DNA Nanotechnology: From Manufacturing to Nanomachinery

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Abstract

DNA is one of the most essential elements in life as it carries genetic information. The ability to process the information may also be exploited to translate DNA into an engineering material. This talk will show how molecular information may be harnessed and programmed into nanoscale structures and mechanical machinery.

I will discuss a synthetic molecular motor from DNA that transports nanoparticle cargos along carbon nanotubes. This DNA walker moves autonomously and unidirectionally by converting chemical energy into mechanical motion through a series of conformation changes. This nanomechanical system is reminiscent of motor protein kinesin that transports intracellular cargos along microtubules in eukaryotic cells. We introduce visible/near-infrared super-resolution microscopy which reveals the mechanics and stochastic nature of motor operation. Our mechanistic study provides design principles for efficient, programmable DNA motors.

This talk will also include new molecular mechanisms for building artificial cells with directional motility. We show that synthetic lipid vesicles with DNA motors can not only migrate on a 2D surfaces, but also recognize and track the moving trajectories of other vesicles. This chemotactic behavior emulates immune response, opening possibilities for new discoveries in fundamental sciences and novel applications in biotechnology. The presentation will be concluded with several exemplary applications.

Biosketch

Jong Hyun Choi is an Associate Professor in Mechanical Engineering at Purdue University. He received his B.S. and M.S. degrees in Mechanical Engineering from Yonsei University, and earned his doctoral degree, also in Mechanical Engineering, in 2005 from the University of California at Berkeley. He completed postdoctoral research in Chemical Engineering at MIT and University of Illinois before joining Purdue in 2009. He is an NSF Career award winner and an ASME fellow. His research focuses on understanding thermodynamics, kinetics, and mechanics of DNA-based materials and devices for various engineering applications.