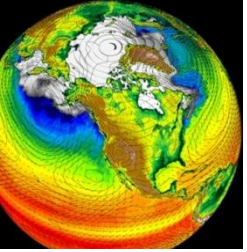
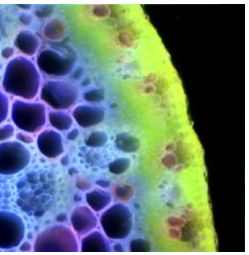
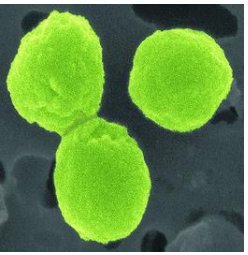


DOE Office of Science

Overview and 2017 Direction

Catherine Ronning, Ph.D.
Program Manager and Genomic Science Program Team Lead
Biological Systems Science Division
Department of Energy, Office of Biological & Environmental Research

March 30, 2017

DOE Office of Science

- Advanced Scientific Computing Research
- Basic Energy Sciences
- **Biological and Environmental Research**
  Sharlene Weatherwax, Associate Director
- High Energy Physics
- Nuclear Physics
- Fusion Energy

Todd Anderson, Director

Biological Systems Science

- Genomic Science
  - Bioenergy Research Centers
- Bioimaging Technology
- Facilities & Infrastructure
  - Joint Genome Institute
  - Structural Biology

Gary Geernaert, Director

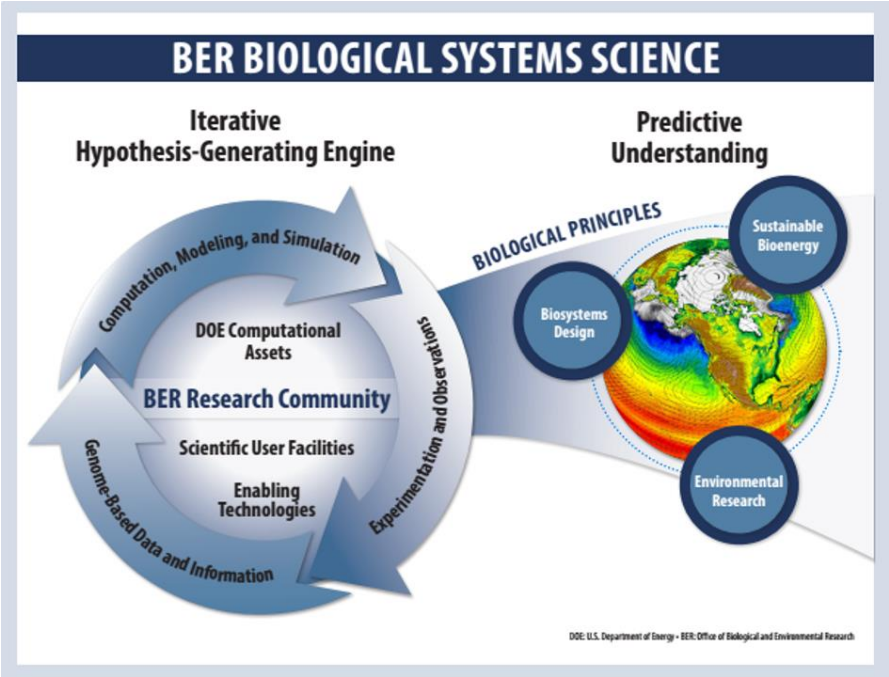
Climate & Environmental Sciences

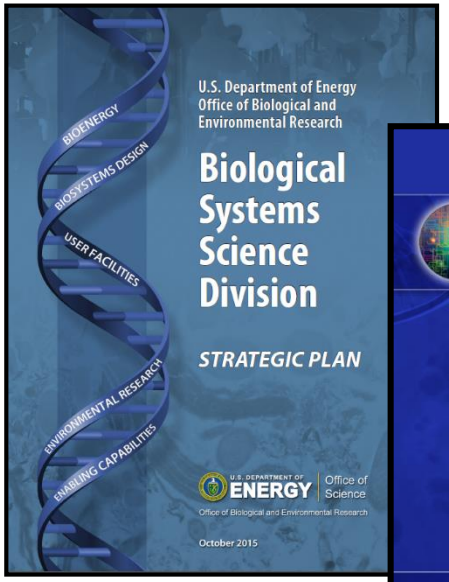
- Atmospheric System Research
- Environmental System Science
- Climate & Earth System Modeling
- Facilities & Infrastructure
  - Environmental Molec. Sciences Lab
  - ARM Climate Research Facility

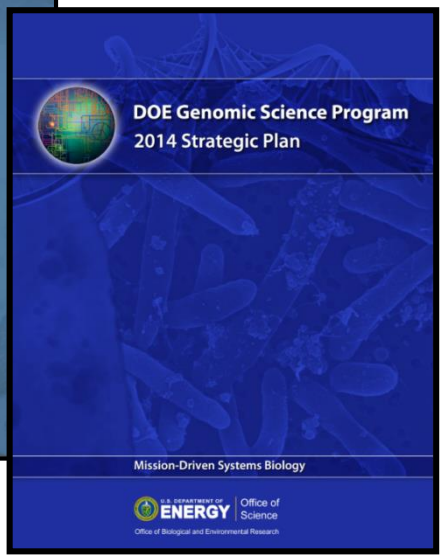
Genomic Science Program

Main Program Components

- *Bioenergy Research Centers (BRCs)**
- *Systems Biology for Bioenergy*
- *Plant Feedstocks Genomics**
- *Biosystems Design**
- *Carbon Cycle/Environmental Microbiological Research*
- *Computational Biosciences*
- *Sustainability Research for Bioenergy**





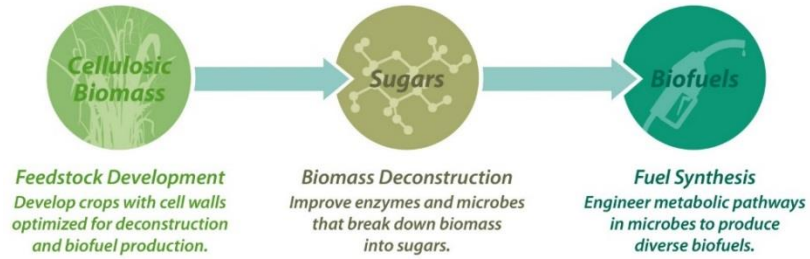


http://genomicscience.energy.gov/strategicplan/index.shtml

Bioenergy Research Centers

Multidisciplinary fundamental science guided by milestones & deliverables, targeted to key areas needed to improve production of biofuels from renewable biomass.

10th Year!!



BESC BioEnergy Science Center

GREAT LAKES BIOENERGY RESEARCH CENTER

jbei Joint BioEnergy Institute

- **BioEnergy Science Center** (Oak Ridge National Lab)
- **Great Lakes Bioenergy Research Center** (U. of Wisconsin, Michigan State U.)
- **Joint BioEnergy Institute** (Lawrence Berkeley National Lab)

BRC Open Competition DE-FOA-0001540

Sustainability* | Feedstock Development | Biomass Deconstruction | Conversion biofuels & bioproducts*

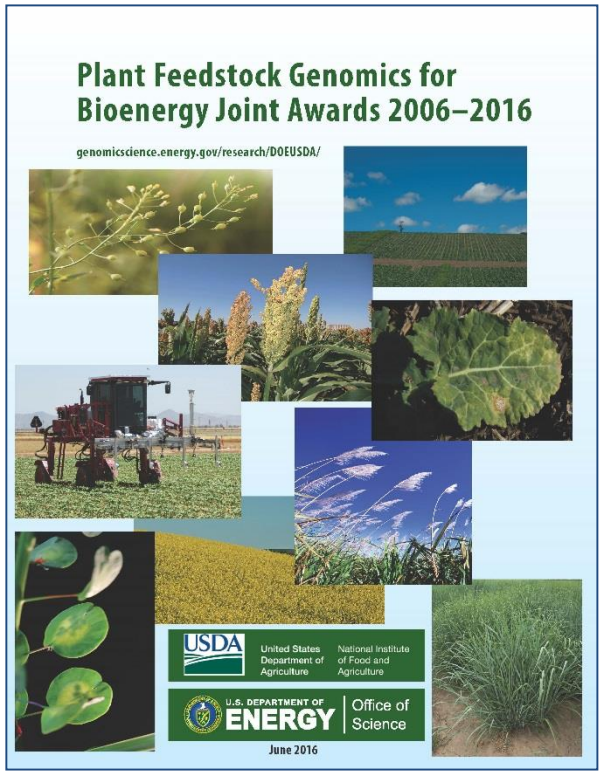
- Pre-applications due 6/17/2016
- Applications due 9/30/2016
- Selections in FY2017; centers begin in FY2018

BER Program Manager: Dr. Kent Peters

Plant Genomics Research for Bioenergy

Research to overcome the biological barriers to the low-cost, high-quality, scalable and sustainable production of bioenergy feedstocks using the tools of genetics and genomics

- Eleven-year collaborative effort with USDA on basic plant biology for bioenergy purposes
- Developing the scientific basis for new bioenergy crops
- Complementary with ongoing bioenergy research in BRCs and Biosystems Design
- New FOA includes plant responses to pathogens oil seed crop research



USDA NATIONAL INSTITUTE OF FOOD AND AGRICULTURE
U.S. DEPARTMENT OF AGRICULTURE

U.S. DEPARTMENT OF ENERGY | Office of Science

BER Program Manager: Dr. Cathy Ronning

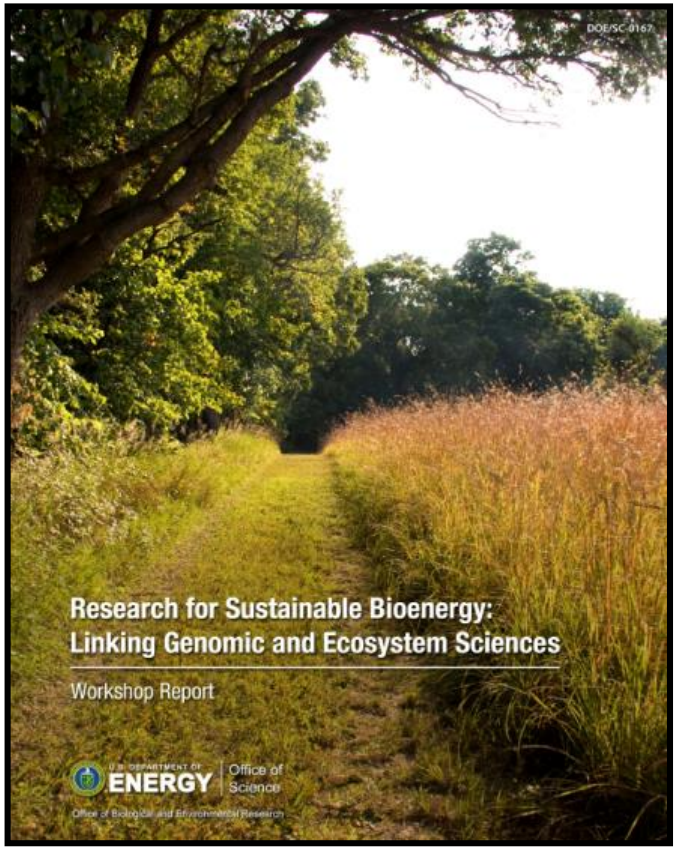
Sustainability Research for Bioenergy

Research to Advance Bioenergy Agriculture

Understanding plant/soil/microorganism interactions in field settings

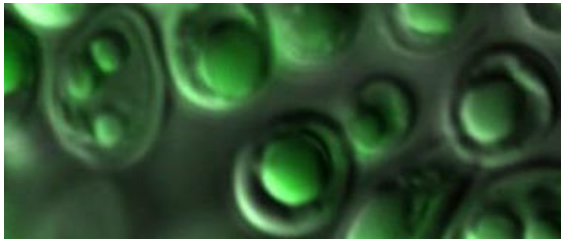
- Enhance biomass productivity under changing conditions by:
  - Investigating molecular and physiological mechanisms that control bioenergy crop vigor, resource use efficiency, resilience/adaptability to abiotic stress;
  - Defining and characterizing interactions of bioenergy crop plants with the surrounding environment.

- Investigate the role(s) of microbial and microbial communities in the complex plant-soil environment in:
  - Contributing to plant performance, adaptation, and resilience under changing environmental conditions and abiotic stressors;
  - Impacts of introducing bioenergy cropping systems on the local ecosystem.



Program Manager: Dr. Cathy Ronning

Biosystems Design



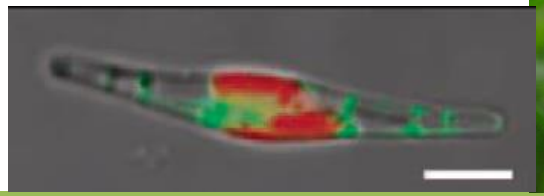
Systems biology and genome engineering research focused on the modeling and design of new biological systems for bioenergy and bioproduct production

Microbial systems design for biofuels and bioproducts

- Integrated experimental and computational approaches aimed at modeling and designing flexible and tunable phototrophic or fermentative microbial systems for the production of advanced biofuels and bioproducts
- Novel *in vivo* and cell-free genome-scale engineering technologies to create new biological functions relevant to bioenergy production
- Development of new platform organisms for genome engineering and innovative high-throughput approaches for screening and testing modified strains

Plant systems design for bioenergy and bioproducts

- Systems-scale biology approaches to advance toward re-designing plants for increased photosynthesis capacity and biomass accumulation, improved nutrient and water utilization, increased non-edible oil and bio product production, and enhanced abiotic stress tolerance
- New technologies for modeling, design, and large-scale genome engineering of potential bioenergy crops to confer new or improved functions for sustainable production of biofuels and chemicals in marginal environments



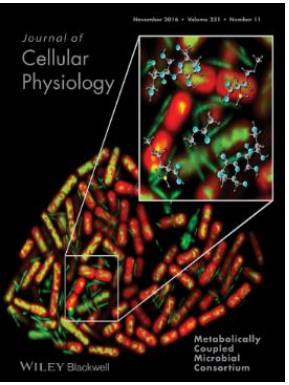
BER Program Manager: Dr. Pablo Rabinowicz

Computational Biosciences: DOE Systems Biology KnowledgeBase

Open software and data platform for addressing the grand challenge of systems biology: **Predicting and designing biological function**

Unified system that integrates data and analytical tools for comparative functional genomics of **microbes, plants, and their communities**

Collaborative environment for **sharing methods and results** and placing those results in the context of knowledge in the field



Designed to support the emergence of collaborative science and a knowledgebase for predictive biology

Program Manager : Dr. Ramana Madupu

http://www.kbase.us

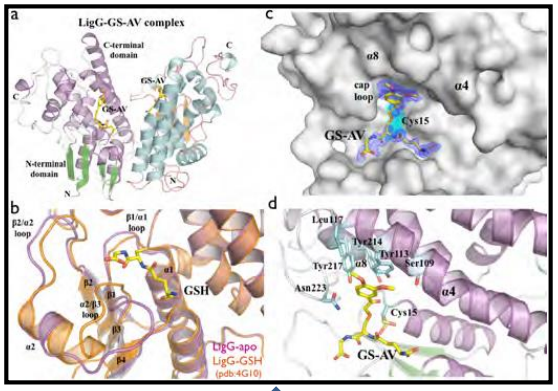
KBase
PREDICTIVE BIOLOGY

Bioimaging Technologies

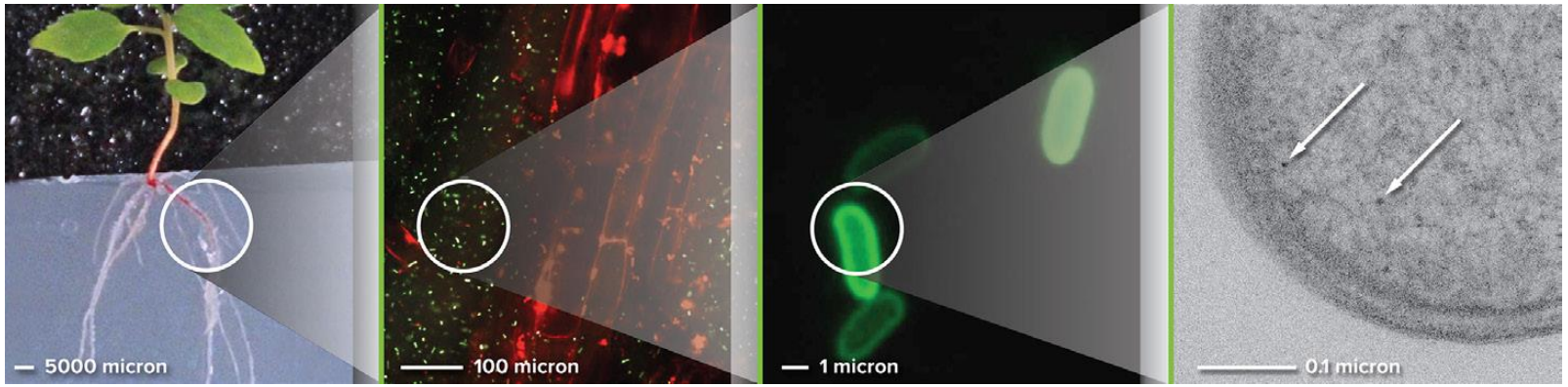
Goal: Develop the enabling computational, visualization and characterization capabilities to integrate genomic and functional information on biological processes relevant to energy and environment.

- Combine biomolecular structural characterization with bioinformatics to infer function and improve genome annotation or design new functions
- Visualize expressed biomolecules within living plant or microbial cells or within microbial communities
- Develop *in situ*, dynamic, and nondestructive multifunctional imaging
- Partnerships with SC light sources and neutron sources

Characterization of biomolecules



Visualization across scales of observation



BER Program Manager: Dr. Prem Srivastava

User Facilities

DOE Joint Genome Institute

http://jgi.doe.gov/

Next Community Science Program (CSP) Call - OPEN

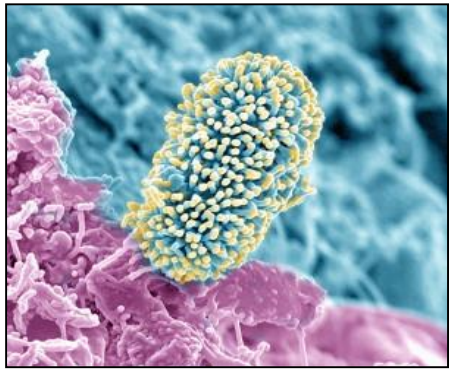
- *Letters of Intent due: March 31, 2017*
- Plant Functional Genomics and Microbiomes of DOE JGI Flagship Plants
- Inter-Organismal Interactions
- Microbiology of Extreme Environments
- Microbes and Communities Involved in Elemental Cycling in Terrestrial and Coastal Environments

FICUS (JGI-EMSL) Collaborative Science Initiative - OPEN

- *Letters of Intent due: April 3, 2017*
- Biofuels and Bioproducts
- Plant-Microbe Interactions
- Biogeochemistry
- Emerging Topics

FICUS (JGI-NERSC) Collaborative Science Initiative - Closed

- *Letters of Intent due: March 17, 2017*



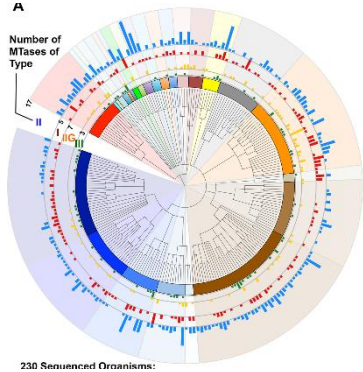
Root associated microbe

Eucalyptus grandis

A. muscaria

Setaria viridis

Updated: Tree of Life



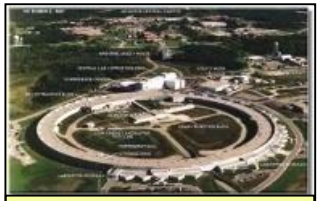
Epigenomics

BER Program Manager: Dr. Dan Drell

Structural Biology Infrastructure Resources

SYBYLS, NCXT,
FTIR Spectromicroscopy
X-ray tomography
SAXS
crystallography

LBNL/Advanced Light Source (ALS)
Dr. Hoi-Ying Holman
Dr. Carolyn Larabell
Dr. John Tainer



ANL/Advanced Photon Source (APS)
Dr. Andrzej Joachimiak

SBC - CAT

BNL/National Synchrotron Light Source-II
Dr. Sean McSweeney

Microfocus x-ray Crystallography, Scattering, Imaging, Footprinting

SLAC/Stanford Synchrotron Radiation Lightsource (SSRL)
Dr. Keith Hodgson

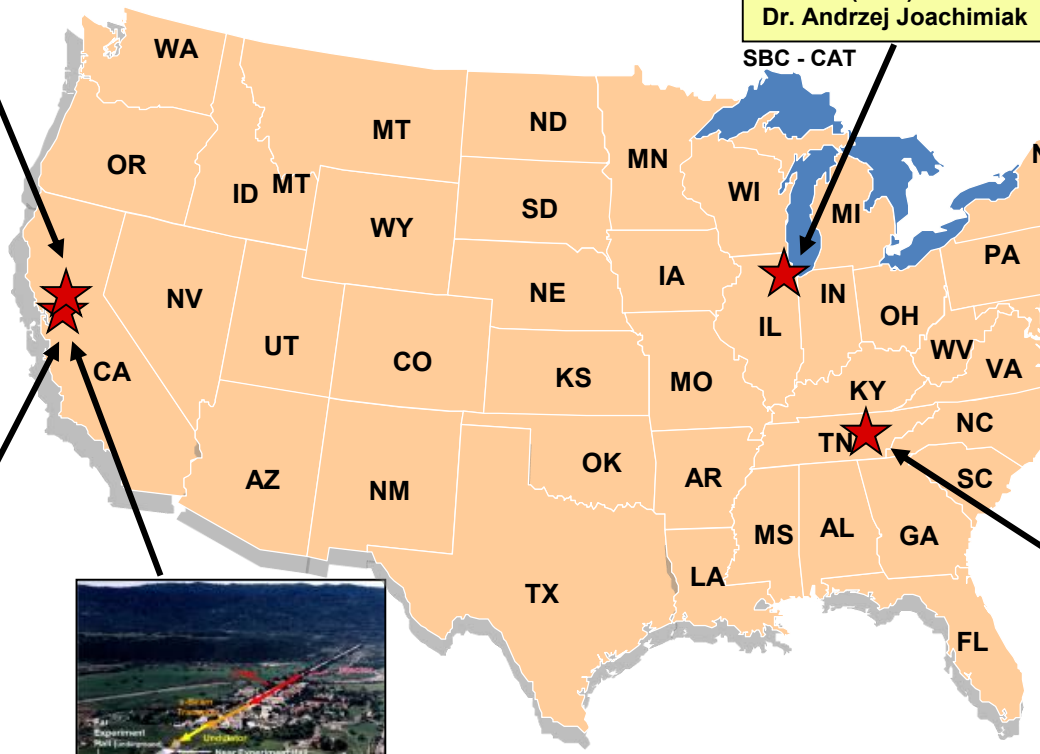
SSRL/SMB crystallography, x-ray spectroscopy and scattering

SLAC/Linear Coherent Lightsource (LCLS)
Dr. Sebastien Boutet
Dr. Soichi Wakatsuki

LCLS XFEL MFX femtosecond crystallography, scattering

ORNL/High Flux Isotope Reactor (HFIR)
Dr. Paul Langan

CSMB - BioSANS



BER Program Manager : Dr. Amy Swain

Funding Opportunities for FY 2017

Plant Feedstock Genomics for Bioenergy: A Joint Research Funding Opportunity Announcement USDA, DOE (DE-FOA-0001688) ***closed***

- *Continues research on plant responses to pathogens*
- *Includes a focus on oil seed crops*

BER Program Manager: Dr. Cathy Ronning

Biosystems Design to Enable Next-Generation Biofuels and Bioproducts (DE-FOA-0001650) ***closed***

- *Plant and microbial genome-scale design and engineering*
- *Expands its focus to biofuels and bioproducts*

BER Program Manager: Dr. Pablo Rabinowicz

Bioenergy Research Centers FOA (recompetition) ***closed***

- *Next steps in bioenergy research*
- *Informed by a June 2014 BER workshop on bioenergy research*

BER Program Managers : Dr. Kent Peters

DOE National Laboratories SFA Opportunity ***closed***

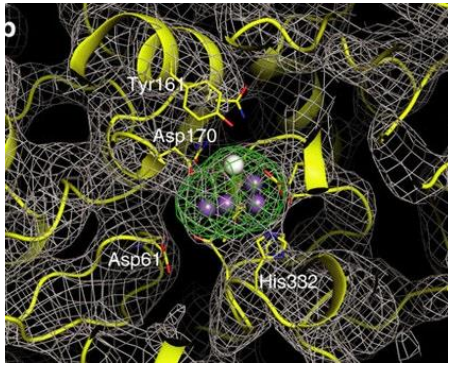
- *Plant Systems Biology for Bioenergy*
- *Biosystems Design for Bioenergy*
- *Soil Microbiome Research*

Systems Biology for Bioenergy FOA ***(Pending)***

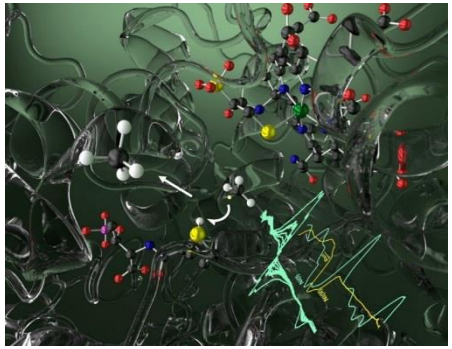
Biosciences Programs in Basic Energy Sciences (BES) Chemical Sciences, Geosciences and Biosciences Division

The BES programs **Photosynthetic Systems** and **Physical Biosciences**, support basic research on the physical, chemical and molecular mechanisms plants and microbes use for **energy capture, conversion and storage**.

- **Photosynthetic Systems**
  - Focused on natural photosynthesis with the goal to develop a fundamental understanding of the chemistry that underlies biological conversion of solar energy to chemically stored forms of energy in photosynthetic systems in plants, algae, and microbes



- **Physical Biosciences**
  - Combines physical science techniques with biochemical, chemical, and molecular biological approaches to discover the underlying physical and chemical principles that govern how plants and microbes capture, convert, and store energy



BES Biosciences

Preapplications and Proposals are solicited through the Office of Science Annual FOA. This FOA is the annual solicitation that covers all of the research areas in the Office of Science and is open throughout the Fiscal Year (until September 30, 2018).

http://science.energy.gov/bes/funding-opportunities/

Review of proposals for Fiscal Year 2017 is currently underway.

For information on the two biosciences-focused programs in BES, Photosynthetic Systems and Physical Biosciences:
http://science.energy.gov/bes/csgb/research-areas/photosynthetic-systems/

http://science.energy.gov/bes/csgb/research-areas/physical-biosciences/

For detailed descriptions of these programs:

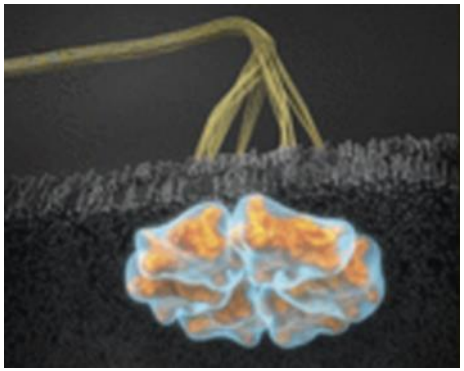
https://science.energy.gov/~/media/bes/pdf/brochures/bes-cras/2017/cra_20_PS.pdf

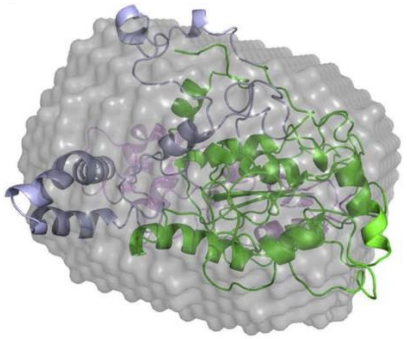
https://science.energy.gov/~/media/bes/pdf/brochures/bes-cras/2017/cra_21_PB.pdf

BES Biosciences Research in the EFRCs

Five of the 36 Energy Frontier Research Centers (EFRCs) are related to biosciences. For more information: http://science.energy.gov/bes/efrc/

- Center for Lignocellulose Structure and Formation (CLSF); Daniel Cosgrove, Pennsylvania State University
- Center for Direct Catalytic Conversion of Biomass to Biofuels (C3Bio); Maureen McCann, Purdue University
- Catalysis Center for Energy Innovation (CCEI); Dionisios Vlachos, University of Delaware
- Center for Biological Electron Transfer and Catalysis (BETCy); John Peters, Montana State University
- Photosynthetic Antenna Research Center (PARC); Robert Blankenship, Washington University in St. Louis





Relationships of BES Biomass-focused EFRCs

Biosynthesis and structure of cellulose and other plant cell wall (PCW) polysaccharides

Mesoscale architecture of the PCW and correlation with biophysical properties

Lignocellulose Biosynthesis and Structure
Catalytic and Pyrolytic Transformations

Biosynthesis of lignin and engineered lignins

Catalytic and pyrolytic transformations of lignin to fuels and chemicals

Catalytic transformations of PCW polysaccharides to fuels and chemicals

BES Basic Research Needs Workshop for Catalysis Science

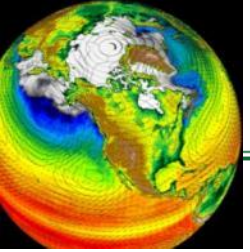
Chair:	Carl Koval (U Colorado)
Co-Chairs:	Susannah Scott (UCSB) & Johannes Lercher (PNNL & TU Munich)
Location:	Gaithersburg, MD
Dates:	May 2017
BES POC:	Bruce Garrett, Raul Miranda

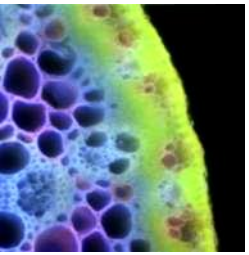
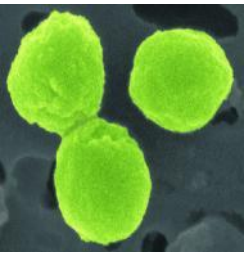
Charge:

- Provide an assessment of the basic science bottlenecks and gaps in our fundamental understanding of issues related to catalysis to advance energy technologies
- Identify basic research needs for catalytic processes that underpin energy resource conversion or utilization, with a focus on new and scientifically challenging areas with potential to significantly impact science and technology

Topics:

- Diversified Energy Feedstocks and Carriers
- Novel Approaches to Energy Transformations
- Advanced Chemical Conversion Approaches
- Cross-cutting Capabilities and Challenges



http://science.energy.gov/ber

Thank you!

http://genomicscience.energy.gov

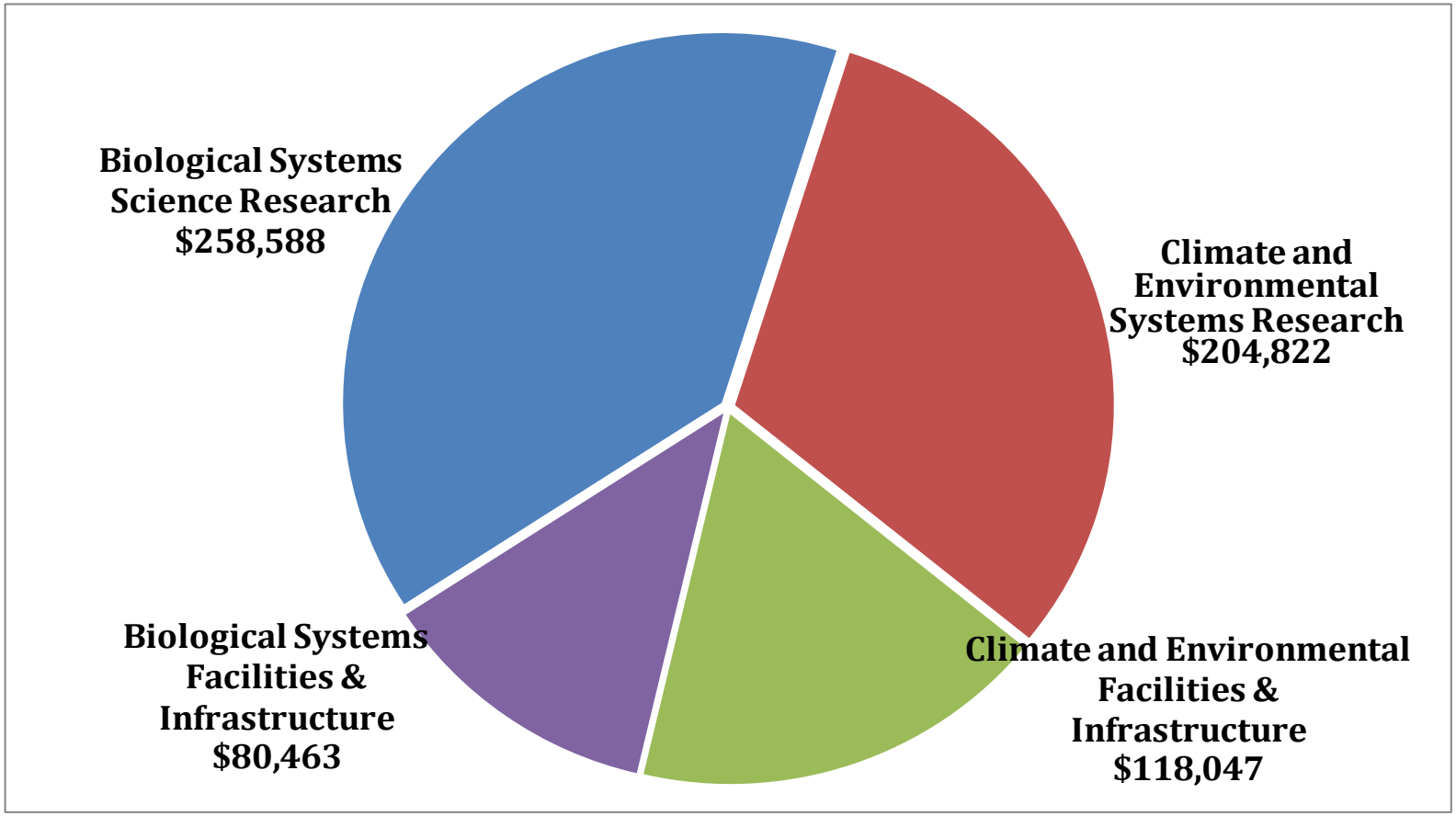
BER FY 2017 President's Request

$661,920 ($609,000*)

(dollars in thousands)

+ $44M
- Mission Innovation
- Microbiome
- Bioimaging

+ $8M
- Integrated Assessment



**Currently operating under a Continuing Resolution (CR) at FY2016 budget till April 28th*