Quantum dot research could lead to medical advances

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(PhysOrg.com) -- Working with atomic-scale particles known as quantum dots, a Missouri University of Science and Technology biologist hopes to develop a new and better way to deliver and monitor proteins, medicine, DNA and other molecules at the cellular level.

The approach would work much like a virus, but would deliver healing instead of sickness, says Dr. Yue-Wern Huang, associate professor of biological sciences at Missouri S&T. Huang is leading the research effort, which is funded through a $225,000 grant from the National Institutes of Health under the American Recovery and Reinvestment Act.

Huang's research involves constructing tiny vessels of cell-penetrating proteins to transport the quantum dots, along with proteins, medicine or DNA, into the cell and release them. He likens the process to the ancient story of the Trojan Horse, which according to Greek mythology was used to delivered Odysseus and his army into the enemy city of Troy. But in this instance, the vessel is a "protein transduction domain," the cargo consists of biomolecules or other therapeutic agents, and the walled city is the cell.

Essentially, the nontoxic protein transduction domain, or PTD, is derived from a virus that can penetrate the cellular membrane. But instead of spreading sickness, it would spread medicine or DNA.

Quantum dots are fluorescent semiconductor nanocrystals - specks that

are only a few nanometers in size - that possess unusual physical and chemical properties, making them attractive as tools for new approaches to medicine. For example, Huang says, the fluorescence of quantum dots does not fade as quickly as that of traditional fluorescent dyes used for tracing or mapping in the body. Moreover, quantum dots have a longer half-life and are more resistant to degradation than traditional fluorescent dyes. Because of these qualities, quantum dots are more effective for detecting cancerous cells and other maladies, Huang says.

"Quantum dots are very photo-stable and they have a very high quantum yield. In other words, you don't need to use very much and it is very easy to detect under the microscope," he says.

Huang and his fellow researchers plan to synthesize cadmium-based fluorescent quantum dots, encapsulated by other elements to render the cadmium harmless, and attach them to protein transduction domain (PTD) materials. The quantum dot/PTD mixture is then combined with the cargo, placed into cell cultures and examined. Though early in the research, Huang says the material populates the cell cultures 10 times faster than a system without PTDs over an hour's time.

According to Huang, this work is unique because it involves the merger of two separate areas of biomedical study - quantum dot research and the PTD delivery system. Before this research, the two disciplines have never been merged, he says.

Huang projects "many potential long-term applications in biomedical areas" to come from this research. They include improvements in medical imaging and monitoring, as well as more efficient delivery of medicines and therapeutic agents at the cellular level and in humans.

Other Missouri S&T researchers working with Huang on the effort are Dr. Jeffrey Winiarz, an assistant professor of chemistry, who is creating

the quantum dots, and Dr. Katie Shannon, assistant professor of biological sciences, who is providing bio-imaging expertise.

Provided by Missouri University of Science and Technology (news : web)