Scientists create PNA molecule with potential to build nanodevices

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For the first time, a team of investigators at Carnegie Mellon University has shown that the binding of metal ions can mediate the formation of peptide nucleic acid (PNA) duplexes from single strands of PNA that are only partly complementary. This result opens new opportunities to create functional, three-dimensional nanosize structures such as molecular-scale electronic circuits, which could reduce by thousands of times the size of today's common electronic devices.

The research results will appear in the October 26 issue of the *Journal of the American Chemical Society*.

"DNA nanotechnology has led to the construction of sophisticated three-dimensional nano-architectures composed exclusively from nucleic acid strands. These structures can acquire a completely new set of magnetic and electrical properties if metal ions are incorporated in the nucleic acids at specific locations because the metal ions have unpaired electrons," said Catalina Achim, assistant professor of chemistry at the Mellon College of Science. "Our goal is to harness the information storage ability of metal-containing PNAs to build molecular-scale devices – tiny replicas of today's electronic circuit components, such as wires, diodes and transistors."

Normally, DNA occurs as the well-known double helix first proposed by James Watson and Francis Crick 50 years ago. Each strand of the helix consists of a backbone linked to nucleobases, which occupy the inside of the helix. Nucleobases of one strand bind only to specific nucleobases of

a complementary strand, and the two strands wind around one another like a twisted ladder. Artificially manufactured PNAs incorporate nucleobases that are bound to a backbone chain of pseudo-amino acids, rather than the sugar-phosphate groups of DNA.

"In modifying our PNAs so that they are significantly more stable, we have discovered that the PNA strands don't have to be fully complementary for a metal-containing PNA duplex to form. This is an important finding because it should permit us to use non-complementary parts of the PNA duplexes to construct larger structures, which are useful for material science applications," said Achim.

Two years ago, Achim was the first scientist to report the construction of PNA duplexes that contained metal ions (nickel ions, specifically) and ligands inserted in place of a central nucleobases pair. Since then, the researchers, including graduate students and postdocs Richard Watson, Yury Skorik and Goutam Patra, have synthesized PNAs with a variety of ligands and metal ions to broaden the range of thermal stability and electronic properties. By replacing a nucleobase of a PNA with the molecule 8-hydroxyquinoline, which readily binds to copper ions, the research team constructed PNAs whose nucleic acid strands are only partly complementary and found that these duplexes are held together by standard Watson-Crick nucleobase pairs, but also by bonds between copper ions and the 8-hydroxyquinolines projecting from each of the two strands.

Source: Carnegie Mellon University