Nano World: Acid sensors for cells

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Scientists have devised the first sensors only nanometers or billionths of a meter long that can detect how acidic the environment around them is, experts told UPI's Nano World.

These sensors give biologists the first means of accurately measuring acidity, or pH, over a wide range in real time inside living cells and tissues. This could help determine, for instance, whether or not some cancers are malignant. Current methods would evaluate a piece of tumor removed via biopsy, a painful and invasive procedure. These new sensors could in the future get used to measure the pH levels inside the cancer with nothing more invasive than an injection.

"Every time I talk with biologists or bioengineers, they're all very excited about what they can measure or discover with these," said lead researcher Naomi Halas, director of Rice University's nanophotonics laboratory in Houston.

The sensors are made from nanoshells. These nanoparticles, each hundreds of times smaller than a cell, consist of tiny cores of non-conducting silica covered with thin shells of metal, usually gold. The metal shells can get tuned to absorb or scatter specific wavelengths of light.

To create the pH nanosensor, Halas and her team coated the nanoshells with a pH-sensitive compound known as pMBA, or paramercaptobenzoic acid. When placed in solutions of varying pH and illuminated with lasers working in near-infrared wavelengths, the sensors provided minute but easily discernable changes in the property of the scattered light. When decoded, these changes can determine the pH of the sensors' local environment to a remarkably high accuracy of a tenth of a pH unit. "That is the most interesting aspect, the accuracy," chemist Richard Van Duyne at Northwestern University in Evanston, Ill., said.

In comparison with pH-sensitive dyes, which are excited by and emit visible light, "greatly restricting their use in living systems," these pH nanosensors are excited by and emit near-infrared light, which can readily penetrate tissues and blood, Halas said. The pH-sensitive dyes also leak from cells, "which prevents their use for local nanoscale pH measurements, and are unable to provide a continuous signal across a broad pH range."

These nanosensors could aid cell transplants designed to help diabetes patients. Islet cells produce insulin and other hormones in the pancreas and get destroyed in diabetes. "Islet cells seem to be the only potential cure for diabetes, but there are many technical problems with transplanting individual cells. Where do they go, do they stay alive or die, how do you track them?" Halas said. Monitoring changes in pH could help see whether transplanted cells are dead or viable and generating insulin, she explained.

In the future, Halas and her colleagues may license and develop or sublicense these devices to Nanospectra Biosciences in Houston, which she helped found. Halas and her colleagues reported their findings in the journal Nano Letters.

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