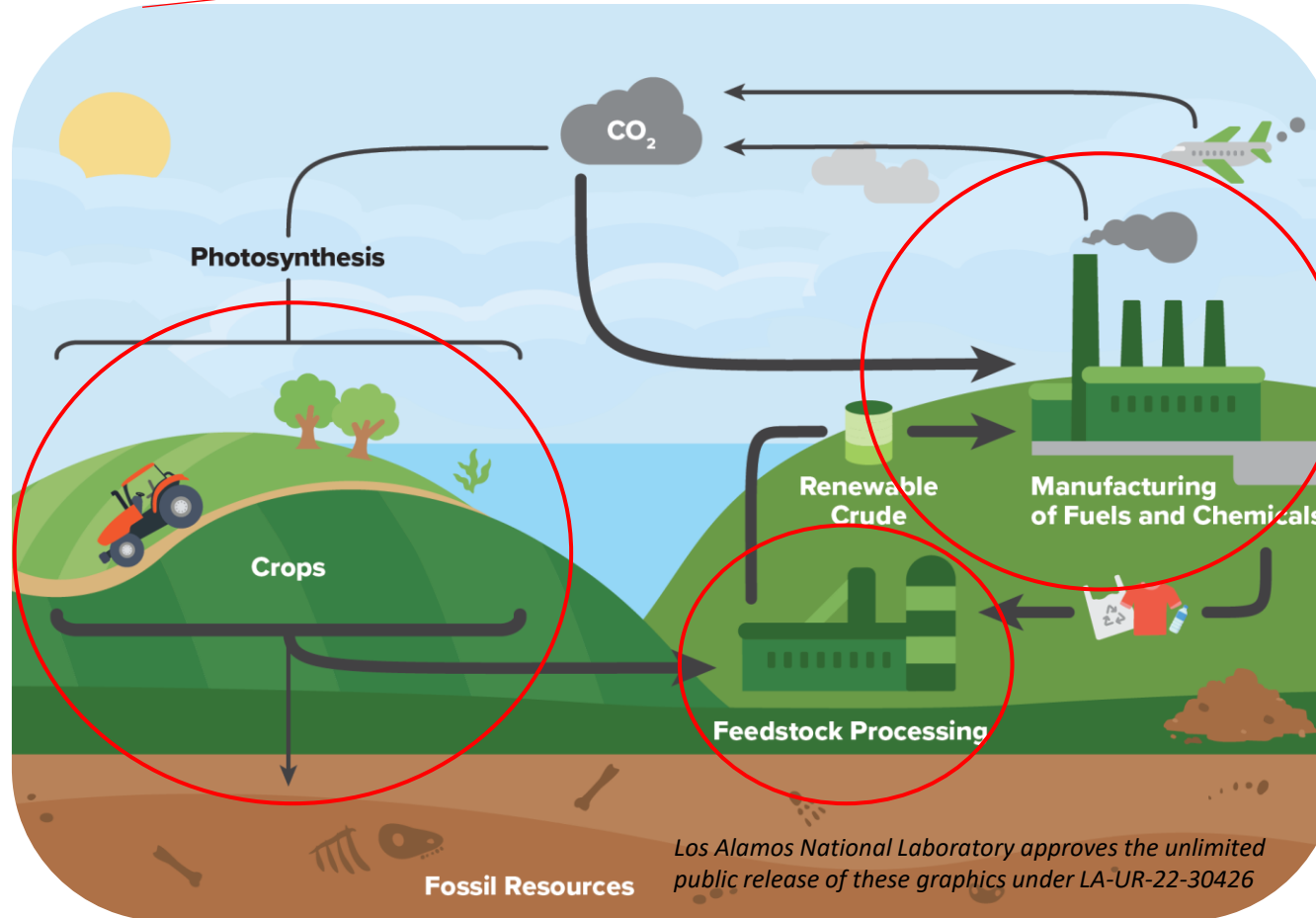


[2019 Gaseous Carbon Utilization](#)

Research Portfolio in Context

BER's Regional/Global Climate modeling - EESSD

Bioenergy Research
- Plant Genomics
- Sustainability Research
Microbiome Research



Biosystems Design
- Secure Biosystems design

Bioenergy Research
- Conversion

New Efforts: Earthshots



Hydrogen Shot™

Long Duration Storage Shot™

Carbon Negative Shot™

Enhanced Geothermal Shot™

Floating Offshore Wind Shot™

Industrial Heat Shot™

RD&D to remove CO2 from the atmosphere

- biological sequestration
- abiotic sequestration
- fundamental reactions/kinetics
- measurement/validation

RD&D to reduce carbon intensity of Industrial processes

- reduce carbon footprint of heating
- alternative to thermal heating
- heat recovery and use

Connections with this Study

RD&D – Carbon Utilization/Circular Bioeconomy

Assess research efforts underway to address barriers in approaches to carbon utilization and identify gaps in research effort:

- Discovery/design of novel metabolic processes (plants and microbes)
 - Carbon utilization from a variety of sources (point sources, atmosphere, water)
 - Production of biomaterials/biominerals
 - Production of commodity chemicals from CO₂.
- Expanding synthetic biology applications relevant to CO₂ utilization
 - new pathways/biomolecules/processes
 - Cell/cell-free systems



Thank you

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

<https://www.energy.gov/science/ber/biological-and-environmental-research>