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Exploring the Evidence, Cracking the Case

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Jun Li

Exploring the evidence, cracking the case

How nanotechnology is helping researchers clue into pathogen, cancer biomarker detection

Several Kansas State University researchers are becoming scientific detectives at the food safety and biomedical scenes.

Under the direction of Jun Li, associate professor of chemistry, they are developing biosensors that can accurately detect even tiny traces of pathogens, blood contamination and cancer cells.

"All of our work centers on nanotechnology," Li said. "It is an exciting area where we can solve health care and food safety problems while protecting lives and preventing financial loss."

Recently, Li and collaborators — including Lateef Syed, a doctoral candidate in chemistry from India — filed a patent for a technique to detect blood contamination. Its commercial potential earned Syed a Kansas State University Research Foundation doctoral research scholarship.

The technique involves attaching chemicals to gold nanoparticles, which light up when blood contamination is detected in a process called chemiluminescence. This method can detect slight traces of biomaterials from less than one blood cell, creating numerous applications for hospitals and crime scene investigations.

"If you spray this material on the computer keyboard or on a doorknob in a hospital, you can see even a slight trace of contamination that otherwise is unnoticeable," Li said. "For crime scene investigations it can chemically trace small amounts of blood, leaving nothing to hide."

Other collaborators include Deryl Troyer, Kansas State University professor of anatomy and physiology, as well as Judy Wu and Mark Richter, both of the University of Kansas. The work was supported by the Institute for Advancing Medical Innovation at the University of Kansas. The institute has filed a provisional patent application for the technique.

A second project for Li and Syed uses carbon nanofibers to create a biosensor chip that detects pathogens such as E. coli and salmonella. The goal is to turn this biosensor into an easy-to-use hand-held electronic device.

"It is important for this biosensor to be hand-held because it could immediately analyze a sample on location and determine contamination," Syed said. "This will make it possible to prevent outbreaks through early-stage detection."

Li has been contacted by companies interested in using the biosensor chip. The researchers are now developing the chip to detect viruses, which is important for food safety and biosecurity.

Li and Syed are collaborating on the biosensor chip project with Christopher Culbertson, associate professor of chemistry. Their work has been supported by the Canadian-based company Early Warning Inc., as well as the U.S. Department of Homeland Security through the Center of Excellence for Emerging and Zoonotic Animal Diseases, or CEEZAD, at Kansas State University.

The team has published articles about this work in the journals Electrophoresis and Electroanalysis. Syed has co-authored two more articles, and the team has a third article submitted.

A third nanobiosensor project by Li is funded by a three-year $444,000 National Institutes of Health grant. The project focuses on cancer research and early detection of cancer-related enzymes. Cancer patients have enzymes called proteases that tumor cells use to destroy surrounding healthy cells so the tumor has room to grow.

"If we can detect those small concentrations of enzymes as cancer biomarkers in a simpler and faster way, it can show us what stage the cancer is and what treatment should be applied," Li said.

Duy Hua, university distinguished professor of chemistry, and Annelise Nguyen, associate professor of diagnostic medicine and pathobiology, are collaborators for this cancer-related research.

"Our work is quite interdisciplinary," Li said. "We have formed strong collaborative partnerships that allow researchers to build on their strengths and combine their expertise to save the lives of many cancer patients."

— Jennifer Tidball