

# DOE's Office of Science

## Biological, Climate, and Environmental Research

**Sharlene Weatherwax, Ph.D.**

Acting Associate Director of Science

Biological and Environmental Research



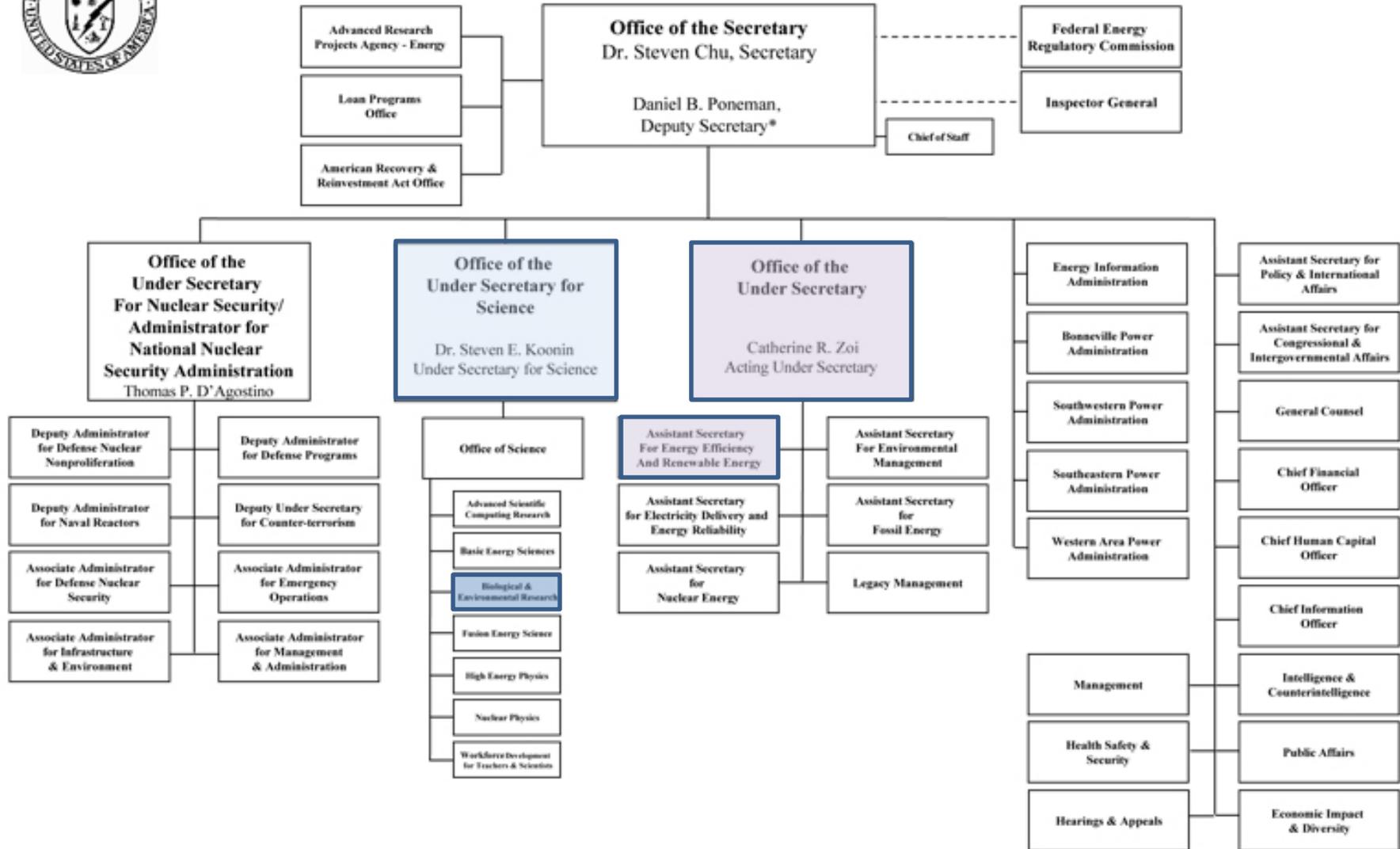
U.S. DEPARTMENT OF  
**ENERGY**

Office  
of Science

Office of Biological  
and Environmental Research



# DEPARTMENT OF ENERGY



\* The Deputy Secretary also serves as the Chief Operating Officer



U.S. DEPARTMENT OF  
**ENERGY**

# Office of Science

**ENERGY**  
LEADING BASIC RESEARCH  
FOR A SUSTAINABLE FUTURE

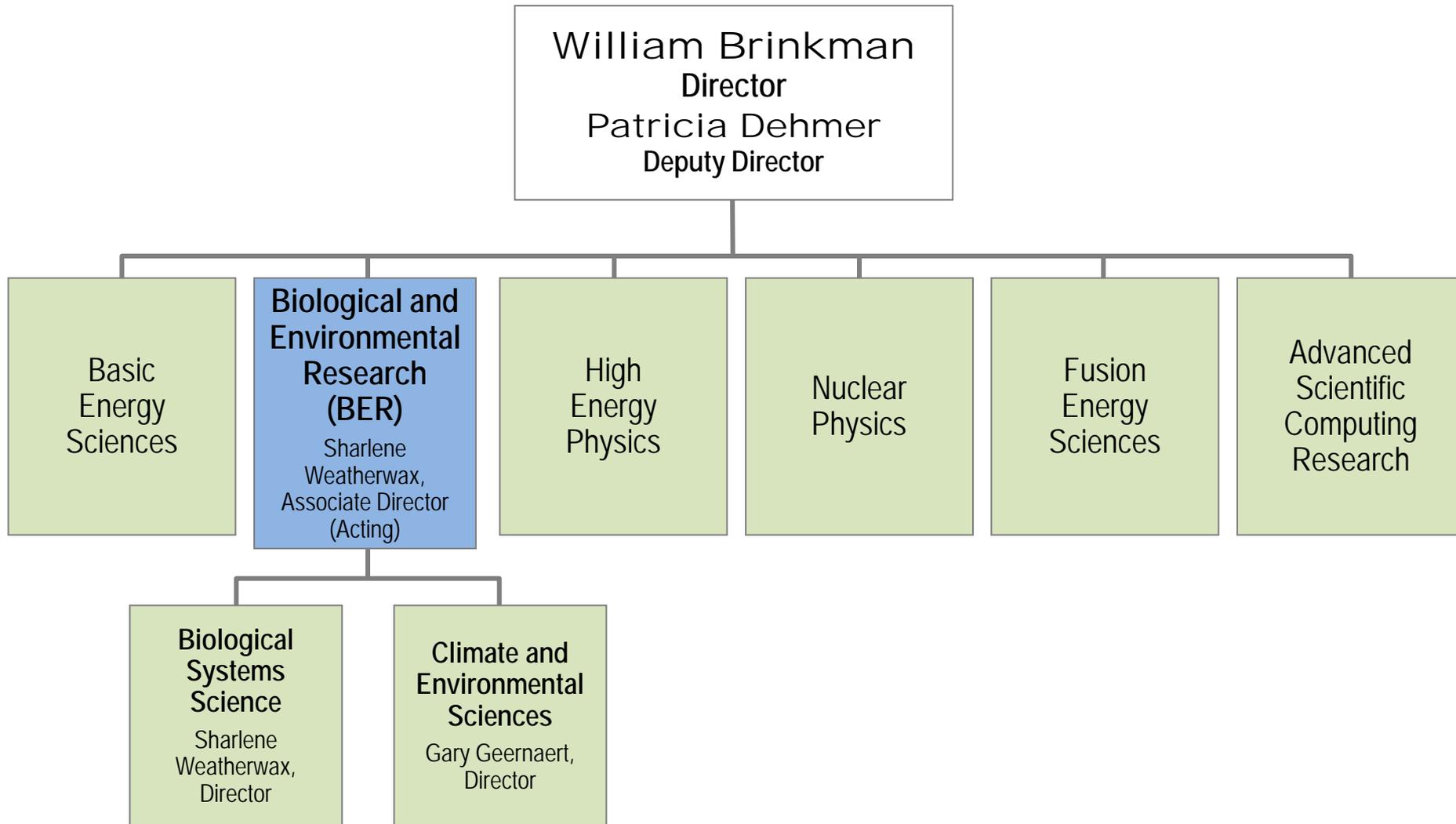
**ENVIRONMENT**  
UNDERSTANDING CLIMATE CHANGE AND  
IMPROVING THE ENVIRONMENT

**INNOVATION**  
BUILDING RESEARCH INFRASTRUCTURE AND  
PARTNERSHIPS THAT FOSTER INNOVATION

**DISCOVERY**  
UNRAVELING NATURE'S  
DEEPEST MYSTERIES

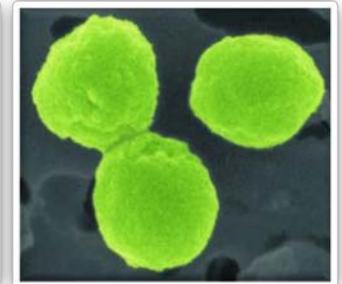
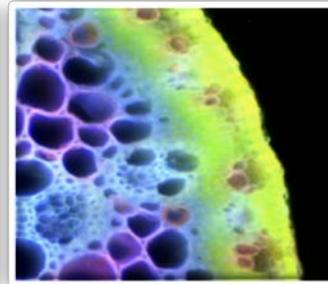
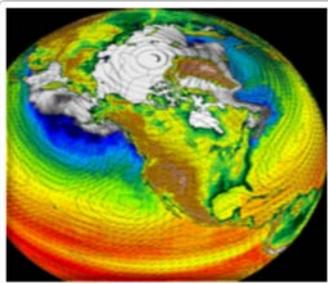
SCIENCE.DOE.GOV

# Department of Energy Office of Science



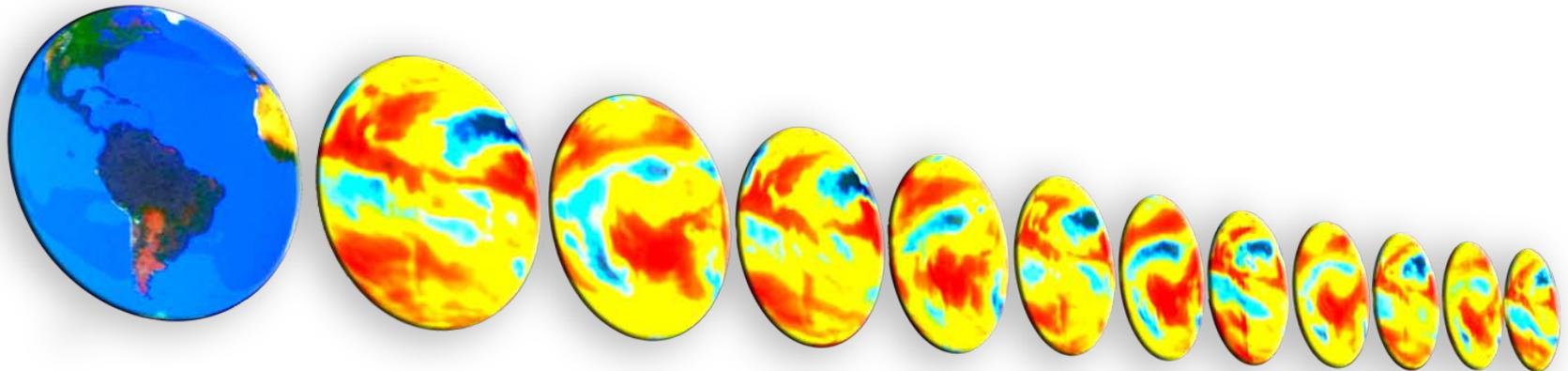
# Biological and Environmental Research Mission

- To 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



# Biological and Environmental Research Approach

- Understanding complex biological and environmental systems across many spatial and temporal scales:
  - From the sub-micron to the global
  - From individual molecules to ecosystems
  - From nanoseconds to millennia
- Integrating science by tightly coupling theory, observations, experiments, models, and simulations
- Supporting interdisciplinary research to address critical national needs
- Engaging national laboratories, universities, and the private sector to generate the best possible science

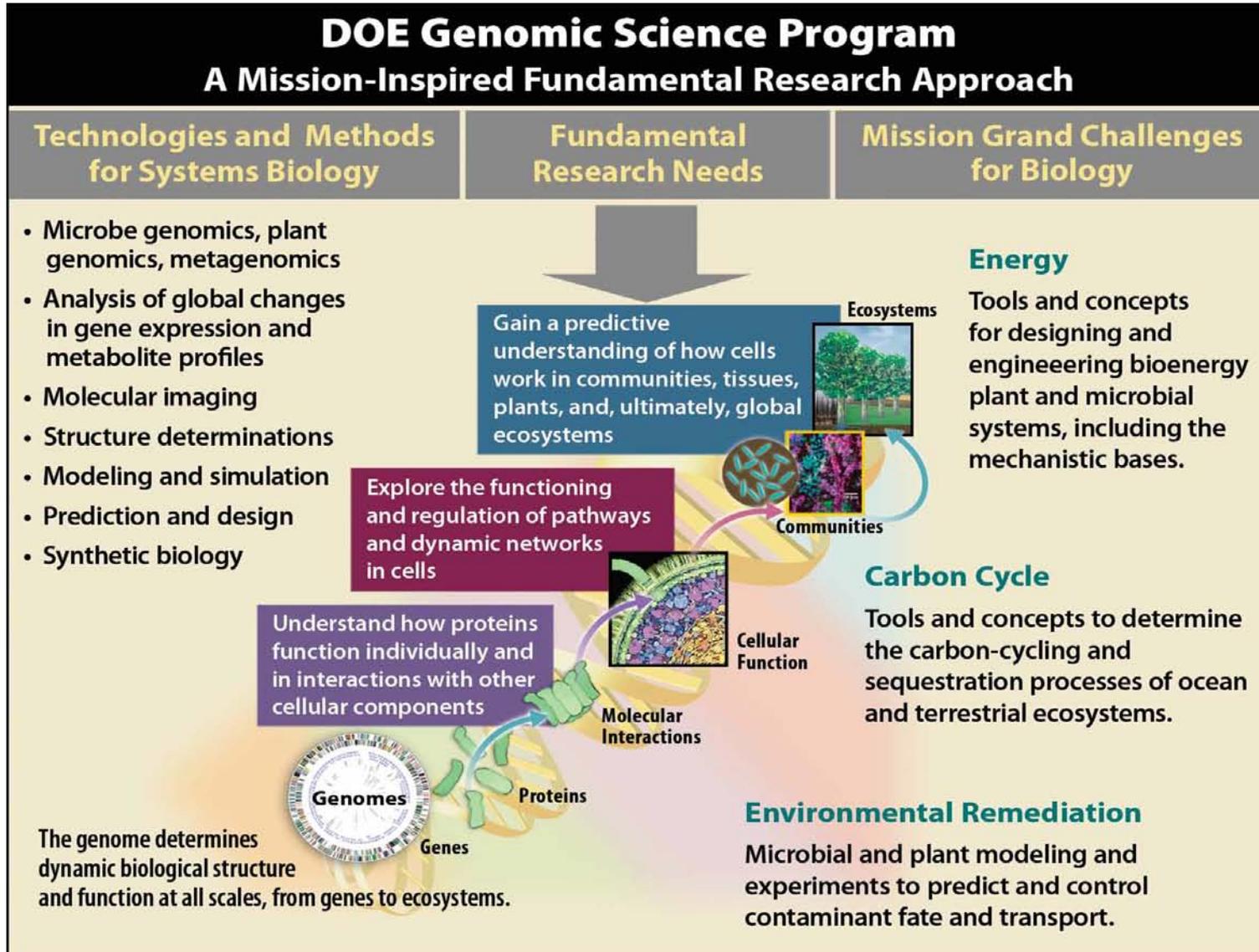


# Biological and Environmental Research

## Budget

Appropriations		FY10	FY11 req
Research	Biological Systems Research	\$225M	\$228M
	<i>Genomic Science</i>	\$166M	\$177M
	<i>Bioenergy Research Centers</i>	\$75M	\$75M
	Climate and Environmental Research	\$179M	\$196M
	<b>Total</b>	<b>\$404M</b>	<b>\$424M</b>
Facilities: Scientific User Facility Operations	Joint Genome Institute (JGI)	\$69M	\$69M
	Structural Biology	\$15M	\$16M
	ARM Climate Research Facility	\$42M	\$46M
	Environmental Molecular Sciences Laboratory (EMSL)	\$52M	\$51M
	<b>Total</b>	<b>\$178M</b>	<b>\$182M</b>
Other	(e.g., Small Business Innovation Research)	\$22M	\$21M
	<b>Total BER</b>	<b>\$604M</b>	<b>\$627M</b>

# Genomic Science Program



**Technology Endpoints**

*Payoffs for the Nation*

Sustainable and Viable Biofuel Technologies

Earth System Modeling and Biosequestration Strategies

Improved Strategies for Environmental Remediation and Long-Term Stewardship

# The DOE Bioenergy Research Centers

New paradigm for research—single focus, multi-disciplinary, team-based transformational science

## BioEnergy Science Center (ORNL)

- Multi-institutional partnership with strategic focus on overcoming biomass “recalcitrance” as route to cost-effective cellulosic biofuels
- Goal of “Consolidated Bioprocessing” – one-microbe or microbial community approach going from plants to fuel

## Great Lakes Bioenergy Research Center (U. W.-Madison, Mich State U)

- Goal of re-engineering plants to produce more starches and oils
- Using HTP technologies to optimize chem/bio process for biomass deconstruction
- Major research thrust on sustainability of biofuels

## Joint BioEnergy Institute (led by LBNL)

- Experimenting with new pretreatment process using room temperature ionic liquids
- Beyond cellulosic ethanol: re-engineering *E.coli* and yeast to produce hydrocarbons – goal of “green” gasoline, diesel, jet fuel

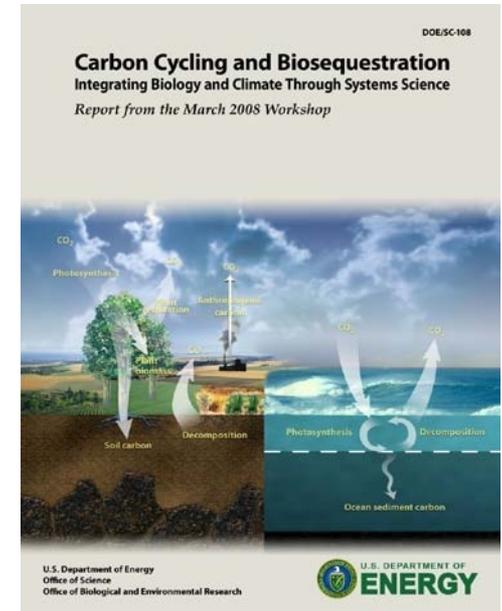
# Carbon Cycling & Biosequestration: Integrating Biology & Climate Through Systems Science

Identifies priorities for fundamental research on biological aspects of the global carbon cycle and biosequestration of carbon in ecosystems

Emphasizes multidisciplinary research and knowledge integration across microbiology, plant biology, ecosystem science, biogeochemistry, oceanography, and modeling efforts

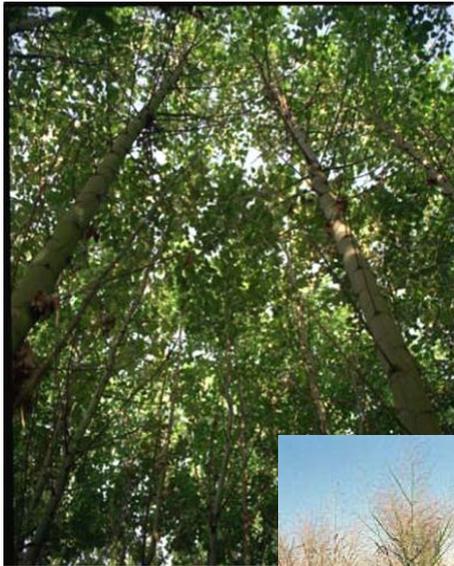
## ***Biological Systems Research on the Role of Microbial Communities in Carbon Cycling*** **FOA DE-PS02-09ER09-25**

- Systems-level studies on regulatory and metabolic networks of microbes and microbial consortia involved in biogeochemical cycling of carbon
- Development of metatranscriptomic, metaproteomic, and other genome-enabled approaches to understand how shifts in environmental variables impact microbially-mediated carbon cycling processes in terrestrial ecosystems
- Development of methods and techniques for imaging and analysis of microbially-mediated carbon cycling processes in terrestrial ecosystems



# Plant Feedstock Genomics for Bioenergy— DOE-BER/USDA-NIFA Joint Research Program

Genomics-based research that will lead to the improved use of biomass and plant feedstocks for the production of fuels such as ethanol or renewable chemical feedstocks.



- functional genomics
- genetic marker and map development
- biomass trait modification
- biomass trait characterization
- development of model bioenergy crops

Phenotyping plant germplasm collections and advanced breeding lines in public breeding programs of bioenergy crops

Brachypodium, rice, switchgrass, sorghum, poplar, perennial grasses, alfalfa, sorghum, and wheat.

# DOE Systems Biology Knowledgebase

## Establishing a systems biology modeling framework

Data generators



### Seamless Submission and Incorporation of Diverse Data

- Standards for data, metadata
- Quality control and assurance
- Automated data handling

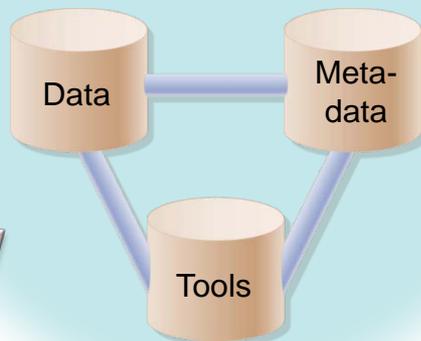
### Open-Access Data and Information Exchange

- Flexible user interfaces
- Easy data retrieval
- Environment for *in silico* experimentation

Data users



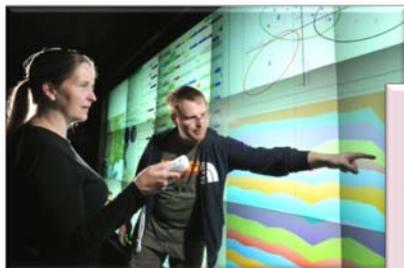
DOE Systems Biology Knowledgebase



### Community-Wide Stewardship

- User, Standards, and Advisory committees
- Value-added analysis
- Training, tutorials, and support

Software and tool developers



### Open Development of Open-Source Software and Tools

- Analysis and visualization
- *In silico* experimentation
- Tracking and evaluation of tool use

# DOE Scientific User Facility DOE Joint Genome Institute



- Focus: Genomes and metagenomes of microbes, microbial communities, and plants vital to DOE missions
  - Provide state-of-the-science capabilities for sequencing and analysis
  - Maintain expert staff in a range of computing and biological research disciplines
  - Host workshops and annotation jamborees
  - Community sequencing program accepts proposals from scientists for sequencing microbes and plants
  - <http://www.jgi.doe.gov/>



## Cellulosic Feedstock development

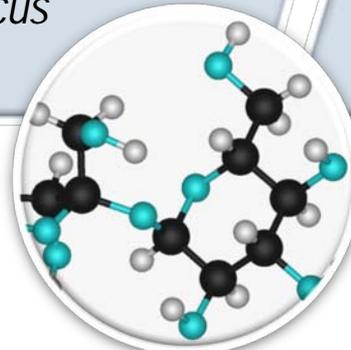
- Poplar
- Maize and corn stover
- Switchgrass
- *Brachypodium*
- Sorghum



**Cellulosic materials**

## Cellulose and lignin degradation

- Termite hindgut microbiota
- White rot fungus
- *Clostridium thermocellum*
- *Saccharophagus degradans*
- *Acidothermus cellulolyticus*



**Sugars**

## Fermentation with ethanol-producing organisms

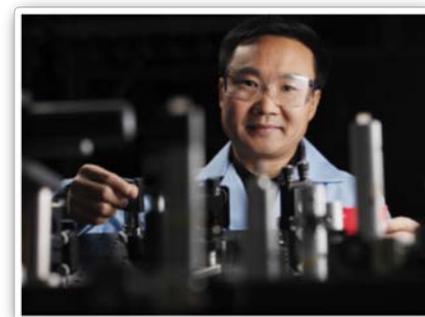
- *Saccharomyces cerevisiae*
- *Zymomonas mobilis*
- *Thermoanaerobacter ethanolicus*
- *Pichia stipitis*



**Bioethanol**

# DOE Scientific User Facility Environmental Molecular Sciences Laboratory

- EMSL science themes:
  - Biological interactions and dynamics
  - Geochemistry/biogeochemistry and subsurface science
  - Science of interfacial phenomena
- Unparalleled capabilities:
  - Integrated experimental and supercomputing capabilities enable users to study molecular-level processes underpinning energy, science, and environmental challenges
  - Expert staff and 60+ leading-edge capabilities are available to university, DOE laboratory, and industry scientists



<http://www.emsl.pnl.gov/>



# How to get involved with DOE programs:

- Look for funding opportunity announcements (FOA's) on our web site <http://doe.sc.gov>
- Contact the DOE scientific program manager in your area of interest
- Look for opportunities to interact with the DOE National Laboratories
- Take advantage of a DOE Scientific User Facility
- Volunteer to serve as a reviewer for a DOE peer review panel
- Participate in a DOE research needs workshop

# Biological and Environmental Research information resources

- **Program information**

- [http://www.science.doe.gov/Program\\_Offices/BER.htm](http://www.science.doe.gov/Program_Offices/BER.htm)

- <http://genomicscience.energy.gov/program/aboutBER.shtml>

- **Workshops: provide community input and signal new research directions**

- [http://www.sc.doe.gov/ober/BER\\_workshops.html](http://www.sc.doe.gov/ober/BER_workshops.html)

- **Research abstracts**

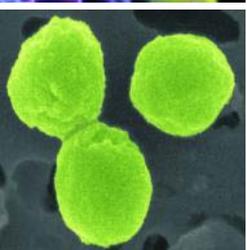
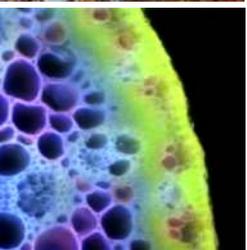
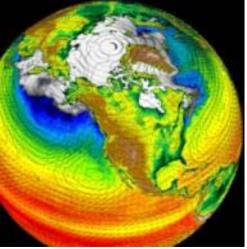
- <http://www.osti.gov/oberabstracts/search.adv.jsp>

- **Funding Opportunity Announcements**

- <http://www.sc.doe.gov/grants/grants.html>

- **Program contacts** (firstname.lastname@science.doe.gov)

- Catherine Ronning— Plant Feedstock Genomics  
Bioenergy Research Centers
  - Joseph Graber—Genomic Science Program
  - Daniel Drell—Joint Genome Institute
  - Susan Gregurick—Systems Biology Knowledgebase
  - Paul Bayer—Environmental Molecular Sciences Laboratory



# Thank you!



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