

Title: Programming the Morphology of Systems of Synthetic Cells

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Abstract

One of the long-standing goals of nanotechnology is the ability to explicitly program the self-assembly of a material. While current technology is limited, biological systems routinely perform such tasks, for example in the spontaneous healing of wounds or morphogenic processes in fetal development. We propose a novel approach to programming self-assembly by mimicking nature's system of autonomous, motile cells coordinated by a gene regulatory network. Our synthetic cells will consist of polymer vesicles made from block polymers that contain membrane-embedded enzymatic catalysts. The enzymes will couple with reagents, promoters, and inhibitors in solution to create a simplified "gene regulatory network" that can induce motility, shape change and aggregation of the ensemble. To study this system, we have assembled a team of experts on (1) block polymer vesicles (Paxton, Chem), (2) programmable control of autonomous systems (Peterson, EcEn) and (3) simulations of nanoscale material dynamics (Tree, ChEn).