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DNA outside biology

Workers at Evanston and Philadelphia have moved closer to laboratory versions of nature's guarded technique, using DNA to fashion materials, says S.Ananthanarayanan.

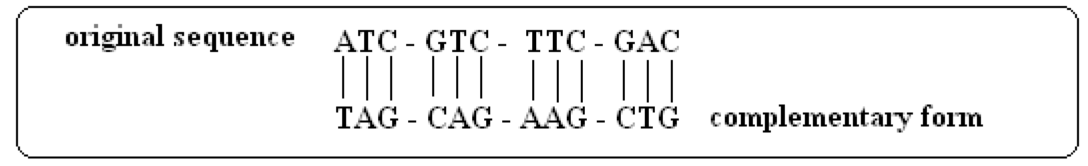
The variety of cells, proteins, enzymes in the simplest life forms may far exceed the capacity of our means of computation. And each component of life needs to be crafted just so, so that they work together and enable complex living things! Yet, nature manufactures these components in their billions with unvarying quality and the best energy economy, starting from the first, single cell.

Blueprint of life

Like a mason builds from an architect's drawing, life reproduces itself with the details of all its components, and how they will work together, with the help of a giant, but microscopic molecule, the DNA. And there is no need for a mason to intervene, for the DNA guides natural substances to combine and recombine, all by themselves, to form enzymes and muscle, bone and tissue and nerves and brain…..

The way DNA works its magic is with just twenty basic building blocks of all proteins – the amino acids. Amino acids, in different combinations, can produce billions of proteins, which can serve different structural or regulatory functions, so that they combine to form living creatures. And for scheduling the order of these basic twenty amino acids for different proteins, DNA uses a simple code of just four components, in groups of three, like words of three letters out of an alphabet of just four letters!

The four components are four chemical formations, called ***bases,*** in pairs, of forms of bases with mutual affinity. The four forms are called A, C, G and T and the affinities are: A pairs with T and C pairs with G. Thus, if a strand of DNA strings out the bases, A,C,G,T in a certain order, the order spells out the complementary sequence, like this:



As each group of three bases identifies an amino acid, or the start or end of the code, the strand of DNA which is a series of groups of three, specifies a sequence of amino acids – and thus a specific protein.

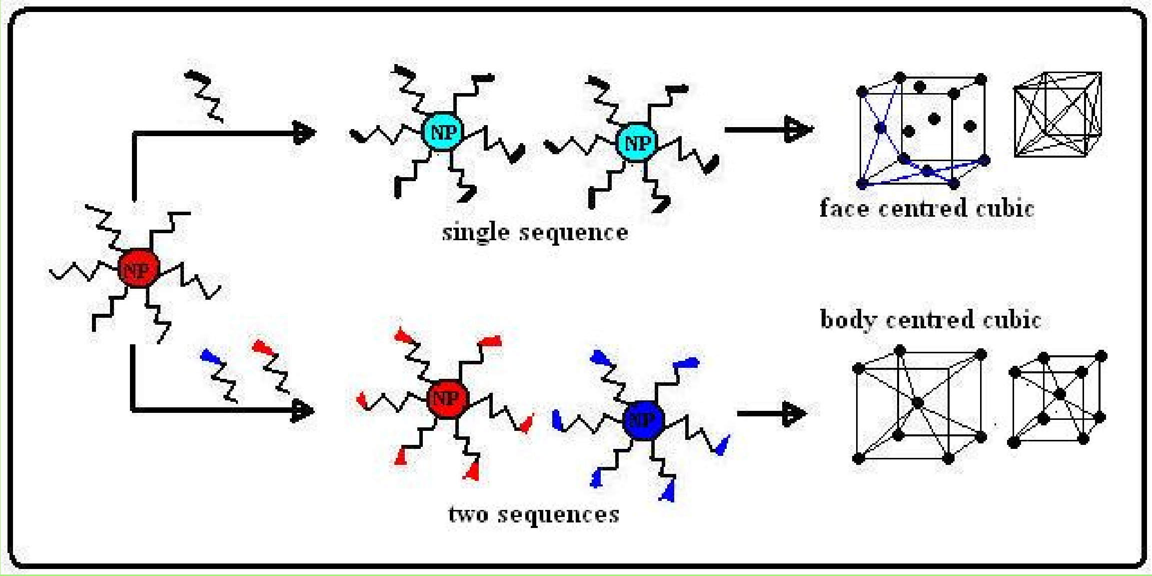
We can see that DNA is thus a molecule-level template for proteins to manufacture themselves, simply by the raw materials being there and thermal agitation to help them find the 'right fit'.

Doing it like nature

Developing custom DNA for creating life forms may be a long way off, but there has been interest in using DNA coding to assemble crystal structures for industry. Chad A Mirkin of Northwestern Univ, Evanston and Oleg Gang in Brookhaven, NY, and colleagues, in their separate papers in this week's ***Nature***, report success in shaping gold nanoparticles into cubic crystal forms with the help of DNA base pairs.

That short DNA sequences can be attached to gold nanoparticles to guide assembly has been known for about ten years. The idea has helped develop powerful methods of guiding probes within individual cells, in diagnosis and in gene-level regulation. But assembly of nanoparticles themselves with the help of DNA base pairs attached to the particles had not made progress.

Mirkin and associates report that gold nanoparticles with bits of DNA attached could be made to align according to the complementary portions of the DNA strand on other nanoparticles. When only one DNA sequence was used, the particles formed the most stable 'face-centred-cubic' structure, as shown in the picture. With two sequences available, the stable form was the 'body centred-cubic' structure.



Oleg Gang and associates, in their paper, note that ability to control the interaction between nanometer-scale building blocks would help us fashion miniature devices with unprecedented precision and variety. Using methods similar to that of the other group, they also achieved 3-dimensisonal crystal structures of remarkably long-range orders, which formed or disintegrated spontaneously when temperature control caused the bonds to form or break

Important step

The development by the two groups in nanoscale manipulation gives us the ability to take advantage of properties of materials at the billionth-of-a-metre scale. The result may be materials with novel magnetic, elastic or optical properties.

The Brookhaven team worked with gold nanoparticles as a model, but they say the method can be applied to other nanoparticles as well. And they fully expect the technique could yield a wide array of crystalline phases with different types of 3-D lattices that could be tailored to particular functions. The Brookhaven Lab, New York has filed a patent for their procedure.