

March 18, 2008 — By Katherine Bourzac

Three-Minute Anthrax Sensor — A new detector uses living cells that light up in the presence of airborne bioterror agents, such as anthrax and smallpox.

A sensor system that can rapidly detect six potential airborne bioterror agents, including anthrax, is now on the market. The detector relies on living immune-system cells genetically engineered to emit light when exposed to a particular contaminant. From sampling the air to getting a readout from the cells, the detection process takes only three minutes. The company selling the sensor, Innovative Biosensors, of Rockville, MD, is marketing it for use in airports and other buildings, including laboratories where research on dangerous pathogens is performed.

Time is of the essence when detecting bioterror agents. Bacteria like anthrax are infective within two to three minutes of exposure, so the faster a building can be evacuated and the agent contained, the better. “We’re harnessing the fastest pathogen identification system there is,” says James Harper, a researcher at MIT Lincoln Laboratory, where the technology was developed by Todd Rider beginning in the late 1990s. “In the body, B cells bind to pathogens and respond in a second,” says Harper.

The mouse B cells at the heart of the Lincoln Lab detection system can be engineered to detect any agent for which an antibody exists. But the six agents that Innovative Biosensors is initially targeting are the smallpox virus, the toxins botulinum and ricin, anthrax, and two other bacteria. The B cells are loaded into pockets in a disc the size of a CD. These discs in turn are loaded into a one-cubic-foot detector containing fans, an imaging system, and a computer processor.

When the detector is turned on, fans suck air into it. Particles in the air are collected in 16 chambers at the perimeter of the disc. Then the disc is spun at high speed to release the cells from their pockets and transport them to the collected particles. If the agent the cells are designed to detect is present, they emit blue light. The detector uses software to analyze light levels from the disc’s chambers to determine whether a bioterror agent is present. The raw data about light peaks and reaction kinetics is complex, says Lincoln Lab researcher Joseph Lacirignola, but algorithms process it to arrive at a yes or no answer.

The system can run 16 tests simultaneously, one in each chamber of the disc. Harper says that when at least two chambers are devoted to each pathogen, there are no false

positives. The Lincoln Lab system can detect anthrax and other agents at concentrations as low as 10 individual particles per 30 liters of air. Each disc can be used only once.

The Innovative Biosensors detector can automatically load a fresh disc after taking a reading, but it need not run continually. It comes packaged with another, less accurate detection device, also developed at Lincoln Lab. This device uses ultraviolet light and triggers the cell-based system if it detects a potential biomolecule.

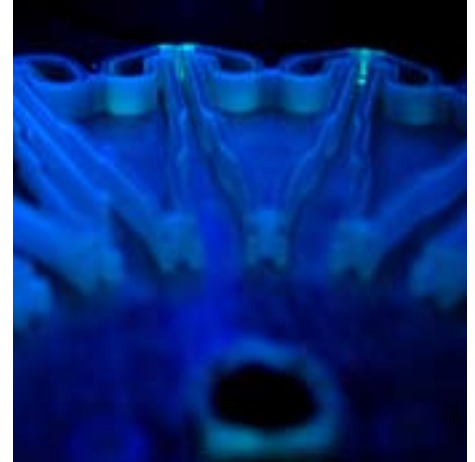
Innovative Biosensors’ system, marketed under the name BioFlash, is intended for use as a first alert. Identifying agents using other methods, such as polymerase chain reaction (PCR), takes about an hour, including sample preparation time. PCR, which can identify particular stretches of genetic material, can give more information about viruses and bacteria than BioFlash can.

B cells are able to identify threats including bacteria and viruses because of the antibodies on their surfaces. Other detection technologies also use antibodies, says Paul Schaudies, president and CEO of GenArraytion, another company in Rockville, MD, developing pathogen-identification technologies. What’s unique about Todd Rider’s technology, Schaudies says, is that it also takes advantage of cells’ rapid response to identified pathogens.

When the antibodies on the surface of a B cell bind to their target, they initiate a cascade of self-amplifying chemical signals inside the cell. One result is an influx of calcium ions. Rider found a way to take advantage of this. He genetically engineered mouse B cells to make a calcium-sensitive fluorescent enzyme derived from jellyfish. When activated by calcium in the cell, this enzyme, called aequorin, reacts with another jellyfish compound called coelenterazine.

One of the products of this reaction is blue light. (The Lincoln Lab researchers have yet to create B cells that can make their own coelenterazine, so the cells must be “loaded” with it.)

Engineered B cells dwelling in the discs have a six-week refrigerated shelf life. They can survive for a week at room temperature. Rider says a system that uses living cells rather than just proteins and other chemical reagents is advantageous, not only because the cells are sensitive and quick to respond



Living sensors: At the heart of a new system for detecting airborne bioterror agents is a CD-size disc with 16 chambers at its perimeter. Particles from the air are collected in the chambers, where they’re exposed to immune cells with antibodies specific to particular agents. If the target agents are present, the cells emit blue light. The light in this image is a simulation; light emitted by cells in the chambers is too faint to be picked up by conventional photography, but it is picked up by light meters in the device. *Credit: MIT Lincoln Laboratory*

to agents, but also because “they grow like weeds.” Unlike detecting reagents based on proteins alone — antibodies, for instance — cell-based detectors replenish themselves.

Innovative Biosensors cannot disclose to whom it has sold the pathogen detectors. However, Richard Thomas, president of its environmental group, notes that the company has a contract with the U.S. Department of Defense for building security in the Washington, DC, area.

Even as the first product based on their technology hits the market, the Lincoln Lab researchers are continuing to develop the system for other applications. One project, says Rider, is to engineer cells that can survive longer in the field without refrigeration. Rider’s group has demonstrated detection of many pathogens and toxins in samples taken from the air, from water, and from nasal swabs, and it is exploring the application of its technology for medical diagnosis.

