Researchers develop drug delivery system using nanoparticles triggered by electromagnetic field

July 8 2010

A new system for the controlled delivery of pharmaceutical drugs has been developed by a team of University of Rhode Island chemical engineers using nanoparticles embedded in a liposome that can be triggered by non-invasive electromagnetic fields.

The discovery by URI professors Geoffrey Bothun and Arijit Bose and graduate student Yanjing Chen was published in the June issue of *ACS Nano*.

According to Bothun, liposomes are tiny nanoscale spherical structures made of lipids that can trap different drug molecules inside them for use in delivering those drugs to targeted locations in the body. The superparamagnetic iron oxide nanoparticles the researchers embed in the shell of the liposome release the drug by making the shell leaky when heat-activated in an alternating current electromagnetic field operating at radio frequencies.

"We've shown that we can control the rate and extent of the release of a model drug molecule by varying the nanoparticle loading and the magnetic field strength," explained Bothun. "We get a quick release of the drug with magnetic field heating in a matter of 30 to 40 minutes, and without heating there is minimal spontaneous leakage of the drug from the liposome."

Bothun said that the liposomes self-assemble because portions of the lipids are hydrophilic - they have a strong affinity for water - and others are hydrophobic - they avoid water. When he mixes lipids and nanoparticles in a solvent, adds water and evaporates off the solvent, the materials automatically assemble themselves into liposomes. The hydrophobic nanoparticles and lipids join together to form the shell of the liposome, while the water-loving drug molecules are captured inside the spherical shell.

"The concept of loading nanoparticles within the hydrophobic shell to focus the activation is brand new," Bothun said. "It works because the leakiness of the shell is ultimately what controls the release of the drugs."

The next step in the research is to design and optimize liposome/nanoparticle assemblies that can target cancer cells or other disease-causing cells. In vitro cancer cell studies are already underway in collaboration with URI pharmacy professor Matthew Stoner.

"We are functionalizing the liposomes by putting in different lipids to help stabilize and target them so they can seek out particular cancer cell types," he said. "We are building liposomes that will attach to particular cells or tumor regions."

Bothun said that research on nanomedicine shows great promise, but there are still many challenges to overcome, and the targeting of appropriate cells may be the greatest challenge.

"Any ability to target the drug is better than a drug that goes everywhere in your system and generates off-target effects," he said, noting that the hair loss and nausea from anti-cancer drugs are the result of the high drug concentrations needed for treatment and the drug's affect on non-target cells. "If you can get an assembly to a targeted site without losing

its contents in the process, that's the holy grail."

Provided by University of Rhode Island