Not your conventional nucleic acids

February 15 2013

Northwestern University's Chad A. Mirkin, a world-renowned leader in nanotechnology research and its application, has invented and developed a powerful material that could revolutionize biomedicine: spherical nucleic acids (SNAs).

Mirkin will discuss SNAs and their applications in therapeutics and diagnostics in a talk titled "Nanostructures in Biology and Medicine" at the American Association for the Advancement of Science (AAAS) annual meeting in Boston. His presentation is part of the symposium "Convergence of Physical, Engineering, and Life Sciences: Next Innovation Economy" to be held Friday, Feb. 15.

Potential applications include using SNAs to carry nucleic acid-based therapeutics to the brain for the treatment of glioblastoma, the most aggressive form of brain cancer, as well as other neurological disorders such as Alzheimer's and Parkinson's diseases. Mirkin is aggressively pursuing treatments for such diseases with Alexander H. Stegh, an assistant professor of neurology at Northwestern's Feinberg School of Medicine.

"These structures are really quite spectacular and incredibly functional," Mirkin said. "People don't typically think about DNA in spherical form, but this novel arrangement of nucleic acids imparts interesting chemical and physical properties that are very different from conventional nucleic acids."

Spherical nucleic acids consist of densely packed, highly oriented

nucleic acids arranged on the surface of a nanoparticle, typically gold or silver. The tiny non-toxic balls, each roughly 15 nanometers in diameter, can do things the familiar but more cumbersome double helix can't do:

- SNAs can naturally enter cells and effect gene knockdown, making SNAs a superior tool for treating genetic diseases using gene regulation technology.
- SNAs can easily cross formidable barriers in the human body, including the blood-brain barrier and the layers that make up skin.
- SNAs don't elicit an immune response, and they resist degradation, resulting in longer lifetimes in the body.

"The field of medicine needs new constructs and strategies for treating disease," Mirkin said. "Many of the ways we treat disease are based on old methods and materials. Nanotechnology offers the ability to rapidly create new structures with properties that are very different from conventional forms of matter."

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. He is director of Northwestern's International Institute for Nanotechnology (IIN).

Last year, Mirkin and Amy S. Paller, M.D., chair of dermatology and professor of pediatrics at Feinberg, were the first to demonstrate the use of commercial moisturizers to deliver gene regulation technology for skin cancer therapy. The drug, consisting of SNAs, penetrated the skin's layers and selectively targeted disease-causing genes while sparing normal genes.

"We now can go after a whole new set of diseases," Mirkin said.

"Thanks to the Human Genome Project and all of the genomics research over the last two decades, we have an enormous number of known targets. And we can use the same tool for each, the spherical nucleic acid. We simply change the sequence to match the target gene. That's the power of gene regulation technology."

Provided by Northwestern University