2017 Genomic Sciences Program
Annual PI Meeting

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Environmental Research

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DOE Biological & Environmental Research Missions

• Understand complex biological, climatic, and environmental systems across spatial and temporal scales.

• BER provides the foundational science to:
  – Support the development of biofuels as major, secure, and sustainable national energy resources
  – Understand the potential effects of greenhouse gas emissions on Earth’s climate and biosphere and the implications of these emissions for our energy future
  – Predict the fate and transport of contaminants in the subsurface environment at DOE sites
  – Develop new tools to explore the interface of biological and physical sciences
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.
Biological Systems Science Division : Personnel Changes

Joe Graber – Genomic Science Program Team Lead

Meredith Rutledge – Scientific Program Specialist (Clemson University)
Funding Opportunities for FY 2017

Plant Feedstock Genomics for Bioenergy: A Joint Research Funding Opportunity Announcement
USDA, DOE (DE-FOA-0001688) *
- 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) *
- 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) *
- 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 Ongoing
- Plant Systems Biology for Bioenergy
- Biosystems Design for Bioenergy
- Soil Microbiome Research

Systems Biology for Bioenergy FOA (Pending)  * Closed to new submissions
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

- **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 Recompetition DE-FOA-0001540**

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

BER Program Manager: Dr. Kent Peters
**Systems Biology for Bioenergy**

*Fundamental, systems-level understanding of microbes and microbial communities relevant to advanced biofuels production.*

- Research to advance the development of promising new model organisms relevant to biofuels production.
- Development of novel microbial functional capabilities and biosynthetic pathways relevant to the production of advanced biofuels and the development of strategies to overcome associated metabolic challenges resulting from pathway modification.
- Development of novel analytical technologies or high throughput screening approaches.

**Broadens the portfolio in microbial research on advanced biofuels production**

**BER Program Manager:** Dr. Dawn Adin

Plant Feedstocks 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

http://genomicscience.energy.gov/research/DOEUSDA/usda_doe_handout.pdf

BER 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
Environmental Microbiology

*Genome enabled research linking structure and function of microbial communities with key environmental or ecosystem processes*

- Systems biology of model microbes and consortia important in carbon cycle and environmental processes of relevance to DOE
- Extending systems biology approaches and understanding to integrated microbial communities and plant-microbe interactions
- Development of environmental “meta–omics” approaches to understand how shifts in environmental variables impact microbial community structure and functional processes
- High resolution, high throughput techniques for analysis of biological processes across multiple scales of spatial and temporal resolution
- Development of new techniques for in situ bioprocess analysis in terrestrial ecosystems

**BER Program Manager: Dr. Dawn Adin**
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
What’s new In KBase?
• Over 60 apps spanning assembly, annotation, comparative genomics, metabolic modeling, expression analysis, RNA-seq, and more
• Enhanced RNA-seq and metabolic modeling (bold = improved, star= new)
• Upload large data objects from the web
• Upload and download select data in bulk
• Greatly enhanced tools supporting 3rd-party software tool development

Modeled and predicted interactions between heterotrophic and autotrophic species in a simple community (Henry et al., J. of Cellular Physiology)

Program Manager: Dr. Ramana Madupu
Bioimaging Technologies

Goal: Develop the enabling computational, visualization and characterization capabilities to integrate genomic information with 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

**Visualization across scales of observation**

**Characterization of energy-relevant biomolecules**

**BER Program Manager: Dr. Prem Srivastava**
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 - OPEN

- Letters of Intent due: March 1, 2017

BER Program Manager: Dr. Dan Drell
Environmental Molecular Sciences Laboratory

Advancing discovery and mechanistic understanding of molecular- to meso-scale biological, chemical and physical processes and interfaces to enable predictive understanding.

EMSL provides access to premier instruments for experimental research, high performance computing (HPC) capabilities and a variety of software codes for a range of modeling studies.

**Science Themes:**

- *Biological Dynamics/Design* – understanding and optimizing biological pathways in plants, fungi and microbes.
- *Terrestrial/Subsurface Ecosystems* – understanding the dynamics of metabolites, nutrients and contaminants at biogeochemical interfaces.
- *Molecular Transformations* – understanding molecular transformations at interfaces.

**Proposal Opportunities:**

- Science Theme Call – due February 27, 2017 **Open**
- FICUS (JGI-EMSL) Call LOI – due April 3, 2017 **Open**
- General and Scientific Partner – submitted anytime **Open**

Call Info: [https://www.emsl.pnl.gov/emslweb/proposal-opportunities](https://www.emsl.pnl.gov/emslweb/proposal-opportunities)

Capabilities: [https://www.emsl.pnl.gov/emslweb/scientific-capabilities](https://www.emsl.pnl.gov/emslweb/scientific-capabilities)

**BER Program Manager – Paul Bayer**

Visualization of ultrastructures and whole cell reconstruction - TEM.

Lipid production in wild type (top) and mutant (top) *Rhodobacter* – SIM.

Protein structures - NMR.

Experimentation and modeling of ionic liquid pretreatment – NMR, Spectroscopy, NWChem.
Structural Biology Infrastructure Resources

BER Program Manager: Dr. Amy Swain
Allocations of Computer Time

6 B hours available at NERSC in 2017
- 4,800 M for DOE Production (mission computing)
- 600 M for ALCC, 600 M for NERSC Director’s Reserve

Compute available to Office of Science–funded PIs

480 M hours allocated initially to BER for 2017
- 390 M for Climate/Environment
- 90 M for Bioscience
- Additional 480 M distributed to Program Managers’ reserves in spring 2017 for them to distribute at their discretion; codes must be ready to run on Xeon Phi

New requests accepted throughout the year for both production and startup

BER Program Manager: Dr. Ramana Madupu

Cori – Cray XC40
9,300 Intel Xeon Phi (KNL) nodes
2,000 Intel Xeon (Haswell) nodes
~30 PF peak

Edison – Cray XC30
5,576 Xeon (Ivy Bridge) nodes
2.57 Pflop/s peak
Complementary Research Programs within DOE

Office of Science – Basic Energy Sciences

Photosynthetic Systems focuses on natural photosynthesis and brings together biochemistry, chemistry, molecular biology, and biophysics to uncover the fundamental science of the biological capture of sunlight and its conversion to and storage as chemical energy.

Physical Biosciences combines experimental and computational tools from physical sciences with biochemistry, chemistry and molecular biology to increase basic understanding of processes to capture, convert and store energy in living systems, with an increasing emphasis on redox biochemistry.

Program managers: Dr. Robert Stack and Dr. Stephen Herbert

Advanced Research Projects agency – Energy (ARPA-E)

The ARPA-E Rhizosphere Observations Optimizing Terrestrial Sequestration (ROOTS) program seek to develop advanced technologies and crop cultivars that enable a 50 percent increase in soil carbon accumulation while reducing N₂O emissions by 50 percent and increasing water productivity by 25 percent.

Program director: Dr. Joe Cornelius

Office of Energy Efficiency and Renewal Energy (EERE)

Bioenergy Technologies Office (BETO)

Multiple outlets for basic research translation to scale in the areas of feedstocks development, biomass conversion technologies, sustainability approaches and new developments in biomanufacturing.

Multi-DOE Lab effort to accelerate a biomanufacturing industry
Systems science to meet DOE mission needs in bioenergy, climate and the environment.

http://science.energy.gov/ber

Thank you!

http://genomicscience.energy.gov