The Biological and Environmental Research (BER) program advances fundamental research and scientific user facilities to support Department of Energy (DOE) missions in scientific discovery and innovation, energy security, and environmental responsibility.

BER seeks to understand the biological, biogeochemical, and physical principles needed to predict a continuum of processes occurring across scales, from molecular and genomics-controlled mechanisms at the smallest scales to environmental and Earth system change at the largest scales. Starting with the genetic potential encoded by organisms’ genomes, BER research aims to define the principles underlying the systems biology of plants and microbes as they respond to and modify their environments. Knowledge of these principles is underpinning renewable energy innovations and deeper insights into natural environmental processes. BER also advances understanding of how the Earth’s dynamic, physical, and biogeochemical systems (atmosphere, land, oceans, sea ice, and subsurface) interact and affect future climate and environmental change. This research improves climate model predictions and provides valuable information for energy and resource planning.

Research Approach for DOE Science, Energy, and Environmental Missions

Providing Scientific User Facilities
Empower an international community of scientists with the most advanced technologies

Achieving Predictive Understanding
Understand complex biological and environmental systems across many spatial and temporal scales

Advanced Scientific User Facilities
Supporting Groundbreaking Research
Conduct interdisciplinary research that engages scientists from national laboratories, academia, and industry

Scientific Insights
Revealing Insights
Leverage diverse scientific insights by coupling theory, observations, experiments, models, and simulations
Scientists obtained a protein crystal structure at 3 Ångstrom resolution by injecting bacterial cells into an X-ray free-electron laser beam. This new ability to collect diffraction patterns from crystals of unprecedentedly small dimensions demonstrates possibilities for studying crystals and other ordered structures in their native environments in living cells. [Sawaya, M. R., et al. 2014. Proceedings of the National Academy of Sciences (USA). DOI: 10.1073/pnas.1413456111]

Researchers used microscopy, stable isotope labeling, nanoSIMS analysis, and computational modeling to examine metabolic activity and energy transfer from methane-oxidizing archaea to sulfate-reducing bacteria. Findings revealed direct interspecies electron transport (movement of electrons from one cell type to another) through the external environment via nanowires. This transfer mechanism enables symbiotic consumption of methane from deep sea vents. [McGlynn, S. E., et al. 2015. Nature. DOI: 10.1038/nature15512]

Researchers mapped metabolic networks in methanogenic microbial communities using a combination of metagenomic sequencing and metatranscriptomic and metabolic analyses. They identified the multidimensional interspecies interactions that define composition and dynamics in such communities, which drive most environmental biogeochemical processes. [Embree, M., et al. 2015. Proceedings of the National Academy of Sciences (USA). DOI: 10.1073/pnas.1506034112]
Scientists used stable isotopes to estimate dissolved inorganic carbon and methane (CH₄) production mechanisms and transport pathways in Arctic tundra watersheds. They found that the majority of subsurface CH₄ was transported upward by plants and ebullition (bubbling), thus bypassing the potential for CH₄ oxidation. [Throckmorton, H. M., et al. 2015. Global Biogeochemical Cycles. DOI: 10.1002/2014GB005044]

Researchers used Doppler cloud radar at the ARM Climate Research Facility to examine entrainment (mixing of cloudy air with clear air) at the top of stratuscumulus clouds. The resulting data provide a unique estimate of entrainment rates and processes at temporal resolutions not practical with other observing systems. [Albrecht, B., et al. 2016. Journal of the Atmospheric Sciences. DOI: 10.1175/JAS-D-15-0147.1]


User Facilities
Empowering an international community of scientists with the most advanced technologies

DOE Joint Genome Institute (JGI)
Sequencing more than 140 trillion DNA bases per year, DOE JGI in Walnut Creek, California, provides state-of-the-science capabilities for genome sequencing, synthesis, and analysis. With more than 950 collaborators worldwide on active projects, DOE JGI is the preeminent resource for sequencing plants, microbes, and microbial communities foundational to energy and environmental research. jgi.doe.gov

DOE Atmospheric Radiation Measurement (ARM) Climate Research Facility
The ARM Climate Research Facility provides highly instrumented ground stations at various locations around the globe, mobile measurement resources, and aerial vehicles to continuously measure cloud and aerosol properties and their impacts on Earth’s energy balance. ARM Facility measurements have set the standard for long-term climate research observations and provide an unparalleled resource for examining atmospheric processes and evaluating climate model performance. www.arm.gov

DOE Environmental Molecular Sciences Laboratory (EMSL)
DOE EMSL, located in Richland, Washington, provides users with a problem-solving environment by integrating premier instrumentation with high-performance computing and optimized codes. This integration of capabilities enables research teams or individual investigators to unravel the fundamental physical, chemical, and biological mechanisms and processes that underpin larger-scale biological, environmental, and energy challenges. www.emsl.pnl.gov

DOE Bioenergy Research Centers
Bringing together top scientists from multiple disciplines, BER established three Bioenergy Research Centers in 2007 to deliver high-return breakthroughs in cellulosic biofuel production.

DOE’s Oak Ridge National Laboratory leads the BioEnergy Science Center in Tennessee. The University of Wisconsin–Madison leads the Great Lakes Bioenergy Research Center. DOE’s Lawrence Berkeley National Laboratory leads the Joint BioEnergy Institute in California.

The centers are using genomics and advanced analytical technologies to understand (1) how to make grasses, wood, and other cellulosic materials easier to break down into sugars and (2) how to advance the microbial production of advanced biofuels and other bioproducts from biomass. genomics.energy.gov/centers/