A new form of DNA

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(Medical Xpress) -- Northwestern University chemists have synthesized a new form of DNA, one that can begin to be used to create new gene regulation therapies, for the prevention or treatment of diseases such as cancer.

The spherical structures, composed entirely of nucleic acids, can naturally enter cells and effect gene knockdown. Current gene regulation therapies require secondary agents to carry nucleic acids into cells, which cause problems in terms of toxicity, limiting their effectiveness.

“The beauty of this discovery is that, in principle, these constructs will lay the foundation for treating many forms of cancer, such as glioblastoma, where there are currently no good therapeutic approaches,” says Chad A. Mirkin, who led the research. “There also may be opportunities to use this approach to facilitate wound healing, a direction we are pursuing with Dr. Amy Paller, a colleague and world-renowned dermatologist at Northwestern’s Feinberg School of Medicine.”

The new approach to gene therapy also could be used to treat many neurological and cardiovascular diseases with known genetic origins, he says.

Mirkin is the George B. Rathmann Professor of Chemistry in the Weinberg College of Arts and Sciences and professor of medicine, chemical and biological engineering, biomedical engineering and materials science and engineering and director of Northwestern’s International Institute for Nanotechnology.

He and his colleagues demonstrated that when DNA is arranged in the form of a densely packed, highly oriented nanostructure, it will enter cells naturally. The design of the core-free polyvalent nucleic acid nanostructures (PNANs), which comprise only cross-linked and oriented nucleic acids, eliminate the need for secondary agents with their associated toxic effects.

The research, which represents an entirely new strategy in the gene regulation field, is published by the *Journal of the American Chemical Society* (JACS).

Gene regulation is a therapeutic approach that targets genetic signals in cells. The idea is that if you can get DNA or RNA into a cell, you can selectively turn off genetic switches associated with disease. The trick is learning how to get it to the correct cells, to get into the cells and to do so in a non-toxic manner. The new nanostructures solve most of these problems.

The PNANs are little hollow nanopods of DNA or RNA crosslinked at the base, an arrangement that leads to rapid cellular uptake. They are able to enter cells easily because the nanostructures pick up proteins that facilitate endocytosis, the process by which cells absorb molecules by engulfing them. Other approaches rely on positively charged polymers, peptides or viruses to deliberately introduce nucleic acids into cells.

“One can now begin to create carrier-free gene regulation therapies based on these nanostructures that are non-toxic and more effective than what is currently available,” says Mirkin, who is co-director of the Northwestern University Center of Cancer Nanotechnology and a member of the Robert H. Lurie Comprehensive Cancer Center of Northwestern University.