# Novel `canary on a chip` sensor measures tiny changes in cell volume

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A novel technology that can test cells in minutes for responses to any stimulus, including antibiotics, pathogens, toxins, radiation or chemotherapy, has been developed by scientists at the University at Buffalo. The paper describing the sensor will appear in the Feb. 15 issue of Analytical Chemistry, and currently is available as an "ASAP" article on the American Chemical Society Web site www.chemistry.org .

Susan Z. Hua, Ph.D., UB assistant professor of mechanical and aerospace engineering and physiology and biophysics, is the lead researcher.

The technology is based on the universal connection between cell volume and the cell environment, or cell volume cytometry. It is particularly useful because it eliminates the need to culture bacteria to assess their sensitivity to antibiotics.

"Now, in a matter of minutes, we can tell if particular antibiotics are active against specific bacteria," said Frederick Sachs, Ph.D., professor of physiology and biophysics at UB, co-director of UB's Center for Single Molecule Biophysics and a coauthor on the paper.

"We have measured the sensitivity to antibiotics of different strains of E. Coli in less than 10 minutes at room temperature. We will get results even faster at higher temperatures."

Hua and her students created the tiny silicon chip that is the heart of the

sensor chamber in which the cells are encased for testing.

"The new technique is so sensitive it can detect changes in cell dimensions never seen before in living cells," she said. "The necessary power can be supplied even by a watch battery and the sensor is so small it could fit into a pencil eraser."

Sachs said the assay can be used on any biological component that is enclosed by a membrane. "It doesn't have to be cells. We can use lipid bilayer vesicles containing a single protein, mitochondria, chloroplasts (plant cells) or cell nuclei, as well as whole cells. We can screen for just about anything."

For example, this technique could be used to rapidly scan cancer cells obtained from biopsies to evaluate the effectiveness of chemotherapy or radiation protocols. The chip has obvious application to measuring toxins relevant to bioterrorism, Sachs said.

Cell volume and physiological function are intimately intertwined, the authors note in their paper. Normal biological activity, such as metabolism, apoptosis (programmed cell death) or cell division affect cell volume, as does abnormal activity, such as exposure to toxic agents. Sachs and Hua call the sensor a "canary on a chip," to highlight its versatility as a first-line indicator of activity.

There are many methods used to measure changes in cell volume, said Hua, but electrical impedance, the resistance to flow of electric current, is the key to this sensor's simplicity.

Cells are electrical insulators, she noted. "When immersed in salt water, which conducts current, the cells displace some of the water and reduce the electrical current. If cells swell, as commonly would happen in the presence of a toxin, the resistance would increase and the current would

become smaller, indicating a cellular response."

In addition to being simple to use, the chip is inexpensive, low power, portable and provides real-time results, said Sachs. "The assay is applicable to an enormous number of problems, and is a particularly powerful tool for drug screening," he noted.