Synthetic cells: De novo assembly with microfluidics and DNA nanotechnology

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Abstract:

Bottom-up synthetic biology has been successful at isolating components from cells and reconstituting subcellular functions in vitro. Progress towards a fully functional synthetic cell, however, requires strategies to recombine and arrange a multitude of components in space and time. Here, we merge two precision technologies, microfluidics and DNA nanotechnology, to position and manipulate various components in synthetic cells [1]. In particular, we use DNA as a near-universal linker to functionalize microfluidic compartments [2]. Our method relies on the self-assembly of single-stranded cholesterol-tagged DNA handles, which provide an addressable anchoring point for complementary DNA carrying an arbitrary functional group. Using this DNA handle approach, we demonstrate the stimuli-responsive attachment of subcellular components and their DNA-based mimics. Following passive encapsulation, we actuate DNA nanostructures in microfluidic or lipid-based compartments [3, 4] to assemble dynamic systems with structural reconfigurability. By the integration of plasmonic probes we achieve real-time optical feedback to monitor the dynamics upon external stimulation [5]. These unique tools, bridging the micro- and nanoscale, enrich the complexity and diversity of functional synthetic cellular systems.


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