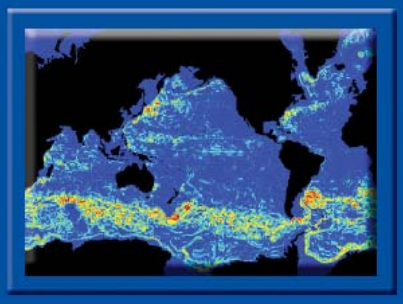
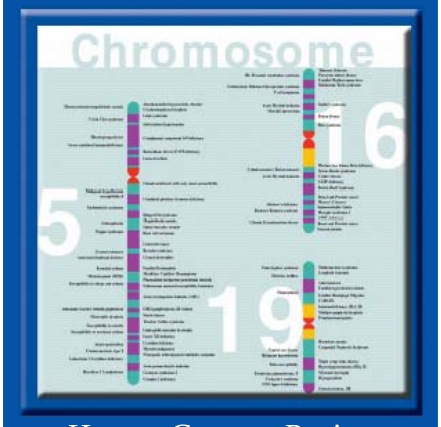
Office of Science
U.S. Department of Energy



Climate modeling



Human Genome Project

Biological and Environmental Research

The Office of Science's Biological and Environmental Research (BER) program supports fundamental research in climate change, environmental remediation, genomics, systems biology, radiation biology, and medical sciences. BER funds research at public and private research institutions and at Department of Energy (DOE) laboratories. BER supports leading edge research facilities used by public and private sector scientists across range of disciplines: structural biology, DNA sequencing, functional genomics, climate science, the global carbon cycle, and environmental molecular science. BER coordinates research across all of these programs with other Federal agencies.

The Opportunity

With the 21st Century dawns what most have called the "biological century"—an era when advances in biology, spurred by achievements in genomic research, including the sequencing of the human genome, will bring revolutionary and unconventional solutions to some of our most pressing and expensive challenges in energy, the environment, and medicine. We will understand how living organisms interact with and respond to their environments so well that we will be able to use biological processes to produce clean energy, remove excess carbon dioxide from the atmosphere, and help clean up the environment. Our understanding of global climate change and ability to predict climate over decades to centuries will enable us to develop science-based solutions to reduce and minimize the impacts of climate change and help us better plan for our Nation's future energy needs.

The Challenge

The BER research program is focused on scientific issues that will greatly improve our understanding of climate change, impact how energy is produced and how environmental cleanup is managed, and dramatically transform advanced medical technology. Major research efforts include:

Climate Prediction. Advanced climate models are needed that describe and predict the roles of oceans, the atmosphere, ice, and land masses on climate over time. So too, the role of clouds in controlling solar and thermal radiation onto and away from the earth needs to be understood since it is the single largest uncertainty in climate prediction. BER is also working to understand how carbon dioxide moves through the environment, ways to increase its removal from the atmosphere, and its impacts on Earth's climate and ecosystems.

A Cleaner Environment. Science-based strategies are needed to reduce the costs, risks, and time required for cleanup of DOE sites contaminated from years of weapons production. BER develops advanced treatment options for nuclear waste, including the use of Earth's own microbe-based clean-up strategies, extending the frontiers of biological and chemical methods for remediation.

Technology for a Healthier Nation. Developments in imaging technology—increases in sensitivity, ease of use, and patient comfort—have the potential to revolutionize all of medical imaging. Technological wonders, like an artificial retina that will give vision to the blind, are on the horizon.

Artificial Retina

A New Biology. BER develops innovative solutions along unconventional paths to solve challenges in energy and the environment. Understanding Nature's remarkable array of multi-protein molecular machines and the intricate workings of complex microbial communities will enable us to use and even redesign these microbial machines and communities to produce clean energy, remove carbon dioxide from the atmosphere, and clean up the environment.

Investment Plan

BER will continue to make investments in core technologies, research infrastructure, and fundamental science needed to address these exciting challenges. However, the most important scientific advances in this new century will occur at the interfaces between scientific disciplines such as the biological, physical, and computational sciences.

Of highest priority is the development of a new research infrastructure needed to understand the fundamental biological principles underlying the function and control of microbial systems. A combination of novel, state-of-the-art, high-throughput user facilities coupled with well- integrated, interdisciplinary research teams forms the basis of a new approach for studying complex biological systems and for using those systems to solve problems in energy and the environment. Our ability to predict climate on global and regional scales and to develop strategies for the removal of excess carbon dioxide from the atmosphere will depend on the continued development of novel user facilities and a close integration of experimental and computational sciences research.

New strategies for cleaning up the environment will benefit from the development of cutting-edge molecular tools for investigating environmental processes and of field research sites for integrating laboratory and real-life experiments. Because of the Office of Science's diverse capabilities across a range of disciplines, from engineering to chemistry to biology to computing, further investments in advanced medical concepts will continue to provide the medical community with novel devices and technologies to improve our Nation's health.

The Benefits

Basic biological and environmental research has broad impacts on our health and our environment. An ability to predict long-range and regional climate enables effective planning for future needs in energy, agriculture, and land and water use. Biotechnology solutions are possible for DOE energy and environmental challenges through understanding of complex microbial systems and development of computational tools to model and predict their behavior. Understanding global carbon cycles and the associated role and capabilities of microbes can lead to solutions for reducing the impact of excess carbon dioxide on global warming. Advanced solutions can be developed to help clean up metals and radionuclides contaminating former DOE weapons sites. Both normal and abnormal health from human development to cancer to brain function can be understood using radiotracers and advanced instrumentation. Understanding the biological effects of low doses of radiation can lead to the development of science based health risk policy to better protect workers and citizens.

Modeling biological pathways

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