DNA origami yields micro map

Molecular artwork could point way for nanotech applications.

Helen Pilcher

Technology really is shrinking the globe. In a map of the Americas unveiled in this week's Nature, the journey from Los Angeles to New York becomes a hop of just tens of nanometres. That's a scale of 1:200,000,000,000,000.

The entire western hemisphere is smaller than a bacterium, and 50 billion copies of the chart could fit inside a drop of water. This might seem tiny, but the map, which is made of DNA, is the biggest and most elaborate nanoscale object created in the lab so far.

Yet its cartographer, Paul Rothemund from the California Institute of Technology, Pasadena, is not satisfied. "I had wanted to make a map of the entire world, but I didn't have enough time," he says. "I feel terrible about it."

Rothemund has invented what he calls 'DNA origami', a method for building just about any two-dimensional pattern out of DNA molecules. His portfolio includes smiley faces, triangles, snowflakes and flowers.

Each item takes a month to plan and a few hours to make. All are made of a standard, single strand of viral DNA folded back and forth over rows of double helices in a template shape. The shape is maintained by DNA 'staples' - specially designed short strands - that stop the viral strand from unravelling.

Round the bend
First, Rothemund draws the shape on a piece of graph paper, and fills it with a single line. He describes the twists and turns of the line to his computer, which determines how many staples are needed and their chemical composition.

Then you send off for the DNA, says Rothemund. When it arrives, mix it together with a little salt, heat to near boiling and allow it to cool slowly. The DNA self-assembles into the required shape.

"It’s revolutionary, in a sense. It will certainly change the way people do things," says Nadrian Seeman from New York University, who works on DNA nanotechnology. Other groups have used more complicated methods to produce smaller flat and solid objects, including squares and octahedrons. But the use of a standard, long DNA backbone makes Rothemund’s designs larger, more complex and easier to make.

Rothemund hopes his method will find a use in electronics and molecular biology. The technique could be used to build a flat scaffold to carry microscopic electronic components. Enzymes could also be attached, creating a tiny protein factory.

"This is just artwork," says Rothemund, "but we have faith that if we master the ability to make shapes out of DNA, we will be able to make useful things with them. And it teaches us a lot about DNA structure along the way."

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References

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