

# **Researchers combine nanotubes and antibodies to detect cancer**

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By coating the surfaces of tiny carbon nanotubes with monoclonal antibodies, biochemists and engineers at Jefferson Medical College and the University of Delaware have teamed up to detect cancer cells in a tiny drop of water. The work is aimed at developing nanotube-based biosensors that can spot cancer cells circulating in the blood from a treated tumor that has returned or from a new cancer.

The researchers, led by Eric Wickstrom, Ph.D., professor of biochemistry and molecular biology at Jefferson Medical College of Thomas Jefferson University in Philadelphia and at the Kimmel Cancer Center at Jefferson, and Balaji Panchapakesan, Ph.D., assistant professor of electrical engineering at the University of Delaware in Newark, present their findings November 17, 2005 at the AACR-NCI-EORTC International Conference on Molecular Targets and Cancer Therapeutics in Philadelphia.

The group took advantage of a surge in electrical current in nanotube-antibody networks when cancer cells bind to the antibodies. They placed microscopic carbon nanotubes between electrodes, and then covered them with monoclonal antibodies – so-called guided protein missiles that home in on target protein "antigens" on the surface of cancer cells. The antibodies were specific for insulin-like growth factor 1 receptor (IGF1R), which is commonly found at high levels on cancer cells. They then measured the changes in electrical current through the antibody-nanotube combinations when two different types of breast cancer cells were applied to the devices.

The researchers found that the increase in current through the antibody-nanotube devices was proportional to the number of receptors on the cancer cell surfaces. One type, human BT474 breast cancer cells, which do not respond to estrogen, had moderate IGF1R levels, while the other type, MCF7, which needs estrogen to grow, had high IGF1R levels.

The BT474 cancer cells, which had less IGF1R on their surfaces, caused a three-fold jump in current. The MCF7 cells showed an eight-fold increase. "When cancer cell bind to antibodies, there is a rush of electrons from the nanotube device into the cell," Dr. Panchapakesan explains. "The semiconductor nanotubes become more conductive," says Dr. Wickstrom. "We saw a larger current increase for the MCF7 cells because it correlates with a greater expression of IGF1 receptors." The cells have a surface protein that is recognized by the antibody on the nanotubes. The current spike occurs only if a target cancer cell with the right antibody target binds to the nanotube array.

"The breast cancer cells don't give a spike if there is a non-specific antibody on the nanotube," he says, "and cells without that target don't cause a current jump whatever antibody is on the nanotubes.

"This method could be used for detection and it could be used for recurring circulating tumor cells or micrometastases remaining from the originally treated tumor," Dr. Wickstrom explains.

"The technique could be cost-effective and could diagnose whether cells are cancerous or not in seconds versus hours or days with histology sectioning," says Dr. Panchapakesan. "It will allow for large scale production methods to make thousands of sensors and have microarrays of these to detect the fingerprints of specific kinds of cancer cells."

Drs. Wickstrom and Panchapakesan would like to test the technique on additional breast cancer markers and markers for other kinds of cancers

to determine its utility and breadth. In future studies, researchers will add cancer cells to a drop of blood and apply the mixture to the nanotube detector to see how sensitive it is in detecting the cancer cells mixed in with real blood cells and proteins. Another test might involve using the device to try to detect specific types of cancer cells shed in the blood from tumors in animals.

The technique has limitations. "We don't know if we can detect more than one antigen at a time on a single cell," Dr. Wickstrom says. Ultimately, the researchers would like to design an assay that can detect cancer cells circulating in the human bloodstream on a hand-held device no bigger than a cell phone.

Source: Thomas Jefferson University

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