Understanding Biological Systems

Our scientists enjoy an open, inclusive, and innovative workplace where they apply high-performance computing (HPC) to discover complex genetic traits critical to bioenergy, climate-resistant crops, and more. We use the Laboratory’s neutron science capabilities to increase understanding of cell structure and intracell interactions. We develop biosdesign tools to engineer safer, more reliable, and more productive ecosystems, and inform development of new disease diagnostics and treatments through fundamental science discoveries.

Bioanalytical mass spectrometry—Developing and deploying high-performance mass spectrometry techniques for characterization of biomolecules

Biological and environmental research information system—Supporting DOE’s Biological and Environmental Research program as its primary communications resource

Biomaterials and biomass characterization—Applying laser and magnetic resonance spectroscopy to characterize the molecular and elemental composition of biomaterials and biomass

Computational and predictive biology—Employing data science, predictive modeling, and HPC to transform biological data into knowledge

Integrative microbiomics—Combining cellular, molecular, and genomic approaches to study microbes and their interactions with hosts and the environment

Molecular and cellular imaging—Advancing and implementing tools to observe biological function in action

Molecular biophysics—Applying scalable computing and data science to characterize the structure, function, and dynamics of complex biomolecular systems

Plant systems biology—Exploring the network of genes, proteins, metabolites, and environmental signals that lead to improved plant performance

Synthetic biology—Developing and applying techniques for biosystems design to solve renewable energy and environmental challenges

“Biosciences span from genes to ecosystems. Our diverse community of scientists employs techniques from exascale computing to microfluidics in enabling biological approaches to environmental sustainability.”

—Biosciences Division Director Julie Mitchell
**Recent Impacts**

- Identified two new species of Sphagnum moss, the ecosystem engineer that stores one-third of the world’s soil carbon in peat bogs.
- Developed a two-step chemical and biological process to break down and upcycle mixed plastics into valuable bioproducts.
- Engineered microbes to convert emissions from industrial processes into acetone and isopropanol.
- Highlighted a hybrid approach that uses microbes and catalysis to convert cellulosic biomass into fuels suitable for aviation and other difficult-to-electrify sectors.
- Created a new microbial trait-mapping capability that accelerates gene function identification and biodesign.
- Discovered a pathway to encourage a type of lignin formation in plants that could make the processing of crops grown for products such as sustainable jet fuels easier and less costly.
- Developed the rhizosphere-on-a-chip, a miniaturized environment to study the ecosystem around poplar tree roots for insights into plant health and soil carbon sequestration.

**Center for Bioenergy Innovation** — The Center for Bioenergy Innovation (CBI) harnesses natural diversity and beneficial plant–microbe interactions to create high-performance biomass feedstocks for environmentally friendly, cost-effective, and industrially relevant bioproducts and biofuels. CBI creates value-added coproducts from lignin residues and engineers microbes and catalysts to increase biofuel production efficiency and to lower costs.

**Advanced Plant Phenotyping Laboratory** — A unique high-throughput plant phenotyping system aids the scientific community in connecting plant gene functions to observable traits. The system, now in the commissioning phase, automates measurement of a range of key plant characteristics using the most diverse suite of imaging capabilities of any system worldwide.

**Center for Molecular Biophysics** — The University of Tennessee/ORNL Center for Molecular Biophysics performs research at the interface of biological, environmental, physical, computational, and neutron sciences. The goal is to study and understand the function of biologically relevant molecular systems by employing HPC simulations in combination with biophysical experiments.

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