Curing Aids

HIV research fights pandemic that already killed 25 million people

Quick read
We've made major discoveries towards a cure for AIDS. Three HIV vaccines nearing clinical trials.

Scientists are finding the cure to stop a virus that has killed more than 25 million people. Research at the Lab targeting the immune response to HIV and viral mutation might stop the pathogen that causes AIDS.

Although current Human Immunodeficiency Virus (HIV) treatment hinders the infection rate and delays death, there is no HIV vaccine or cure available for the Acquired Immune Deficiency Syndrome (AIDS). The United Nations estimates 14 million children have been orphaned by this disease, and 40,000 Americans will likely become infected this year.

LANL researcher Bette Korber and her team are solving challenging problems regarding HIV evolution and transmission and, importantly, how the human immune system reacts to the virus. Korber's team is designing three vaccines to target this rapidly mutating virus. Animal tests are underway, with promising results and human trials will begin soon. These vaccines might finally deal a lethal blow to the AIDS virus.

"HIV expands and contracts like an accordion," Korber, recipient of acclaimed awards, told an audience during a Los Alamos lecture. "The mystery is why we can't clear it with our immune response."

The HIV virus's mechanisms make it extraordinarily good at avoiding triggering an immune response, making it nearly impossible to fight the infection. Korber's team's vaccine model is based on a mixture of synthetic proteins that address the virus's evasive nature. Not only does the HIV-1 virus mutate quickly, increasing its drug resistance, but its evolution affects the virus's sequence. The virus is also protected by a cloak of sugar molecules that prevents antibodies from blocking the HIV proteins used to invade the cell.

In mid-October, nine hundred experts convened at the international AIDS vaccine conference in South Africa. Doubts were expressed about whether a vaccine is on the horizon. "Fundamentally we don't understand enough about the human immune system and we don't know how the immune system deals with HIV," said Lynn Morris, conference co-chair.

Korber's HIV immunity research might quickly turn the tides.

Coming Together for a Common Goal

LANL knowledge of the virus's evolution and its diversity-aided by the Lab-designed GenBank, a database of all publicly available genetic sequences of nearly all organisms and the first pathogenic database-is impressive.

Los Alamos scientists work in a unique interdisciplinary environment that creates groundbreaking research. Scientists skilled in computation, modeling, and statistics used the Lab's world-class supercomputing facility to create optimized data that aligned HIV sequences, revealing that the virus's evolution began spreading through the human population as far back as 1930. Further modeling ruled out controversial theories about HIV's origin.

The Lab's Theoretical Biology and Biophysics Group played an integral part in clarifying the host-viral dynamics and the HIV evolution. Additional research, including use of an algorithm, unveiled how the human immune response affected viral variation. Also, Korber's team is defining human genes that increase HIV susceptibility.

This team also designed artificial HIV sequences that are highly similar to current strains; proteins from these sequences are now widely used to study cellular immune responses. Healthcare officials hope these proteins could lead to highly effective vaccines that combat AIDS.
Korber's team made a significant discovery about this dynamic virus. Detailed experiments revealed that the T cells (white blood cells) responsible for hosting HIV and allowing it to replicate remain alive only one day after production has begun, a vicious cycle. Her team determined HIV mutates quickly enough to be resistant to a single drug. This finding, along with observations that drug therapy could rapidly decrease the viral load, led to combination drug treatment for AIDS.
Korber and colleagues were able to demonstrate through theoretical and experimental approaches that virus survival is contingent upon viral lineage in addition to mutation, contrary to previous analysis methods and beliefs.
Additional AIDS Research
A Los Alamos National Laboratory mathematical model provided answers for the first time about offspring from a virus closely related to that which causes AIDS.
Thanks to this model, LANL researcher Alan Perelson and colleagues found that a single Simian Immunodeficiency Virus (SIV) produces about 50,000 offspring (viral burst) from a single cell, far more than previously believed. SIV and HIV infect hosts in highly similar ways. With this information about SIV, AIDS researchers can more effectively create methods to reduce the number of virus progeny and limit infection.
Together, LANL AIDS researchers may soon find the answer to destroy this plague that is possibly the most dangerous disease the world has witnessed.

Pushing Frontiers

In the second half of 2008, Los Alamos National Laboratory made significant advances in its primary mission: safeguarding the U.S. nuclear deterrent and pushing the frontiers of science on multiple fronts.
The national stockpile stewardship program achieved a major milestone in September with the production of the first life-extended W76-1 ballistic missile warhead for Trident submarines. The achievement culminated more than a decade of work by scientists and engineers at Los Alamos and across the nuclear weapons complex-including two crucial experiments conducted by the Laboratory's Hydrodynamic Experiments Division.
Another highlight: Roadrunner reached a new performance record of 1.105 petaflops, keeping it atop the list of the world's fastest supercomputers. Built by IBM for the Lab, Roadrunner was the first computer the crack the petaflop barrier: one thousand TRILLION operations per second. Initial applications will range widely: studying in great detail the evolution of HIV... exploring deeply the formation—as well as deformation—of metallic nanowires...and-toward producing biofuels more efficiently-unraveling the processes by which bacteria break down cellulose.
Safety and environmental stewardship were again a major theme for our work in the latter half of 2008. In November, the last group of unvented high-activity drums left Los Alamos for the Waste Isolation Pilot Plant near Carlsbad. That shipment fulfilled a commitment to the Defense Nuclear Facilities Safety Board to prioritize disposal of the highest-activity transuranic wastes stored at the Lab.
Los Alamos also strengthened security, ensuring that nearly six dozen classified and unclassified computing systems are managed and operated securely. The Lab has now complied with all 14 security actions mandated two years ago by the Department of Energy. And, through our program to recruit cognizant systems engineers, we met the crucial need for sufficient numbers of engineers to keep vital mechanical and electrical safety systems functioning properly in our nuclear facilities.
The latter half of 2008 proved once again why Los Alamos is the nation's premier institution for scientific research. Capping the list of accomplishments was a new technology called MagViz that could eventually provide increased security at major airports. Based on medical MRI technology, MagViz can identify contents of bottles and other containers, distinguishing potentially hazardous liquids from the harmless shampoos and perfumes a traveler might carry onboard a jet. MagViz was demonstrated successfully in December at Albuquerque's airport.
We continued a long tradition of supporting U.S. space exploration. A NASA mission, launched in October to probe the far edge of the solar system from a high Earth orbit, carried a Los Alamos device called the High Energy Neutral Atom Imager. Its goal: to detect

atoms emitted from a region where the outermost reaches of our solar system meet the vast interstellar space-giving us a panoramic view of this gateway to the galaxy.
Closer to home, Los Alamos continues to explore solutions to the energy needs of tomorrow. For example, scientists at the Lab hope to use tiny semiconductors called quantum dots to convert sunlight to electricity more efficiently than is possible with current solar panels-and to create new, efficient solid-state lighting.
Equally electrifying, Los Alamos materials scientists are helping unravel the mysteries of superconductivity. During the latter half of the year, LANL researchers identified entirely new mechanisms for superconductivity that could form the basis for new superconducting materials.
Underscoring the wealth of scientific talent at the Lab, Bob Albers, Paul Johnson, and Kurt Sickafus were named Laboratory Fellows in December. These three Fellows represent diverse disciplines, including theoretical physics, energy science, and geophysics.
Los Alamos may be one of the world's great technology incubators, yet we also strive to help others develop new ideas and products. In January, the Lab selected four young local companies as the newest recipients of awards from the LANS Venture Acceleration Fund. LANS, which manages and operates the Lab, supports the fund through donations from its earnings.
The Lab and LANS also teamed last September with a venture capital firm and a local venture capital fund to spin off technology developed by Lab scientists, with an emphasis on creating companies in Northern New Mexico. The Lab could contribute up to one million dollars to the initiative over the first three years.
We also are pushing to build top-flight research facilities for the future. In July 2008, workers hoisted the final steel beam atop the skeleton of what will be the Radiological Laboratory Utility Office Building, part of the Lab's Chemistry and Metallurgy Research Replacement Project. Once completed, the CMRR nuclear facility will house several of the Lab's mission-critical projects, including analytical chemistry, materials characterization, and actinide research and development capabilities. They'll be relocated from their current location in the historic—yet antiquated—Chemical and Metallurgy Research building at Technical Area 3.
In December, Los Alamos welcomed hundreds of employees who transferred from KSL, the subcontractor whose work the Lab brought in-house. The move was geared to improve efficiency and reduce costs associated with site-support services, including maintenance, waste removal, and custodial work.
Throughout the Lab's history, Los Alamos has helped play a vital role in the surrounding communities, and in 2008, that tradition continued. Lab employees pledged a million dollars, and LANS matched one hundred percent: a record Los Alamos contribution to United Way of TWO MILLION dollars. Contributions from the Lab and LANS also helped fund dozens of nonprofit organizations and scholarship programs, including a LANS donation of $500,000 to a LANL Foundation scholarship named for former long-time New Mexico Senator Pete Domenici.
These accomplishments and many more added up to a strong year. Our customer, the National Nuclear Security Administration, reached the same conclusion in its very favorable assessment of the Lab's performance for fiscal year 2008. It's unmistakable: the extraordinary talent, commitment, and creativity that Los Alamos employees dedicate every day to national security science and the betterment of their communities.

About Our Capabilities, Facilities, and Staff

"Los Alamos National Laboratory plays an indispensable role in building America as a science and technology powerhouse, and our staff are an incredible resource to the nation and the world." Michael Anastasio, Dir.

Solving Complex R&D Problems with Special Blend of Staff, Capabilities and Facilities
Now in its seventh decade, LANL is one of the few laboratories that can bring great breadth of fundamental and discovery science, technology, and engineering rapidly together to create tangible solutions for national security needs.
Our staff, working with partners throughout science and industry, must be able to deliver today's solutions while maintaining the depth of capabilities to deliver the next generation of discoveries.
Los Alamos has demonstrated a cycle of innovation where we have developed world-leading capabilities and facilities in response to urgent, unique missions. Our new

discoveries continue to responde to emerging missions.
Being able to integrate and apply our capabilities rapidly to new challenges will be a key advantage in an increasingly competitive landscape.

Our Science, Technology and Engineering Priorities
Science that Matters

Information science and technology enabling integrative and predictive science
Experimental science focused on materials for the future
Fundamental forensic science for nuclear, biological, and chemical threats

How We Work

Collaborate, partner and team to make decisive contributions to our sponsors
Outstanding operational excellence for safety, security, and efficient pursuit of ST&E for our missions

Transform Our Scientific Campus

Campus for 2020 (consistent with complex transformation)
Modern science facilities: LANSCE refurbishment, CMR replacement, Science Complex
Signature facilities