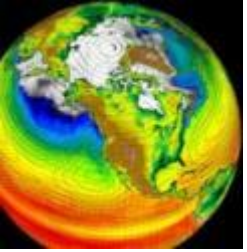
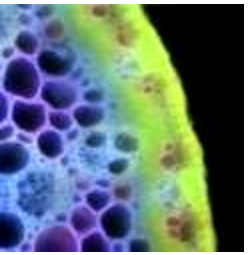
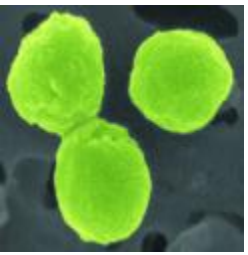


DOE Office of Biological and Environmental Research

Biological Systems Science Division

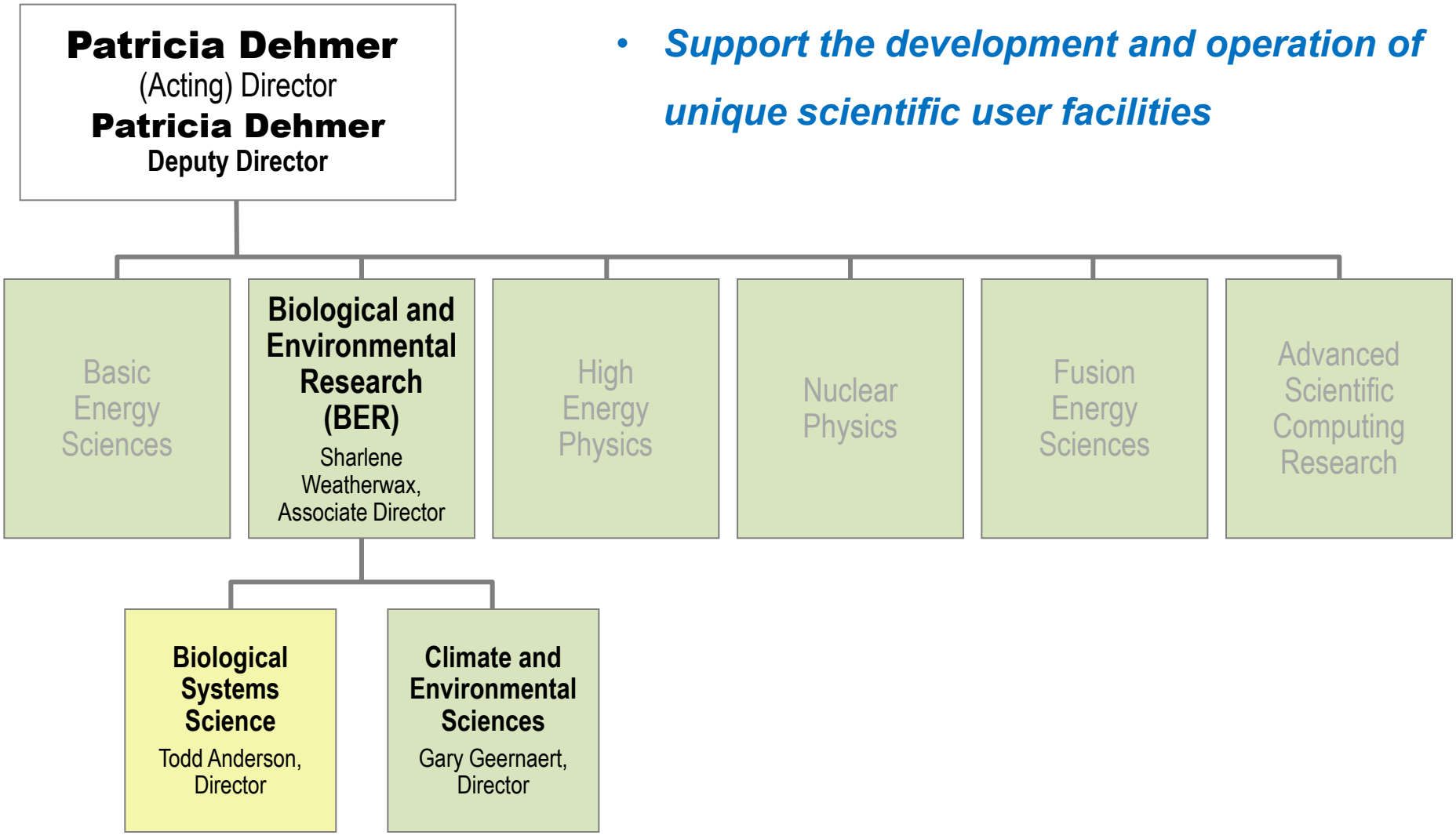
Genomic Science Program

Biosystems Design

Pablo Rabinowicz
Program Manager

Department of Energy Office of Science

- ***Support fundamental scientific research***
- ***Support the development and operation of unique scientific user facilities***

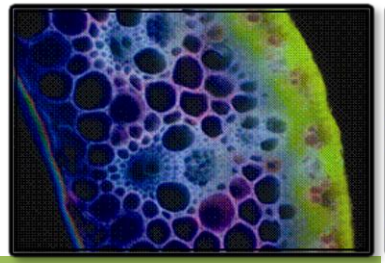
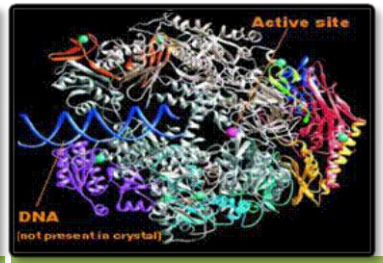


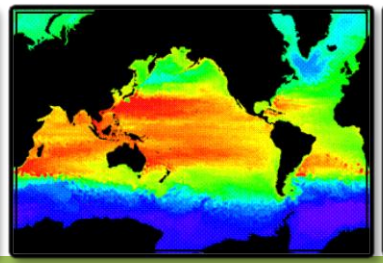
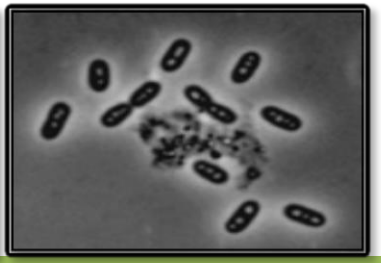
Biological and Environmental Research

Understanding complex biological, climatic, and environmental systems across vast spatial and temporal scales

The Scientific Challenges:

- Understand how genomic information is translated to functional capabilities, enabling more confident redesign of microbes and plants for sustainable biofuel production.
- Understand the roles of Earth's biogeochemical systems (atmosphere, land, oceans, sea ice, subsurface) in determining climate so we can predict climate decades or centuries into the future, information needed to plan for future energy and resource needs.

DOE Genomic Science Program

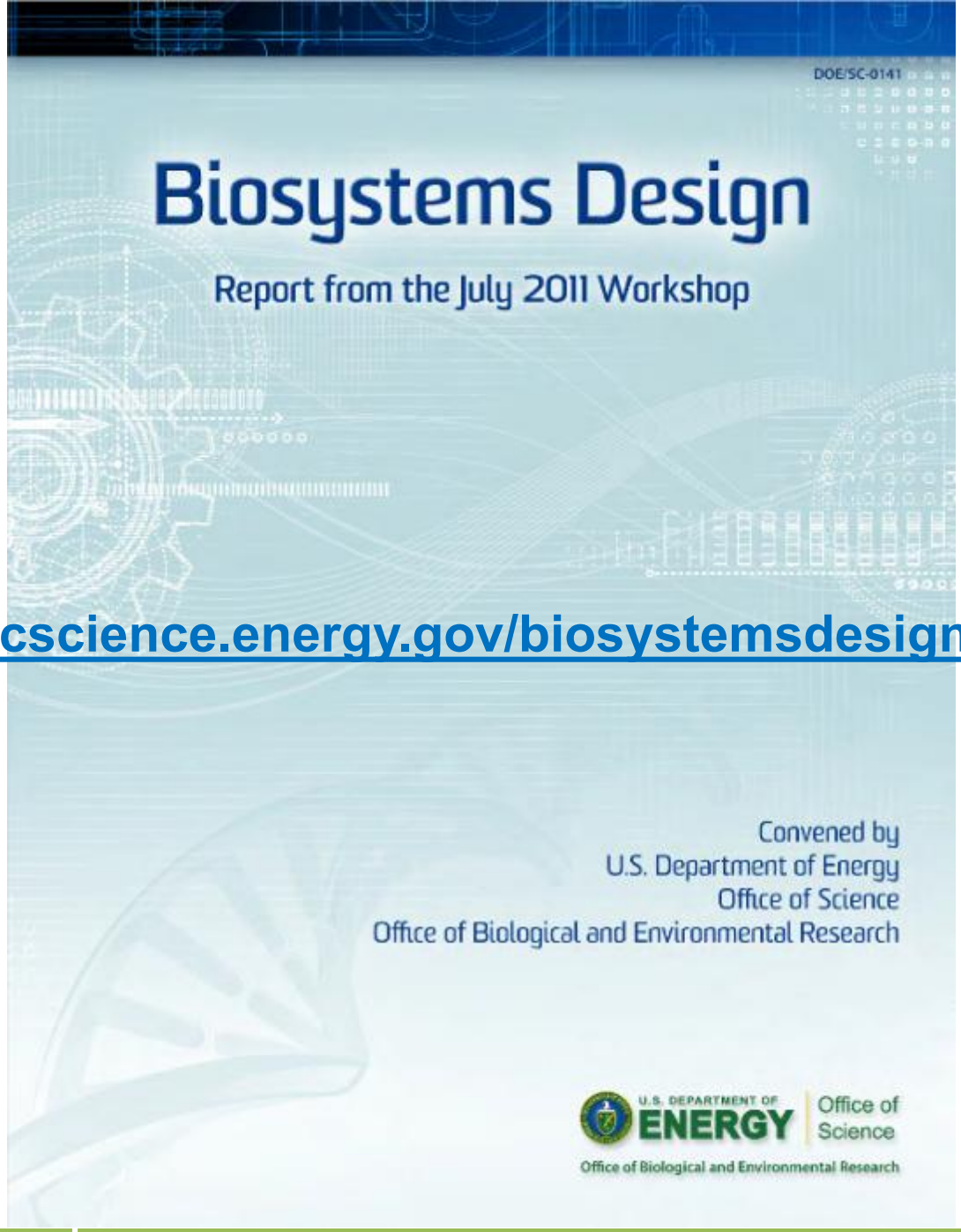
A mission-inspired fundamental research approach

Genomic Science Program Goal and Objectives

Genome Sequence → **System-Wide Biological Investigations** → **Predictive Understanding**

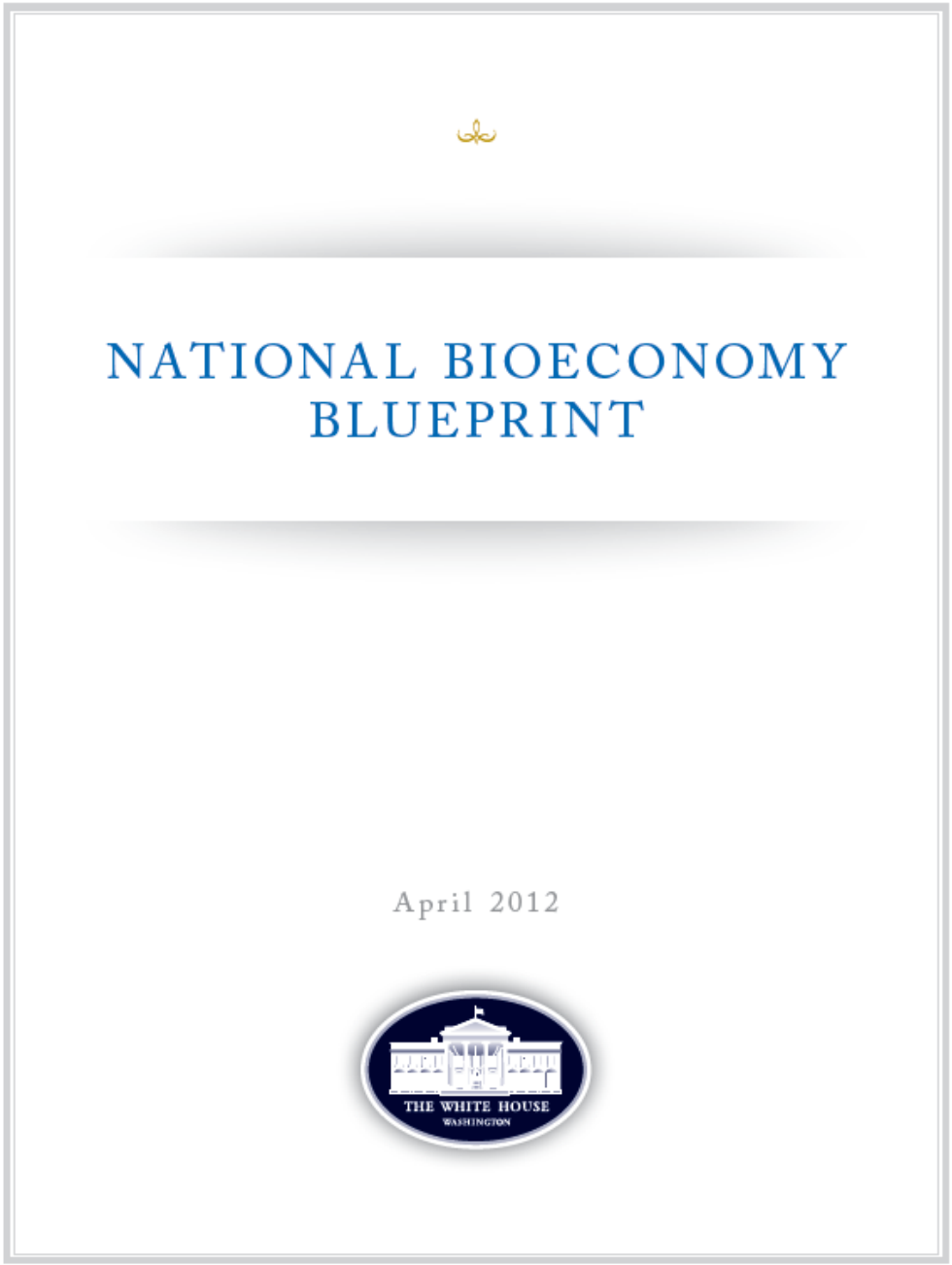
Goal: Achieve a predictive, system-level understanding of plants, microbes, and biological communities, via integration of fundamental science and technology development, to enable biological solutions to DOE mission challenges in energy, environment, and climate.

- **Objective 1:** Determine the genomic properties, molecular and regulatory mechanisms, and resulting functional potential of microbes, plants, and biological communities central to DOE missions.
- **Objective 2:** Develop the experimental capabilities and enabling technologies needed to achieve a genome-based, dynamic system-level understanding of organism and community function.
- **Objective 3:** Develop the knowledgebase, computational infrastructure, and modeling capabilities to advance the understanding, prediction, and manipulation of complex biological systems.



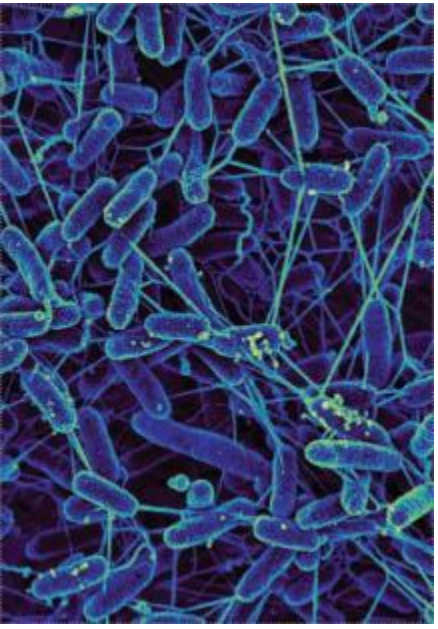
http://genomicscience.energy.gov/biosystemsdesign/index.shtml

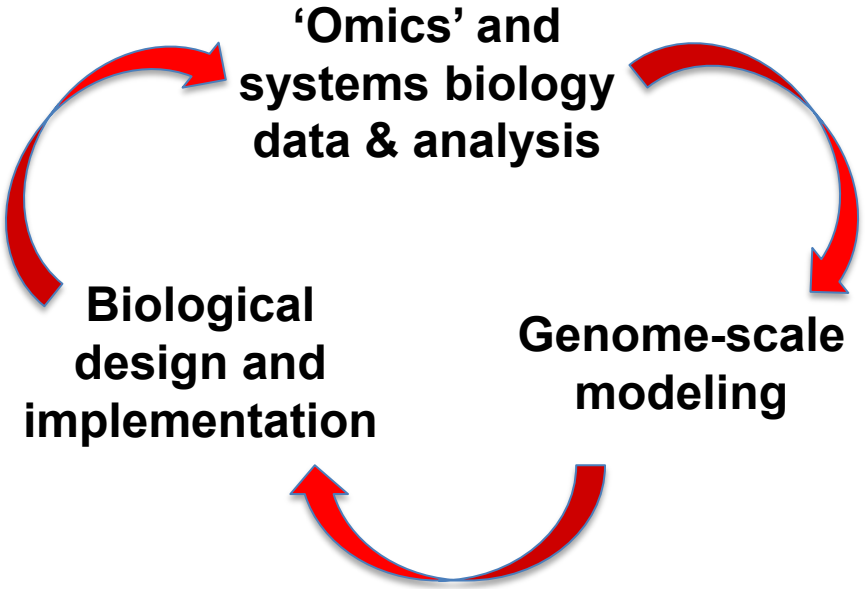
"Synthetic biology, the design and wholesale construction of new biological parts and systems, and the re-design of existing, natural biological systems for tailored purposes, integrates engineering and computer-assisted design approaches with biological research."



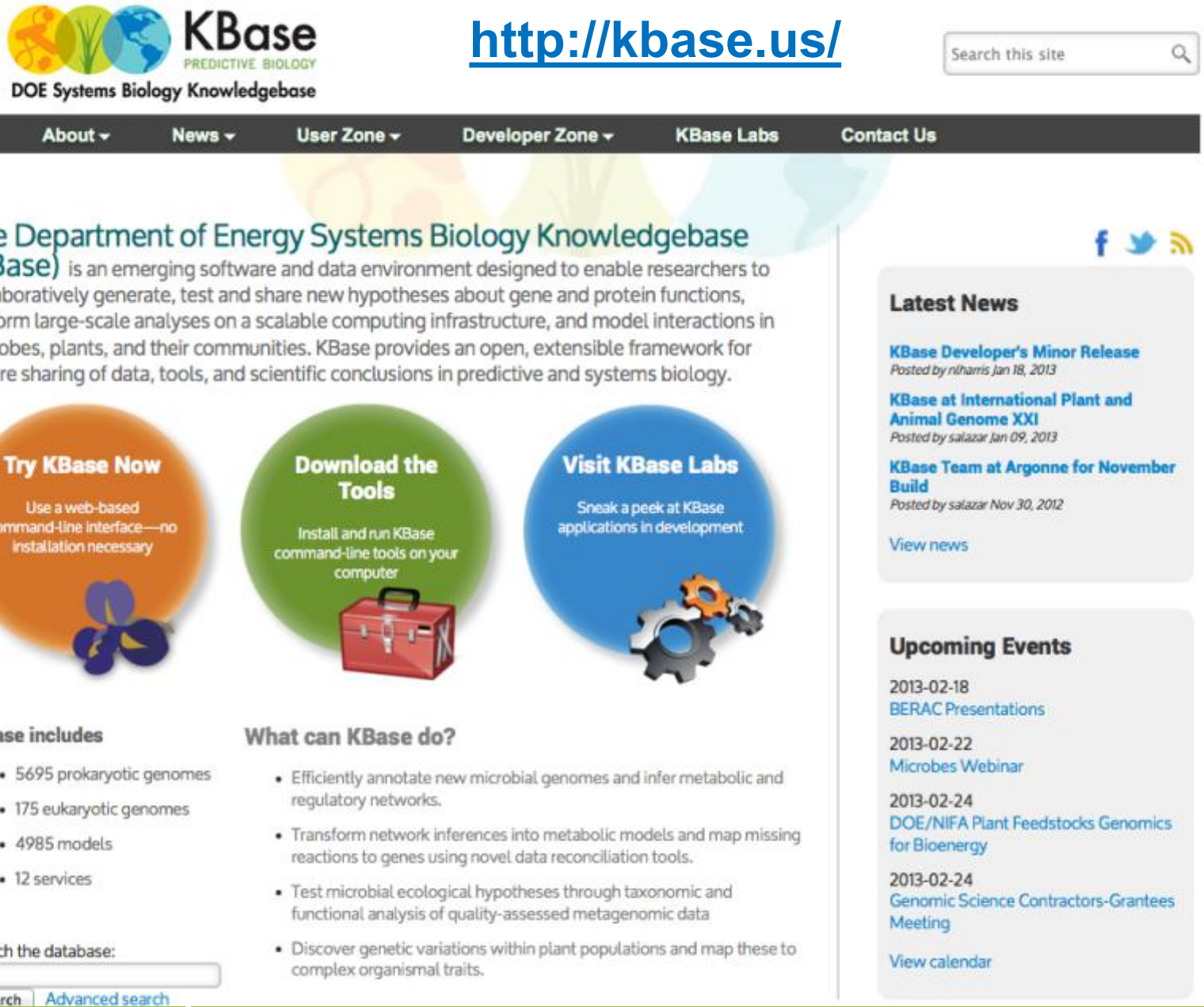
Biosystems Design Program

Iterative cycle to reach comprehensive, predictive understanding of the fundamental laws or principles that govern the function of evolved biological systems





Systems Biology Knowledgebase (KBase)



BER-BSSD Genomic Science FOA:
Biosystems Design to Enable Next-Generation Biofuels

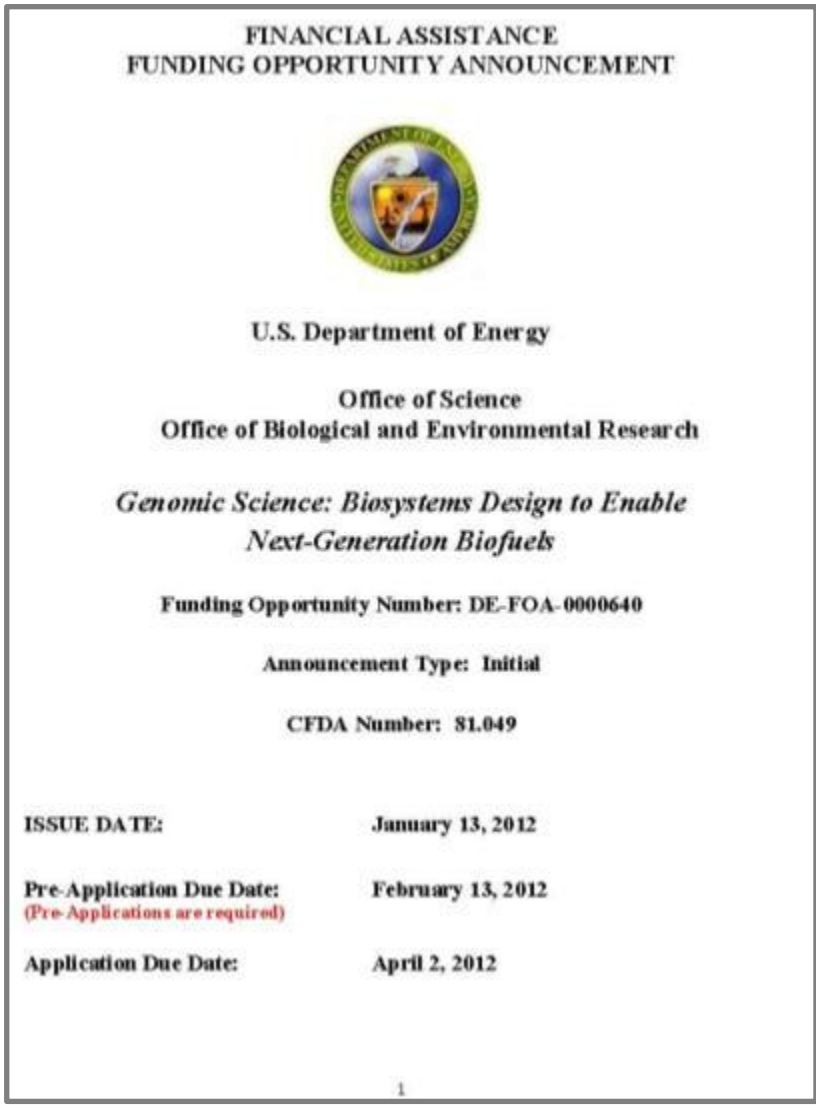
Solicitation issued on January 2012

Research areas:

a) Microbial systems design: Iterative network and functional measurements, computational modeling, and genome-scale engineering to design new microbial systems for the production of advanced biofuels

b) Plants systems design: Integrative systems biology and large-scale genome engineering approaches to deconstruct cell walls and convert them into advanced biofuels

Eight awards in FY 2012: (4 Microbial, 4 Plant)



FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT

U.S. Department of Energy

Office of Science
Office of Biological and Environmental Research

Genomic Science: Biosystems Design to Enable Next-Generation Biofuels

Funding Opportunity Number: DE-FOA-0000640

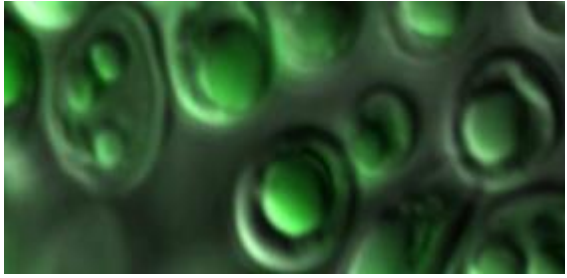
Announcement Type: Initial

CFDA Number: 81.049

ISSUE DATE:	January 13, 2012
Pre-Application Due Date: (Pre-Applications are required)	February 13, 2012
Application Due Date:	April 2, 2012

1

Microbial Systems Design



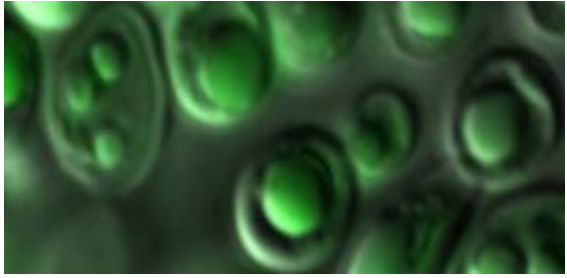
Gregory Stephanopoulos (*Massachusetts Institute of Technology*)

Optimizing oil production in oleaginous east by cell-wide measurements and genome-based models

Collaborators: Scott Baker (*Pacific Northwest National Laboratory*), Jens Nielsen (*Chalmers University, Sweden*), James Liao (*University of California, Los Angeles*).

Metabolic modeling (Ensemble Modeling), transcriptomics and metabolomics measurements of lipid biosynthesis to engineer the oleaginous yeast *Yarrowia lipolytica* for ethylene and isobutanol production from sugars and acetate.

Microbial Systems Design



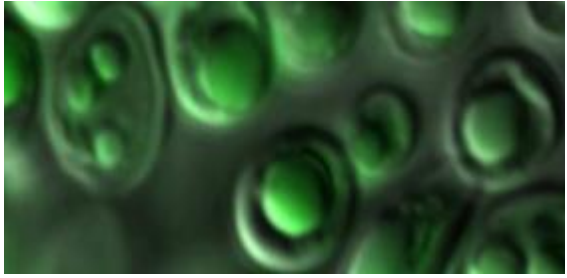
Ryan Gill (*University of Colorado, Boulder*)

A platform for genome-scale design, redesign, and optimization of bacterial systems

Collaborators: Rob Knight (*University of Colorado, Boulder*), Adam Arkin (*Lawrence Berkeley National Lab*), Pin-Ching Maness (*National Renewable Energy Lab*)

Engineer *Escherichia coli* strains with enhanced recombineering capabilities to develop the next-generation of high throughput synthetic biology and genomic engineering technologies.

Microbial Systems Design



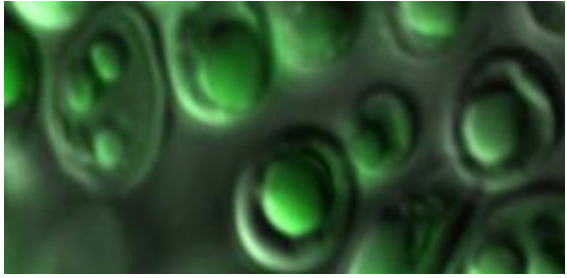
Eric Alm (*Massachusetts Institute of Technology*)

Assembling reusable genetic modules for efficient biofuel production from marine macroalgae

Collaborators: Martin Polz (*Massachusetts Institute of Technology*), Christopher Rao (*University of Illinois*), HuiMing Zhao (*University of Illinois*)

Brown macroalgae-associated microbes (*Vibrio* and uncultured microbes) to engineer strains that degrade their alginate, laminarin, and fucoidan cell walls, avoiding the problems of recalcitrance of lignocellulose.

Microbial Systems Design



Andrew Allen (J.C. Venter Institute;): Genome-scale metabolic modeling and engineering in the diatom *Phaeodactylum tricornutum* for lipid production.

Andrew Allen (*J.C. Venter Institute, San Diego*)

Optimization of energy flow through synthetic metabolic modules and regulatory networks in a model photosynthetic eukaryotic microbe

Collaborators: Christopher Dupont (*J. Craig Venter Institute, San Diego*), Bernhard Palsson (*University of California, San Diego*), Graham Peers (*Colorado State University*)

Genome-scale and comparative metabolic modeling of the diatom *Phaeodactylum tricornutum* and other photosynthetic organisms informed by multiple “omics” techniques, to enhance carbon and energy flux toward the production of lipid-based biofuels. Genomic engineering to introduce large extrachromosomal DNA segments into diatoms.

Plant Systems Design

Eduardo Blumwald (*University of California, Davis*)
Expanding the breeder's toolbox for perennial grasses
Collaborators: John Vogel, Christian Tobias, Roger Thilmony (*USDA Agricultural Research Service*)

Engineering double haploid switchgrass and *Brachypodium sylvaticum* lines using centromere-specific histone mutants to facilitate breeding for drought tolerance and nutrient use efficiency in perennials, avoiding the complications of tetraploidy. Will also develop transgenic systems to minimize gene flow.

Plant Systems Design

John Cushman (*University of Nevada, Reno*)

Engineering CAM photosynthetic machinery into bioenergy crops for biofuels production in marginal environments

Collaborators: Karen Schlauch (*University of Nevada, Reno*); James Hartwell (*University of Liverpool*); Anne Borland, Jin-Gui Chen, Madhavi Martin, Timothy Tschaplinski, Gerald Tuskan, David Weston, Xiaohan Yang (*Oak Ridge National Laboratory*)

Engineer crassulacean acid metabolism (CAM) photosynthesis in C3 plants like poplar and *Arabidopsis* to increase water use efficiency for better growth in marginal lands. 'Omics analyses of mono and dicot CAM plants to modulate carbon assimilation and stomatal control

Plant Systems Design

Clint Chapple (*Purdue University*)

Modeling and manipulating phenylpropanoid pathway flux for bioenergy

Collaborators: Natalia Dudareva, John Morgan (*Purdue University*)

Advanced kinetic modeling and flux analysis to engineer the shikimate and phenylpropanoid/phenylalanine pathways in *Arabidopsis* for 2-phenylethanol production, a promising biofuel candidate due to its high energy density, low hygroscopicity, and low volatility.

Plant Systems Design

Tom Brutnell (*Donald Danforth Plant Science Center, St. Louis*)
A systems-level analysis of drought and density response in the model C4 grass Setaria viridis
Collaborators: Ivan Baxter (*USDA Agricultural Research Service; Donald Danforth Plant Science Center, St. Louis*); Asaph Cousins (*Washington State University*); Jose Dinneny, Sue Rhee (*Carnegie Institution for Science, Stanford*); Andrew Leakey (*University of Illinois*); Todd Mockler (*Donald Danforth Plant Science Center*); Daniel Voytas (*University of Minnesota*)

Extensive quantitative trait loci (QTL) and phenotyping study of drought tolerance and planting density in the model C4 grass *Setaria viridis* to build integrated metabolic and genetic networks. Plant engineering using new transformation technologies and methods for monitoring transgene flow.

http://genomicscience.energy.gov/

Genomic Science Program ...

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Genomic Science Program
Systems Biology for Energy and Environment

U.S. DEPARTMENT OF ENERGY
Office of Science

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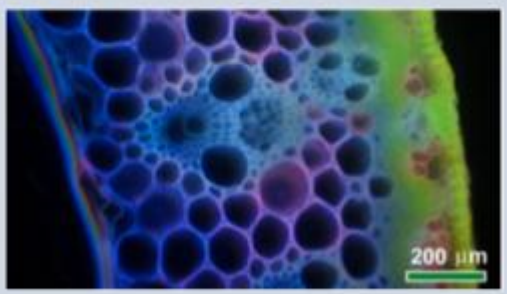
Genomic Science Program

Today, scientists have in hand the complete DNA sequences of genomes for many organisms—from microbes to plants to humans. The U.S. Department of Energy's Genomic Science program (formerly Genomics:GTL) uses microbial and plant genomic data, high-throughput analytical technologies, and modeling and simulation to develop a predictive understanding of biological systems behavior relevant to solving energy and environmental challenges including bioenergy production, environmental remediation, and climate stabilization. Learn More »

FEATURING



Biofuels

Alternative fuels from renewable cellulosic biomass are expected to significantly reduce U.S. dependence on imported oil while enhancing national energy security and decreasing the environmental impacts of energy use. Developing a cost-effective, commercial-scale cellulosic biofuel industry will require transformational biological research in feedstock development, biomass deconstruction, and fuel synthesis. Learn More »

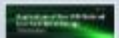
FEATURING

2013 GSP Research Summary
- Ongoing research projects in or associated with the program in 2013

DOE JGI Strategic Planning for the Genomic Sciences [8/12]
- Executive Summary PDF
- Fast-Download PDF

Plant Feedstock Genomics for Bioenergy Abstracts [08/12]
- Overview
- Fast-Download PDF

Biosystems Design [04/12]
- Funded Projects (PDF)
- Report Download (PDF)
- Executive Summary PDF



Applications of New DOE

Thank you!