Gold nanoparticles may pan out as tool for cancer diagnosis

July 31 2007

When it comes to searching out cancer cells, gold may turn out to be a precious metal. Purdue University researchers have created gold nanoparticles that are capable of identifying marker proteins on breast cancer cells, making the tiny particles a potential tool to better diagnose and treat cancer.

The technology would be about three times cheaper than the most common current method and has the potential to provide many times the quantity and quality of data, said Joseph Irudayaraj, an associate professor of agricultural and biological engineering.

"We hope that this technology will soon play a critical role in early detection and monitoring of breast cancer," said Irudayaraj (pronounced ee-roo-THY'-a-razh), leader of a research team that developed a new method for fabricating the nanoparticles that is published online this month in the journal Analytical Chemistry. "Our goal is to see it in commercial use in about four years."

The gold nanoparticles, or nanorods, are tiny rod-shaped gold particles, even smaller than viruses, which are equipped with antibodies designed to bind to a specific marker on cell surfaces. Researchers analyze these surface markers, proteins on a cell's exterior, because they can contain valuable information about what type of cell they belong to or what state that cell may be in.

"In cancer diagnosis, the ability to accurately detect certain key markers

will be very helpful because certain types of cancers have specific surface markers," Irudayaraj said.

In another study published last month in *Nano Letters*, Irudayaraj showed that the nanorods, when combined with a special imaging technique, were capable of recognizing cancer stem cells by binding to known markers on their exterior. Cancer stem cells are important to detect because they are particularly invasive and more likely than other types of cancer cells to spread, or metastasize, to other organs. These and other types of cells the technology utilizes are obtained from blood tests as opposed to biopsies.

The nanoparticles, or "gold nanorod molecular probes," are fabricated so that their size is unique to their target marker. That way, when nanorods bind to their marker, they "scatter," or disrupt light in a characteristic manner that researchers can then pair to the nanorod's dimensions, its antibody and the target cancer marker, which must be present for binding to occur.

More than 200,000 women are diagnosed with breast cancer every year in the United States, and 80 percent of those women receive some type of therapy, Irudayaraj said. Since 40 percent of them will have a relapse, regular monitoring, which this technology aims to do, is vital.

Irudayaraj said using gold nanorods for cancer detection will be about one-third the cost of the current analogous technology, called flow cytometry. This method works by attaching fluorescent probes to cancer cells, whereas the nanorod technology has its basis in sensing plasmons, or sub-atomic particles present in the gold nanoparticles.

The nanorods also require only a few cells, whereas flow cytometry requires hundreds to thousands of cells. This could be advantageous when dealing with scarce sample sizes, Irudayaraj said.

Irudayaraj and his team - postdoctoral researcher Chenxu Yu and Harikrishna Nakshatri, a researcher at the Indiana University School of Medicine - demonstrated that the nanorods bind to three different markers. Two of the markers were used to calculate the invasiveness of the cancer cell, while one marker - present equally among the different cancer types - was used to calculate the degree to which the other markers were expressed, or present. Irudayaraj said his gold nanorods may be able to detect as many as 15 different markers in the future, possibly opening the door for even more comprehensive tests.

Ultimately, Irudayaraj imagines a new kind of routine and cost-effective procedure for the identification of cancer cells. A patient gives blood, from which cancer cells are obtained. Nanorods are then added to bind to specific markers, if present. Next, the cells are placed on a microscopic slide for imaging. After the rods absorb and re-emit radiation, a special camera records the scattered light, which a computer helps to analyze. Finally, based upon the data, a diagnosis is made.

Source: Purdue University