Oak Ridge National Laboratory’s (ORNL’s) Biological and Environmental Systems Science Directorate (BESSD) leads convergence research in biology, ecology, engineering, data discovery, physical sciences, and computing to advance US competitiveness in the global bioeconomy and Earth system sustainability.

Our researchers enjoy an open, inclusive, and innovative workplace where they collaborate to advance renewable energy solutions, improve Earth system models, and push the frontiers of systems and synthetic biology. Focus areas include understanding how genes influence ecosystem-level processes; learning more about how biodiversity shapes the world around us; developing novel, secure biodesign tools and test beds for enzyme engineering; applying the world’s fastest supercomputers to transform biological and environmental data into knowledge; advancing signature technologies for dynamic characterization of complex biological and environmental systems; and applying emerging capabilities that promise to transform how science is done through automated, data-rich, and interconnected systems.

Through our R&D, we aim to strengthen the nation’s economic competitiveness, enable resilient and sustainable economies, and facilitate stewardship of managed and natural resources.

“We translate fundamental science discoveries into solutions addressing some of society’s greatest challenges, such as climate change, clean water, and sustainable communities.”

—Associate Laboratory Director Paul Langan, Biological and Environmental Systems Science
Our Research

Environmental Sciences—Our researchers expand scientific knowledge and develop innovative strategies and technologies that help sustain Earth’s natural resources.

Biosciences—Our scientists advance knowledge discovery and develop technology to characterize and engineer complex biological systems that benefit the environment and our bioeconomy.

Systems Science at Every Scale

BESSD is home to the US Department of Energy’s (DOE’s) Atmospheric Radiation Measurement (ARM) Data Center, which provides cutting-edge computing capabilities and data to scientists around the world. The Center for Bioenergy Innovation, a DOE Bioenergy Research Center, enables high-impact and value-added advances along the bioenergy supply chain. The Climate Change Science Institute fosters the integration of experiments, measurements, and simulation to achieve a predictive understanding of our changing world. The University of Tennessee/ORNL Center for Molecular Biophysics explores the structural dynamics of biomolecules by uniquely working at the interface of biology, chemistry, and the physical sciences, aided by neutron and computational sciences. The ORNL Distributed Active Archive Center for Biogeochemical Dynamics provides scientists with access and tools to explore terrestrial ecology data from NASA Earth Science missions.

Recent Impacts

Building upon a rich history of breakthroughs in biology and ecology, BESSD scientists are proud to have sequenced the first tree genome, pioneered the field of global change biology, and solved the 40-year mystery of how bacteria transform mercury into highly toxic methylmercury. Recently, BESSD scientists have

- Established carbon-negative production of acetone and isopropanol by gas fermentation at industrial pilot scale
- Provided new data to better prepare hydropower operators for extreme weather events and shifts in seasonal energy demands caused by climate change
- Validated the presence of alternate genetic coding activity in bacterial phages for the first time
- Developed and licensed technology that measures solar-induced fluorescence, monitoring plant productivity and health
- Expanded evidence for the ‘bradykinin storm’ hypothesis of COVID-19 pathogenesis
- Launched new high-performance computing capabilities for the ARM Data Center to facilitate scientific discovery using 30 years of atmospheric data