Titanium Dioxide Nanoparticles Catalyze Brain Tumor Death

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(PhysOrg.com) -- Scientists from the U.S. Department of Energy's (DOE) Argonne National Laboratory and the University of Chicago Medical Center's Brain Tumor Center have developed a way to target brain cancer cells using inorganic titanium dioxide nanoparticles bonded to antibodies. Thousands of people die from malignant brain tumors every year, and the tumors are often resistant to conventional therapies. These composite nanoparticles eventually may provide an alternative form of therapy that targets only cancer cells and does not affect normal living tissue.

"It is a real example of how nano and biological interfacing can be used for biomedical application," said Argonne's Elena Rozhkova, Ph.D., who led the study. "We chose brain cancer because of its difficulty in treatment and its unique receptors." The results of this study were published in the journal *Nano Letters.*

This new therapy relies on a two-pronged approach. Titanium dioxide is a versatile photoreactive nanomaterial that can be bonded with biomolecules. When linked to an antibody, nanoparticles recognize and bind specifically to cancer cells. Focused visible light is shined onto the affected region, and the localized titanium dioxide reacts to the light by creating free oxygen radicals that interact with the mitochondria in the cancer cells. Mitochondria act as cellular energy plants, and when free radicals interfere with their biochemical pathways, mitochondria receive a signal to start cell death.

“The significance of this work lies in our ability to effectively target nanoparticles to specific cell-surface receptors expressed on brain cancer cells,” said Maciej S. Lesniak, M.D., of the University of Chicago Medical Center’s Brain Tumor Center. “In so doing, we have overcome a major limitation involving the application of nanoparticles in medicine; namely, the potential of these agents to distribute throughout the body. We are now in a position to develop this exciting technology in preclinical models of brain tumors, with the hope of one day employing this new technology in patients.”

X-ray fluorescence microscopy performed at Argonne’s Advanced Photon Source also showed that the tumors’ invadopodia, actin-rich micron-scale protrusions that allow the cancer to invade surrounding healthy cells, also can be attacked by the titanium dioxide nanoparticles. So far, tests have been done only on cells in a laboratory setting, but animal testing is planned for the next phase. Following a 5-minute exposure to focused lights, there was an almost 100% cancer cell toxicity rate 6 hours after exposure and 80% toxicity 48 hours after exposure. Also, since the antibody targets only the cancer cells—unlike other cancer treatments such as chemotherapy and radiotherapy—surrounding healthy cells are not affected.

This work, which is detailed in the paper “A high-performance nanobiophotocatalyst for targeted brain cancer therapy,” was supported by the National Cancer Institute. An abstract is available at the journal’s Web site.

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