Controlling Assembly and Function of DNA Nanostructures and Molecular Machinery

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The programmability of DNA and RNA base pairing has enabled the creation of a very wide range of synthetic nanostructures: it is possible to synthesize synthetic oligonucleotides such that a target structure, by design the most stable assembly product, forms spontaneously when these molecular components are mixed. More sophisticated design techniques can be used to control the kinetics as well as the thermodynamics of the interactions between nucleic acid molecules, creating the potential to improve yields through design of assembly pathways and allowing the construction of dynamic systems that process information and of synthetic molecular machinery. Techniques of simulation and verification are important in understanding and designing these increasingly complex systems. I shall present a broad review of this rapidly developing research field, with particular emphasis on our work on DNA origami assembly pathways, kinetic control of strand displacement reactions, molecular motors, and molecular machinery for the control of chemical synthesis.