

DNA: Not Merely the Secret of Life

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We build branched DNA species joined using Watson-Crick base pairing to produce N-connected objects and lattices. We have used ligation to construct DNA topological targets, such as knots, polyhedral catenanes, Borromean rings and a Solomon's knot.

Nanorobotics is a key area of application. We have made robust 2-state and 3-state sequence-dependent programmable devices and bipedal walkers. We have constructed 2-dimensional DNA arrays with designed patterns from many different motifs. We have used pairs of 2-state devices to capture a variety of different DNA targets. We have constructed a molecular assembly line using a DNA origami layer and three 2-state devices, so that there are eight different states represented by their arrangements. We have demonstrated that all eight products are built. Recently, we connected the nanoscale with the microscale using DNA origami.

We have self-assembled a 3D crystalline array and reported its crystal structure to 4 Å resolution. We can use crystals with two molecules in the crystallographic repeat to control the color of the crystals. Rational design of intermolecular contacts has enabled us to improve crystal resolution to better than 3 Å. We now do strand displacement in crystals to change their color, thereby making a 3D-based molecular machine. Thus, structural DNA nanotechnology has fulfilled its initial goal of controlling the internal structure of macroscopic constructs in three dimensions. A new era in nanoscale control awaits us.