The emergence of multicellular systems represents a significant step in evolution (1). A better understanding of the ruleset governing this biological phenomenon could impact approaches in tissue regeneration and cancer treatment (2). In order to understand this phenomena, we engineered a synthetic biological system that mimics cellular self-assembly. Here, we report the development of self-assembling, magnetic biorobots that incorporate living cells. These cells, genetically engineered E. coli, carry a synthetic gene construct encoding a self-assembly program. They form millimeter-scale, helically swimming magnetic robots upon induction with L-arabinose by activating expression of a surface displayed protein that crosslinks the cells and magnetic microparticles. When induced, the cells form a flexible magnetic mass that assumes an elongated, helical shape within a glass capillary and can be propelled by an external rotating magnetic field. This work demonstrates a new class of hybrid biomagnetic robot in which cells are genetically programmed to encode the physical architecture of the robot. In addition, this model system provides a research platform with which to study the principles that govern multicellular aggregation, and the influence of surface displayed proteins on the form and function of multicellular structures.

References