“Firefly” Light Could Aid Drug Development

University of Michigan researchers have used luciferase—the same enzyme that lights up fireflies—to watch cells die, a process that could give scientists new insight into the effectiveness of drug treatments.

“When you’re treating cancer with various chemicals and proteins, it’s really hard to find out if the treatment is working or not because it takes a long time for cancer to shrink in size,” said Alnawaz Rehemtulla, co-director of the Michigan Center for Molecular Imaging and part of the team that made the recent announcement. By literally shedding light on which cells are dying without having to open the body, the enzyme could offer doctors an important treatment tool, Rehemtulla said.

The team took the firefly gene and modified it so that, under normal conditions, it is inactive and not illuminated. The group also modified the gene so that in the presence of cells that are undergoing apoptosis—or self-destruction—it becomes active. The team tested the enzyme on mice with cancer and used a sensitive CCD camera to monitor the process. The cells that died in reaction to the cancer treatments lit up.

“The beauty of luciferase is that it emits in a certain portion of the red wavelength,” Rehemtulla said. “When luciferase is inside the body of the animal, the red light can be detected by the CCD camera.”

Chris Contag of the Stanford University Medical School is part of a group that pioneered in vivo imaging of luciferase activity as a marker of biological function in animals. The group patented the technology through Stanford, and founded a company—Xenogen Corp.—to commercialize it.

“Luciferase has a long and rich history as a reporter gene, used both in cell culture and more recently in living animals,” Contag said. “Modification of this reporter gene such that it can be used to reveal one of the enzymatic steps involved in programmed cell death is a

Securing Borders Through Optics

Optical memory cards have become the standard for green cards issued by the governments of Canada and the United States. Now the same data recording technology is being used to facilitate border crossings for millions of Mexicans who visit the U.S.

The cards’ embedded optical storage technology is sensitive to laser light at a particular wavelength—780 nm. They can hold 2.8 MBytes of data, including everything from facial images to fingerprints, said Stephen Price-Francis, vice president of business development for LaserCard Systems, the company providing the technology to the U.S. government.

The U.S. Immigration and Naturalization Service (INS) began using the technology for permanent residency cards in the mid 1990s. Similar border-crossing cards have been available to Mexicans since 1998. But reviewing the biometric data was only recently made possible when the INS installed “reader” systems for the cards at six points along the U.S.-Mexico border. About 5.5 million border-crossing cards have been issued so far. They include a facial image, two fingerprint images and two fingerprint templates for biometric matching, Price-Francis said. “There are a lot of communities where people move back and forth across the border. They shop, go to church,” Price-Francis said. “This offers convenience for the people who play the game straight.”

The INS was drawn to the cards because earlier cards were easy for counterfeitters to alter, said Sergio Mesa, assistant chief inspector with the INS. The new cards contain various security features, including holograms that cannot be erased, changed or altered. They are encoded onto the optical write-once-read-many media. Another advantage: the new cards can carry much more information about individuals than earlier cards, Mesa said. The border-crossing cards are issued to Mexicans who make frequent, short trips to the U.S. Eventually the cards could be used to log border entries and exits, Price-Francis said.

It’s too soon to say how well the biometric readers are working along the Mexican border, Mesa said. But so far “we’ve seen some good results,” he said. Italy is planning to issue the optical memory cards as identification for its 56 million adult residents by the end of 2007, Price-Francis said.
tremendous advancement that has been made by the Michigan team.”

The next step is the development of software to better localize and quantify the dying cells, Rehemtulla said. Light scatters as it leaves the animal, which means the information about affected cells is two-dimensional and crude at this point, Rehemtulla said. But the research potential of this technique is vast, he said. Scientists could use it not only for tracking the success of cancer drugs, but also for the study of diseases such as Alzheimer's and Parkinson's.

**UV Light: Dangerous or Necessary?**

The federal government’s latest Report on Carcinogens lists some new dangers, including broad-spectrum ultraviolet radiation generated both by the sun and by artificial sources such as tanning beds. The biennial report, mandated by Congress, now includes 228 “known” or “reasonably anticipated” cancer-causing substances identified by the Department of Health and Human Services.

Ultraviolet A, B and C radiation are reasonably anticipated to be human carcinogens because animal studies show a relationship between exposure to each of these wavelength groups and skin cancer, according to the report. Data on skin cancer in humans for these different wavelengths are limited, the report states, because it is impossible to determine whether the humans who were studied were exposed to “pure” individual components of ultraviolet radiation or mixtures of the components.

Some scientists call the report misleading, however, because it doesn’t account for the benefits of some types of ultraviolet light. Michael F. Holick, a professor of medicine, physiology, biophysics and dermatology at Boston University Medical Center, says sunlight is a very important part of the evolution of all vertebrates. When exposed to the Ultraviolet B portion of sunlight, humans produce Vitamin D, which is critical for bone health, Holick said. Some foods are fortified with the vitamin, but sunlight is a primary way humans gain exposure to it.

“Moderate, intelligent use of sunlight is probably very important to the overall health and wellbeing of most humans,” Holick said. The report implies that “any exposure to sunlight will give you cancer. There may be an increased risk for some individuals.” But a chronic Vitamin D deficiency can be dangerous, too, and the report should have been qualified to reflect that, he said.

Howard Cyr, acting branch chief of the FDA’s Centers for Devices and Radiologic Health, said there’s not enough data to support an assertion that sunlamps cause melanoma. “There’s suggestive data there,” he said. “We as an agency do warn people. But I don’t think the data is strong enough to say it’s a known carcinogen.”

**DID YOU KNOW?**

Two U.S. defense contractors have been tasked with developing a 25,000W electrically powered, solid-state laser that ultimately could support systems designed to destroy short-range attack missiles or inactivate an enemy’s optical sensors. Late last year, the U.S. Air Force awarded a $16.9 million contract to Raytheon, El Segundo, California, and a $21.3 million contract to TRW Inc., Redondo Beach, California. Both contractors will have until the end of 2004 to show how well the lasers work. [The Air Force works with solid-state, diode, fiber, chemical and carbon dioxide lasers (pictured here).]

Luciferase allows doctors to highlight cells that are responding to drugs.

Ultraviolet radiation from the sun probably causes skin cancer, a new government report says.

Articles in “Scatterings” are written by Kim Douglass, assistant managing editor of Optics & Photonics News. Do you have a story idea? Write her at kdoug@osa.org.