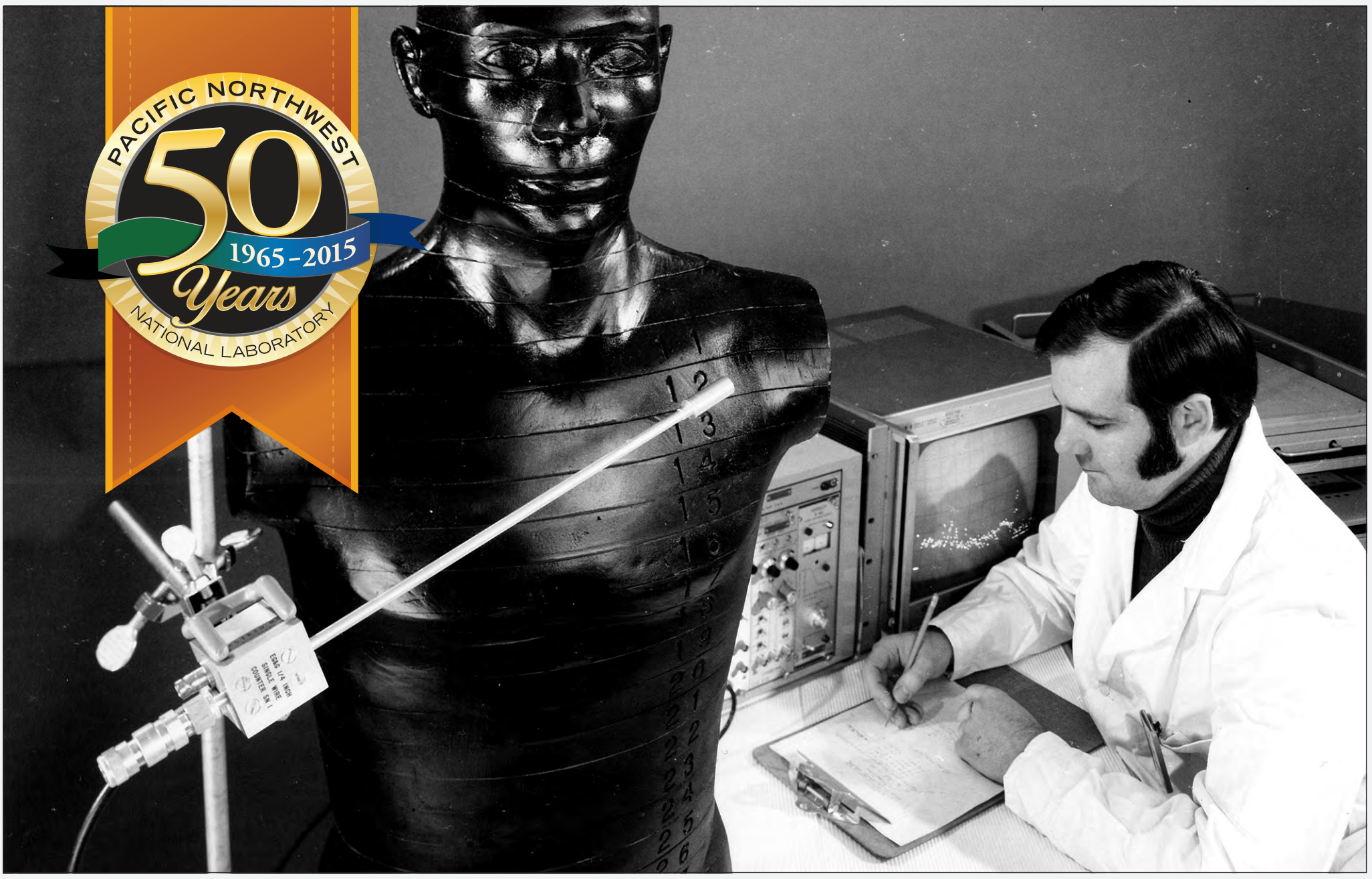


Pacific Northwest National Laboratory's health research has its earliest roots in developing the standards and devices for setting and measuring radiation doses received by nuclear workers. Today, PNNL's science and technology focus is on analyzing biological systems to better understand and predict how those systems respond to environmental exposures, disease and treatment.

PNNL health research: from dosage to diagnoses

This is the fifth of a 12-part series that features some of the scientific challenges PNNL has tackled over its 50-year history and highlights its vision for the future. PNNL is one of 10 national laboratories overseen by the U.S. Department of Energy's Office of Science and has been managed by Battelle since its inception in 1965. Through this enduring partnership—and by working closely with sponsors and collaborators—PNNL builds upon its legacy to advance science and solutions that improve the lives of Tri-Citians and people around the world. This edition is focused on PNNL's health-related research, from its earliest days building an understanding of the effects of radiation to more recent work centered on detecting and treating cancer and more.

PACIFIC NORTHWEST NATIONAL LABORATORY

Imagine a world where the word cancer isn't a dreaded diagnosis, but a disease that is easily detected and treated. Researchers at the Department of Energy's Pacific Northwest National Laboratory may help make that future a reality. They are leveraging capabilities in analytical chemistry and proteomics —or the study of proteins, their structures and functions—in a search for cancer biomarkers that may reveal cancer at its earliest stages.

"PNNL researchers conduct studies and experiments to understand biological systems to advance DOE's energy and environment missions," said Doug Ray, associate laboratory director for PNNL's Fundamental & Computational Sciences Directorate. "Our research contributes to bioenergy and bioremediation, as well as enabling the early detection of disease and improving therapies."

By drawing upon the unique instrumentation and expertise at PNNL and at DOE's Environmental Molecular Sciences Laboratory—a national user facility on PNNL's campus—researchers are exploring the fundamental differences between cancer cells and their normal counterparts, which can lead to earlier detection of disease. They are searching for biomarkers that could indicate prostrate, breast and ovarian cancers.

PNNL's work in human health has roots that date back to 1943—nearly 20 years before the Hanford Laboratories were separated from the Hanford Site, and Battelle began managing what is now PNNL. In those early years, researchers were investigating the health effects of radiation.

In the 1960s, PNNL developed the standards and devices for setting and measuring radiation doses received by nuclear workers. Tens of thousands of people, including children, have been measured by whole-body counters since then to relate the amount of radioactive materials in their bodies to sources such as food and water.

In 1992, a PNNL-developed technology that measures exposure to radiation was named one of the year's top 100 innovations by *R&D Magazine*. The technology led to a new generation of devices called dosimeters, which measure the radiation dose received by radiation workers. It was a significant improvement over conventional dosimetry technologies because it was more sensitive, lasted longer and cost less. The benefits appealed to Landauer, a Chicago-based company that collaborated with PNNL and licensed the proprietary technology for use in its commercially available dosimeters.

PNNL supports a DOE research program dedicated to low-dose radiation exposure, which could affect pilots and other frequent fliers, health care workers, nuclear workers, or victims of terrorism events such as dirty bombs. In one project, researchers are using a three-dimensional skin model to examine the effects of low-dose radiation on humans.

Over the years, PNNL's fundamental biological research has included a wide variety of health studies, primarily sponsored by the National Institutes of Health, that include improving the materials for bone implants, understanding the effects of electromagnetic fields and radon, and cancer detection and treatment.

One cancer treatment is based on researchers' improvements in the chemistry for producing an ultra-pure medical isotope called yttrium-90 from nuclear waste. With these advancements, researchers helped create a targeted cancer treatment for brain, neck and kidney tumors, as well as pancreatic and prostate cancer, that is now used in cancer drug products worldwide.

In addition to a legacy of health research, PNNL is also tackling health challenges found in today's headlines. Last month, PNNL published a study about exposure to BPA, or bisphenol A, which is used to make some plastics and to seal canned foods. The study revealed that coating the mouth with food containing BPA, like soup, does not lead to higher than expected levels of BPA in blood. Researchers concluded that oral exposure does not create a risk for high exposures, consistent with the U.S. Food and Drug Administration decisions that BPA is safe for use in food packaging.

Owned by the U.S. Department of Energy; operated by Battelle; and supported by academic, industrial and governmental collaborators, Pacific Northwest National Laboratory is celebrating 50 years of inspiring and enabling the world to live prosperously, safely and securely. Interdisciplinary teams at PNNL address many of America's most pressing issues in energy, the environment and national security through advances in basic and applied science. With an annual budget of about $1 billion and nearly 4,300 staff members, Battelle is the largest employer in the Tri-Cities.

Learn more about PNNL at **www.pnnl.gov** and through stories to commemorate 50 years of scientific discovery contributed by employees, retirees and the community at **www.celebrate.pnnl.gov**.

PNNL researchers are collaborating with the University of Wisconsin-Madison on a project designed to provide a detailed molecular understanding of how humans respond to viral pathogens like Ebola, West Nile virus and influenza. PNNL's role includes acquiring molecular data and creating computer models. Models that predict how bodies behave when infected by the viruses can help researchers find new approaches to prevent or fight infection.

As part of the LungMAP consortium, a team of PNNL investigators and collaborators are mapping the molecular components of normal lung development. This "molecular atlas" will help expand the understanding of lung development in children during the critical period between about four months before birth until about two years old. The results could help reduce the high mortality rate in premature babies.

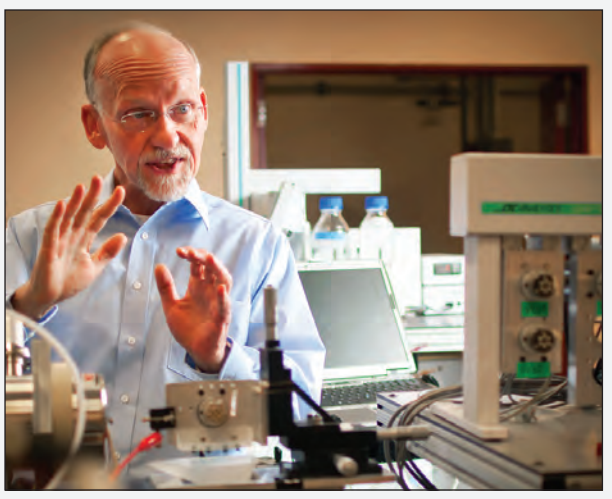
A fairly new area of research for PNNL is taking a closer look at the microbiome, or the community of all microorganisms that typically inhabits a particular environment, such as a body site or ecosystem. PNNL's Microbiomes in Transition program is taking a multidisciplinary approach to develop multi-scale models that will improve the understanding of how microbiomes function. Studies range from examining the impact of climate change on microbial communities in certain ecosystems to determining the long-term impacts of antibiotics on the gut microbiome in humans.

Ray described PNNL's health research as two sides of the same coin. "We have spent decades working to understand how human health, the environment and the climate are affected by legacy nuclear production and conventional energy systems," he said. "At the same time, we leverage those research efforts to also broadly improve human health."

In the 1990s, researchers at PNNL developed and commercially licensed a patented process to make ultrapure yttrium-90, an important radioisotope for cancer therapy. An automated Y-90 generator that milks Y-90 from its strontium source, purifies it and strips it into a usable form—ready to attach to a cancer therapy drug—has since been patented and is available for commercial licensing.

Scientists at PNNL use state-of-the-art nuclear magnetic resonance capabilities at the Environmental Molecular Sciences Laboratory to conduct proteomic research such as identifying breast cancer suppressor proteins. Researchers from around the world can access this and other resources available at the DOE national user facility to conduct research related to health, energy and the environment.

This palm-sized detector is used by medical radiology technicians, cancer treatment specialists and others to measure the radiation they receive at the workplace. The technology was developed at PNNL and commercialized by Battelle and Landauer, the world leader in providing personnel radiation monitoring services.



Researchers at PNNL can apply their capabilities and leverage investments in equipment and instruments to conduct research for DOE, as well as other sponsors. Health-related research at PNNL is funded primarily by the National Institutes of Health, in addition to the Department of Defense, the Environmental Protection Agency, Centers for Disease Control and others. PNNL received about $25 million from NIH in 2014 for health research in areas including cancer, infectious disease, diabetes, and heart, respiratory and digestive health.