# Bioscience & Biotechnology

End-to-End Solutions for Biological Problems

Lawrence Livermore National Laboratory's (LLNL's) Biosciences and Biotechnology Division applies cutting-edge technologies in combination with experimental and computational methods to solve important national problems in biosecurity, human health, and environmental biology. We perform fundamental and applied research in areas such as genomics, molecular toxicology, nanotechnology, host–pathogen biology, structural biology, genetics, microbial systems, and medical countermeasures. Our scientists employ world-class facilities and up-to-the-minute advances in the biosciences, physical sciences, nanotechnology, and imaging and measurement science to solve problems that matter.

Everything we do supports Laboratory missions in:

- Biosecurity and biosurveillance
- Disease detection
- Environmental remediation
- Public health drug safety
- Bioenergy solutions
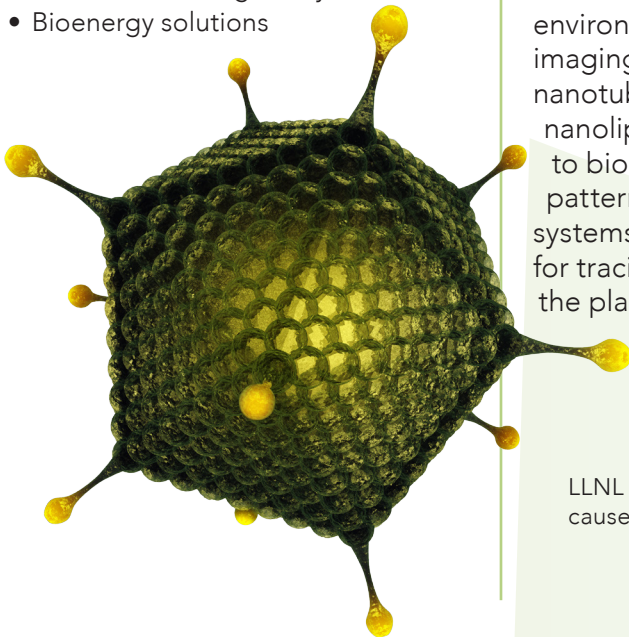
BIOHAZARD DETECTION AND MITIGATION

Our expertise in physics, chemistry, materials science, and biology facilitates basic and applied research for LLNL's missions in nonproliferation, counterterrorism, and life sciences. A crucial component of this strategy is detection of and response to infectious agents, pathogens, and other hazardous toxins in the environment. Ongoing efforts include bioanalytical and molecular imaging instrumentation for nanoscale characterization, carbon nanotube fabrics that repel chemical and biological agents, and nanolipoprotein technology to deliver medical countermeasures to biological threats. In addition, we have modeled dispersion patterns of airborne contaminants in underground transportation systems, tested antidotes for nerve agents, and developed aerosols for tracing toxic airborne particles. Our work also extends above the planet, where we are studying human and environmental microbiomes on the International Space Station.

LLNL develops biological detection systems that identify and combat diseases caused by many different pathogens, including emerging viruses and bacteria.

BIOCOMPUTING

Our biologists and bioinformaticists use high-performance computing tools to describe and predict biological systems, as well as to complement experimental efforts in designing and developing solutions to a range of problems. Simulations of very complex biological systems such as the human body help us to understand how pathogens interact with the host and then predict how the host will respond after exposure. We are working to develop more predictive physiologically based pharmacokinetic models and couple these with cellular and whole-organ models to improve development of new drugs and countermeasures. Other research areas leveraging biocomputing expertise in support of LLNL's national security mission include genomic and pharmacokinetic modeling, epidemic prevention, organismal interactions, and mechanisms of viral and bacterial threat agents.

Drug molecule
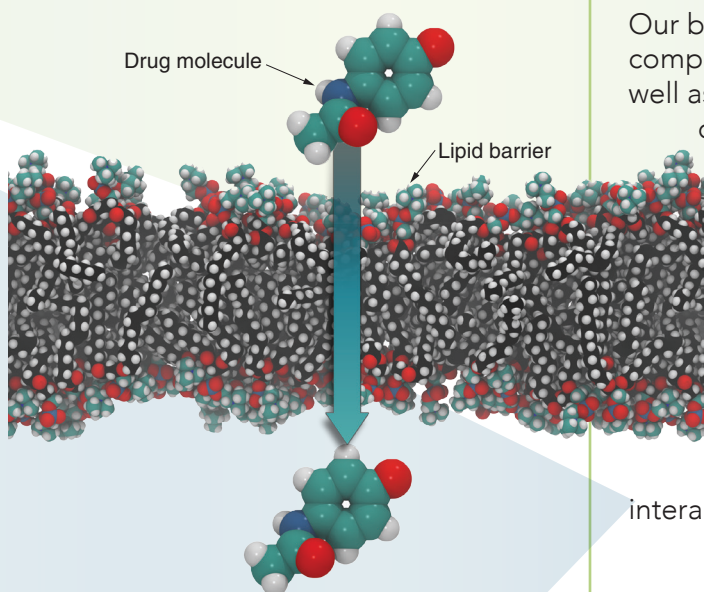
Lipid barrier

Predicting the behavior of drug compounds—such as in this simulation involving the lipid barrier between the bloodstream and the brain—could help drug researchers better gauge drug efficacy and catch potentially serious side effects at an early stage of drug development.

MEDICAL BREAKTHROUGHS

At LLNL, we create multidisciplinary teams that apply leading-edge technologies to solve important problems in public health and medicine. By combining expertise in human biology, engineering, and physical sciences, we can create innovative methods for predicting the course of disease progression, accelerating drug development, and developing novel biosensors. Advanced analytical methods such as accelerator mass spectrometry have allowed us to evaluate microdoses of potential new drug candidates in humans. We have identified a gene involved in fracture repair, leading to new therapies for bone injuries, and biomarkers for arthritis progression to help personalize prevention methods. We are also developing vaccines for infectious diseases, such as *Chlamydia trachomatis*, the world's most common bacterial sexually transmitted infection. Our innovative "human on a chip" models the biology of the heart, nervous system, and blood–brain barrier on an engineering platform. This device could reduce the need for testing of drugs and chemicals on animals and humans.

The "human on a chip" microphysiological systems integrates biology and engineering with a combination of microfluidics and multi-electrode arrays to model human responses.

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