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Detect and defend

From 'smart skin' to a lab on a chip, array of biosensors in development could save lives

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By ALEXANDRA WITZE / The Dallas Morning News

Last in an occasional series

Canaries may have helped miners sniff out toxic gases, but birds are useless on a battlefield. Tomorrow's soldiers and civilians may rely instead on a new generation of biological sensors.

Texas laboratories are developing many of them.

For instance, Dallas engineers have fashioned a "smart skin" plastic embedded with electronic sensors that could monitor soldiers' health. Houston chemists use tiny gold-plated balls to screen for viruses that could include biological weapons. Lubbock researchers are inventing ways to monitor and stop the spread of certain poisons.

Before Sept. 11, many scientists considered biosensors as high-tech gadgets, things that could help doctors diagnose disease or travelers check the local water. Now the gadgets have taken on prominence for their wartime applications.

The new biosensors could save lives by sniffing out unsafe food, water, or air in an age of terrorism.

"Now everybody's scrambling to produce a practical solution," says electrical

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engineer Henryk Temkin of Texas Tech University in Lubbock.

"It's an open field," he adds. "Nobody really has a complete answer on how to deal with biological threats."

More complex

In part, that's because biological weapons are more complicated than chemical weapons. Only a dozen or so chemical agents are commonly considered as weapons. In contrast, biological weapons can include a dizzying array of bacteria and viruses, which can also be genetically engineered to evade the latest monitoring system.

In June, leading scientists and engineers recommended that the Army step up its research into biosensors. The recommendations, published by the National Research Council, advised that the Army start relying more on new developments in biotechnology research.

That research includes some new discoveries taking place in Texas labs.

At Southern Methodist University, for instance, the newly developed "smart skin" differs from traditional sensors by being built on flexible plastic instead of a rigid silicon wafer.

Engineers Zeynep Celik-Butler and Donald Butler studded the plastic with tiny sensors, each about the width of a human hair, that measure temperature changes. The result: a bendable "fabric" that senses heat flowing across the surface.

Robots might wear the new material when venturing into dangerously hot areas, the scientists say. Or butchers might wrap meat in the stuff, which would track any temperature changes that might lead to spoilage. Doctors might use the fabric to clothe patients who need their health closely monitored.

A tougher plastic

The Butlers work with SMU chemist Patty Wisian-Neilson, who is developing a tougher and more heat-resistant plastic to house the sensors.

So far, the scientists haven't focused on military applications for their work, says Dr. Celik-Butler. "We're developing the science, the basic ground rules," she says.

Still, the smart skin could help identify soldiers whose bodies are responding to biological or chemical attack, she notes.

Also on the battlefield, the military might use a new "lab on a chip" developed in San Antonio. It would be far easier to use than the current truck-based laboratories, says its inventor, James Chambers of the University of Texas at

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San Antonio.

His new device could analyze a questionable substance from start to finish. A soldier would put a drop of unknown liquid onto a thumbnail-sized chip, then place it into a reader to compare it with known substances.

The scientists developed the chip to detect the bacterium that causes plague. But it could be modified to test for other agents, Dr. Chambers says. Ideally, one day it could test for many biological weapons at once, he says.

A similar project at Rice University in Houston began as a way to test more quickly for bloodborne viruses, including the AIDS virus.

Engineers Jennifer West and Naomi Halas teamed up to work on "nanoshells" balls of gold-coated silica that measure just millionths of a millimeter across. The scientists can make the nanoshells just the right size to absorb infrared light. And infrared is the right wavelength of light in which to study biological phenomena.

Traditional HIV tests must purify a blood sample so that it becomes transparent enough for study. But when nanoshells absorb infrared light, the blood essentially becomes transparent. So a nanoshell-based test could theoretically work in seconds instead of days, says Dr. West.

The same technology could be modified for almost any biological material including biological weapons, she adds. She and Dr. Halas have founded a company, Nanospectra, to bring the method to market.

Ultraviolet ID

Meanwhile, scientists in Lubbock are using a different wavelength of light to hunt deadly bacteria.

Dr. Temkin works with ultraviolet light, which can cause many organisms including proteins and bacterial cells to glow eerily. So ultraviolet light might form the basis of a new biosensor, he thought.

He and his colleagues etched tiny channels into a small glass disk; each channel contains a material known to react with a specific bacterium or virus. The researchers drop the disk into an unknown substance, then shine ultraviolet light on the disk to see which material has lighted up and, presumably, which bacterium or virus is also present.

"This is still in the research stage," he cautions. "We are not making these things for sale."

The work is part of Texas Tech's Adm. Elmo R. Zumwalt Jr. National Program for Countermeasures to Biological and Chemical Threats. The project involves nearly 50 faculty members who have been working on

counterterrorism research for several years, says its director, Ron Kendall.

A look at ricin

Some Texas Tech scientists are looking at ricin, a poison produced naturally by castor beans that is considered a potential biological weapon. (Ricin is so poisonous that taking castor oil would kill you if it weren't heat-treated to remove the ricin.)

Richard Zartman, a soil scientist at Texas Tech, studies how ricin spreads through the ground. He discovered that the poison moves at different rates depending on temperature, humidity, the types of minerals and microbes that exist in the soil, and other factors.

One happy note for Dallas-Fort Worth residents: The same clay soil that cracks house foundations when it gets wet and swells is good news when it comes to a ricin attack. The local montmorillonite clays absorb ricin much faster than do other types of clays underlying other cities, such as Chicago or Atlanta, says Dr. Zartman.

Joe Fralick, a Texas Tech microbiologist, is developing a new biosensor to detect ricin.

He uses the power of numbers. He makes millions of short chains of amino acids, called peptides, on the off chance that one of them might latch onto a ricin molecule and bind with it. By pounding a sample with enough peptides, the biosensor would ideally find a match and thus detect ricin or any other biological threat, Dr. Fralick says.

"To me, the part that's exciting is that I think we can find a peptide ... that will essentially bind to almost any biological agent we want to target," he says.

Peptides would be easier to handle than current biosensors, which rely on antibodies that must be kept frozen until use, he says.

Like many scientists involved in biosensor research, Dr. Fralick worked on these issues long before Sept. 11. But he always considered his research to be strictly military.

"At first, I thought this was more for biowarfare fought by the Army," Dr. Fralick says. "I didn't think it was for civilians."

Then he adds, "Of course, you always hope that your research has some relevance and use."

TEXAS VS. TERRORISM

This series, about Texas laboratories' efforts to combat biological and chemical terrorism, has appeared in the Discoveries pages of Texas Living on Mondays.

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