# Biological and Environmental Systems Science

## Environmental Sciences

Expand scientific knowledge and develop innovative strategies and technologies that will strengthen the nation's leadership in creating solutions to help sustain Earth's natural resources.

### Biodiversity and Sustainable Systems

*Explore how genes, organisms, populations, and communities influence, and are influenced by, the management, health, and sustainability of ecological systems.*

1. *Water Resource Science & Engineering* — Advance the state of water resources engineering and science through multidisciplinary research on data analytics, model simulation, engineering design, decision support, and visualization.
2. *Biodiversity and Ecosystem Health* — Develop and implement tools and methods to quantify and mitigate threats to biodiversity (genes, species, habitats, and ecosystems) and ecosystem services.
3. *Bioresource Analytics & Decision Science* — Develop and implement advanced quantitative tools in modeling and data analysis to support government, industry, and other stakeholders in designing innovative, robust systems for biomass production, delivery, and use to enable sustainable expansion of the US bioeconomy.
4. *Environmental Risk and Energy Analysis* — Develop foundational science and advanced simulations to understand human health, economic, and environmental protection dimensions of existing and emerging sustainable energy alternatives.

### Earth Systems Science

*Understand and predict how terrestrial and aquatic ecosystems exchange carbon, water, nutrients, and trace elements across multiple spatial and temporal scales.*

1. *Ecosystem Processes* — Advance a predictive understanding of the spatial and temporal dynamics of Earth's vital and changing ecosystems by using unprecedented ecosystem-scale manipulative experiments, observations, and integrated modeling.
2. *Plant-Soil Interactions* — Advance a deeper understanding of how plants, soil microorganisms, and their surrounding environment drive important ecosystem functions by using cutting-edge experimental, modeling, and analytical (e.g., spectroscopic and stable isotope) approaches.
3. *Biogeochemical Dynamics* — Understand how biogeochemical cycles contribute to broader environmental patterns and responses through use of novel observational and manipulative approaches.
4. *Earth Systems Modeling* — Develop a predictive understanding of interactions among Earth's physical, biological, ecological, and human systems, with a focus on numerical simulation and quantitative analysis of coupled Earth systems.

5. *Watershed Systems Modeling* — Develop integrated models for water movement and the associated transport and transformation of waterborne constituents in watersheds.

**Earth System Informatics and Data Discovery**

*Advance next-generation computational and data analytics to extract and transfer information to understand ecosystems and their representation in numerical models.*

1. *ARM Data Science and Integration* — Provide vision, strategy, leadership, and end-to-end design and execution of earth system data operations, data discovery, interoperability, high-resolution model-data ecosystem, advanced data analysis, science data product delivery, and user interactions.
2. *Remote Sensing and Environmental Informatics* — Advance biogeochemical, ecosystem, and environmental research by providing integrated data products, data management and delivery systems and services, and data analytics to facilitate research, education, and decision-making in the environmental sciences.

## Biosciences

Characterize and engineer complex biological systems to benefit the environment and the US bioeconomy.

**Biodesign and Systems Biology**

*Characterize and engineer biological behavior and determine how rational or automated design can be used to drive innovation in biotechnology and the environment.*

1. *Plant Systems Biology* — Explore and characterize the network of genes, proteins, metabolites, and environmental signals that lead to improved plant characteristics and performance.
2. *Integrative Microbiomics* — Integrate cellular, molecular and genomic approaches to study microbes, communities and their interaction with hosts and the environment.
3. *Synthetic Biology* — Develop and apply principles and techniques for biosystems design in non-model organisms, biofuels crops and associated biosystems to solve renewable energy and environmental challenges.

**Biocomputing and Information**

*Advance frontiers in computational methods to analyze chemical, physical, and biological data and arrive at new predictions and discoveries.*

1. *Molecular Biophysics* — Apply scalable computing and data science to characterize the structure, function and dynamics of complex biomolecular systems.
2. *Computational and Predictive Biology* — Develop and apply the tools of data science, predictive modeling and high-performance computing to transform biological data into knowledge.
3. *Information Systems (Biological and Environmental Research Information System, BERIS)* — Develop communication strategies and informational materials about the fundamental research emanating from DOE's Office of Biological and Environmental Research.

**Bioimaging and Analytics**

*Harness technologies in neutrons, quantum imaging, mass spectrometry and beyond to collect and interpret how molecular patterns, properties, and processes at smaller scales translate to larger-scale phenomena.*

1. *Molecular and Cellular Imaging* — Observe biological function in action by advancing and implementing tools for neutron science, quantum imaging, nanotechnology and microscopy.
2. *Metabolomics and Biomass Characterization* — Apply functional genomics and analytical characterization techniques to understand and enhance sustainable biomass crop productivity and quality for biofuels and bioproducts.
3. *Bioanalytical Mass Spectrometry* — Develop and deploy high-performance mass spectrometry techniques for analytical characterization and chemical imaging of non-volatile biomolecules, including proteomes and lipidomes.