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**Emergent Pattern Formation in a Synthetic Bacterial Population**

Synthetic biology is an emerging field that integrates biology, engineering, and physical sciences with broad applications in systems biology as well as real-world concerns. In this talk, I will use our recently engineered patterning system as an example to illustrate how synthetic biology can be employed to tackle important biological questions. A fundamental challenge in developmental biology is to understand how global spatial patterns emerge from local interactions in a population of isogenic cells. Using a synthetic biology approach, we constructed a two-signal bacterial patterning system where one signal serves as an activator and the other as an inhibitor. An initially homogenous lawn of our engineered bacteria spontaneously produces Turing-like patterns with a spatial scale much larger than that of a single cell. Our experiments further suggest that the emergent patterns originate from a collective intercellular decision-making process rather than from initial spatial heterogeneity, population growth, or random cell-fate decisions of individual cells. To achieve a quantitative understanding of the patterning mechanism, we developed a stochastic mathematical model producing simulations that correlate well with our experimental patterns and also allow us to examine the importance of gene expression noise in pattern formation. This synthetic system reveals design principles of biological patterning organisms, provides a platform for studying general features of cellular fate determination in developmental biology, and can be useful for programmed control over tissue development.