New nanoparticle could improve cancer detection, drug delivery

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(PhysOrg.com) -- University of Florida scientists have developed a new nanoparticle that could improve cancer detection and drug delivery. The particle, called a 'micelle' and made up of a cluster of molecules called aptamers, easily recognizes tumors and binds strongly to them. It also has properties that allow it to easily get inside cells for intracellular studies and drug delivery.

“That is important, because we could attach a drug to the aptamer so that the drug could get into a cell,” said Yanrong Wu, who recently completed her doctoral research at UF. Wu was the first author of a paper describing the findings in January in the Proceedings of the National Academy of Sciences.

In allowing more targeted treatment of diseased cells, the micelles would help reduce damage to healthy cells even with large doses of chemotherapy. Current methods often destroy normal cells while trying to kill tumor cells.

In biological studies, molecules termed “probes” have properties that enable them to detect other molecules or organisms of interest, such as viruses. Compared with existing probes such as antibodies, the aptamers offer advantages in terms of ease of production and identification, faster response time and much lower molecular weight.

Aptamers, the building blocks of the micelles, are short single strands of DNA that can recognize other molecules based on certain chemical

conformation.

In previous drug delivery tests, aptamers on their own could only attach limited drug molecules and sometimes could not effectively recognize tumor cells, so UF researchers re-engineered the molecule to improve its usefulness in biomedical studies in the watery environment inside the body.

They effectively turned the aptamer molecules into a molecular recognition and drug delivery system combination that escorts water-insoluble compounds such as drugs into cells by encapsulating them inside a water-soluble structure.

To do so, the team, led by Weihong Tan, the V.T. and Louise Jackson professor of chemistry at the College of Liberal Arts and Sciences and a professor of physiology and functional genomics in the UF College of Medicine, attached a “water-hating” — or hydrophobic — tail to the aptamers. The new molecules cluster together to form a micelle by tucking their water-hating tails together, exposing only the “water-loving” — or hydrophilic — portion of the structure. In that way, the micelle can shield water-insoluble agents such as drugs within its center, and help usher them into cells.

“It was kind of a stealth situation where the cell sees only the hydrophilic part, but inside, the drug is in the hydrophobic part,” said Nick Turro, the William P. Schweitzer professor of chemistry at Columbia University, who was not involved in the study. “This opens a number of avenues that were unavailable before.”

In tests that mimic physiological conditions, the micelles were more sensitive than the molecular probes alone. The micelle bound more strongly to target cells. That could lead to easier and earlier detection of biomarkers of disease such as cancer.

“When you are talking about diagnosis, these aptamers in micelles will have a much higher signal than individual aptamers, so we may be able to detect very small amounts of the substance we’re testing for,” said Tan, also a member of the UF Genetics Institute, the UF Shands Cancer Center and the Moffitt Cancer Center and Research Institute.

The micelle structures also might prove useful to more accurately determine how much diseased tissue is left behind after chemotherapy or surgery.

Now that the researchers have demonstrated the micelle’s ability to bind in simulated physiological conditions, the next step will be to test it in real tumors.

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