

UCLA researchers design nanomachine that kills cancer cells

Researchers from the Nano Machine Center at the California NanoSystems Institute at UCLA have developed a novel type of nanomachine that can capture and store anticancer drugs inside tiny pores and release them into cancer cells in response to light. Known as a "nanoimpeller," the device is the first light-powered nanomachine that operates inside a living cell, a development that has strong implications for cancer treatment.

UCLA researchers reported the synthesis and operation of nanoparticles containing nanoimpellers that can deliver anticancer drugs March 31 in the online edition of the nanoscience journal *Small*.

The study was conducted jointly by Jeffrey Zink, UCLA professor of chemistry and biochemistry, and Fuyu Tamanoi, UCLA professor of microbiology, immunology and molecular genetics and director of the signal transduction and therapeutics program at UCLA's Jonsson Comprehensive Cancer Center. Tamanoi and Zink are two of the co-directors for the Nano Machine Center for Targeted Delivery and On-Demand Release at the California NanoSystems Institute.

Nanomechanical systems designed to trap and release molecules from pores in response to a stimulus have been the subject of intensive investigation, in large part for their potential applications in precise drug delivery. Nanomaterials suitable for this type of operation must consist of both an appropriate container and a photo-activated moving component.

To achieve this, the UCLA researchers used mesoporous silica nanoparticles and coated the interiors of the pores with azobenzene, a chemical that can oscillate between two different conformations upon light exposure.

Operation of the nanoimpeller was demonstrated using a variety of human cancer cells, including colon and pancreatic cancer cells. The nanoparticles were given to human cancer cells in vitro and taken up in the dark. When light was directed at the particles, the nanoimpeller mechanism took effect and released the contents.

The pores of the particles can be loaded with cargo molecules, such as dyes or anticancer drugs. In response to light exposure, a wagging motion occurs, causing the cargo molecules to escape from the pores and attack the cell. Confocal microscopic images showed that the impeller operation can be regulated precisely by the intensity of the light, the excitation time and the specific wavelength.

"We developed a mechanism that releases small molecules in aqueous and biological environments during exposure to light," Zink said. "The nanomachines are positioned in molecular-sized pores inside of spherical particles and function in aqueous and biological environments."

"The achievement here is gaining precise control of the amount of drugs that are released by controlling the light exposure," Tamanoi said. "Controlled release to a specific location is the key issue. And the release is only activated by where the light is shining."

"We were extremely excited to discover that the machines were taken up by the cancer cells and that they responded to the light. We observed cell killing as a result of programmed cell death," Tamanoi and Zink said.

This nanoimpeller system may open a new avenue for drug delivery under external control at specific times

and locations for phototherapy. Remote-control manipulation of the machine is achieved by varying both the light intensity and the time that the particles are irradiated at the specific wavelengths at which the azobenzene impellers absorb.

"This system has potential applications for precise drug delivery and might be the next generation for novel platform for the treatment of cancers such as colon and stomach cancer," Zink and Tamanoi said. "The fact that one can operate the mechanism by remote control means that one can administer repeated small-dosage releases to achieve greater control of the drug's effect."

Tamanoi and Zink say the research represents an exciting first step in developing nanomachines for cancer therapy and that further steps are required to demonstrate actual inhibition of tumor growth.

Source: University of California - Los Angeles

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