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RNA Could Form Building Blocks For Nanomachines

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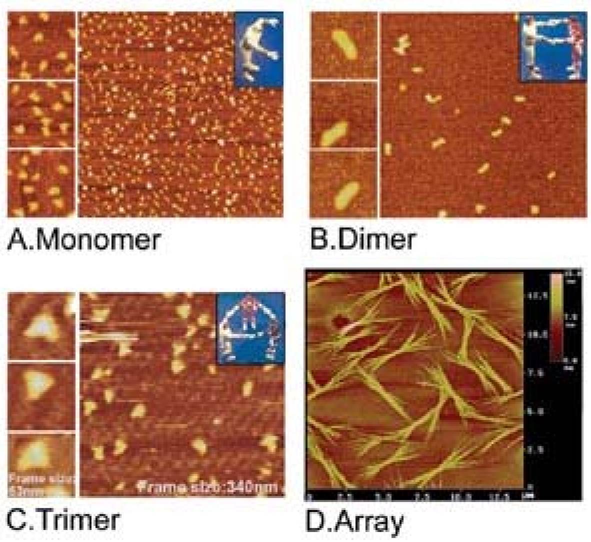
Microscopic scaffolding to house the tiny components of nanotech devices could be built from RNA, the same substa messages around a cell's nucleus, reports a Purdue University research group.

By encouraging ribonucleic acid (RNA) molecules to self-assemble into 3-D shapes resembling spirals, triangles, r the group has found what could be a method of constructing lattices on which to build complex microscopic mac RNA blocks, the group has already constructed arrays that are several micrometers in diameter - still microsco exciting because manipulating controllable structures of this size from nanoparticles is one of nanotechnology's mair



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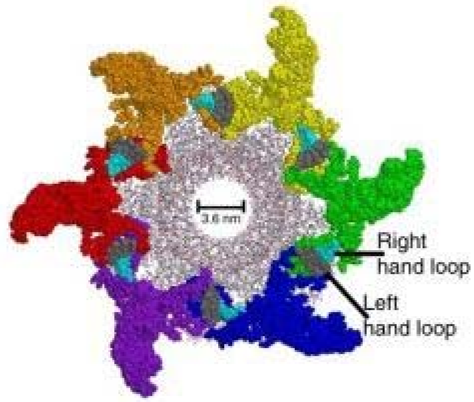
These images show some of the shapes formed of RNA in the lab of Purdue's Peixuan Guo. The first three abstract shapes - monomers, dimers and trimers - are further illustrated with the analogy of human figures grasping each others' arms (see inset illustrations in figures A, B and C). Guo's team has found a way to make these elementary shapes form more complex, 3-D structures such as the array in figure D. Such arrays might form tiny scaffolding on which to construct nanotech devices. (Purdue University graphic/Guo Laboratories)



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Three dimensional structure of the DNA packaging nanomotor of bacterial virus phi29 that contains six RNA molecules. During replication, bacterial virus phi29 uses a nanomotor to package its genomic DNA into a preformed protein shell. The figure shows the three dimensional structure of the DNA packaging motor, with six different colors representing six copies of the RNA molecule. The central channel is the path that DNA follows during replication. (Purdue University graphic/Guo Laboratories)

"Our work shows that we can control the construction of three-dimensional arrays made from RNA blocks of diffe sizes," said Peixuan Guo, who is a professor of molecular virology in Purdue's School of Veterinary Medicine. "With RNA could form the superstructures for tomorrow's nanomachines."

The paper, which Guo co-authored with Dan Shu, Wulf-Dieter Moll, Zhaoxiang Deng and Chengde Mao, all of Purdu August issue of the journal Nano Letters.

Nanotechnologists, like those in Guo's group, hope to build microscopic devices with sizes that are best measured ir billionths of a meter. Because nature routinely creates nano-sized structures for living things, many researche biology for their inspiration and construction tools.

"Biology builds beautiful nanoscale structures, and we'd like to borrow some of them for nanotechnology," Guo saic when we're working with such tiny blocks, we are short of tiny steam shovels to push them around. So we ne construct materials that can assemble themselves."

Organisms are built in large part of three main types of building blocks: proteins, DNA and RNA. Of the thre investigated and understood is RNA, a molecular cousin to the DNA that stores genetic blueprints within our typically receives less attention than other substances from many nanotechnologists, but Guo said the mole advantages.

"RNA combines the advantages of both DNA and proteins and puts them at the nanotechnologist's disposal," Gu versatile structures that are also easy to produce, manipulate and engineer."

Since his discovery of a novel RNA that plays a vital role in a microscopic "motor" used by the bacterial virus p story), Guo has continued to study the structure of this RNA molecule for years. It formed the "pistons" of a ti created several years ago, and members of the team collaborated previously to build dimers and trimers - molec two and three RNA strands, respectively. Guo said the methods the team used in the past made their recent, mor construction work possible.

"By designing sets of matching RNA molecules, we can program RNA building blocks to bind to each other in precise he said. "We can get them to form the nano-shapes we want."

From the small shapes that RNA can form - hoops, triangles and so forth - larger, more elaborate structure constructed, such as rods gathered into spindly, many-pronged bundles. These structures could theoretically form t which other components, such as nano-sized transistors, wires or sensors, could be mounted.

"Because these RNA structures can be engineered to put themselves together, they could be useful to indus specialists, who will appreciate their ease of engineering and handling," said Dieter Moll, a postdoctoral researc "Self-assembly means cost-effective."

Moll, while bullish on RNA's prospects, cautioned that there was more work to be done before nanoscale models cou

"One of our main concerns right now is that, over time, RNA tends to degrade biologically," he said. "We are alı ways to make it more resistant to degradation so that it can form long-lasting structures."

Guo said that though applications might be many years away, it would be most productive to take the long-term ap

"We have not built actual scaffolds yet, just 3-D arrays," he said. "But we have built them from engineered biologic that could help us bridge the gap between the living and the nonliving world. If nanotech devices can eventually b organic and inorganic materials, it would ease their use in both medical and industrial settings, which could multiply considerably."

This research was sponsored in part by the National Science Foundation, the National Institutes of Health and th Defense. Moll's postdoctoral research is funded by the Austrian Science Fund's Erwin Schroedinger Fellowship.

Guo is affiliated with Purdue's Cancer Center and Birck Nanotechnology Center. The Cancer Center, one of just eigh Institute-designated basic research facilities in the United States, attempts to help cancer patients by identifyin targets and designing future agents and drugs for effectively detecting and treating cancer.

The Birck Nanotechnology Center is located in Purdue's new Discovery Park, located on the southwestern edge of c include undergraduate teaching, graduate research and technology transfer initiatives with industry partners. Scie chemistry, physics and several engineering disciplines participate in the research.

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