MAR06-2005-030052

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Programming bacterial dynamics by synthetic killer circuits

LINCHONG YOU, Duke University

In addition to offering insight into biological "design" principles, de novo engineering of synthetic gene circuits may impact broad areas including computation, engineering, and medicine. However, it remains challenging to realize predictable and robust circuit performance due to noise in gene expression and cell-to-cell variation in phenotype. We address these issues by using cell-cell communication to regulate cell killing to enable precise programming of bacterial dynamics. To establish cell-cell communication, we take advantage of quorum sensing systems that many bacteria use to detect and respond to changes in the cell density. As a prototype example, we have built and characterized a population control circuit in bacterium Escherichia coli. This circuit autonomously controls cell density by regulating the death rate using a quorum sensing module. Upon activation, the circuit will lead to a stable steady state or sustained oscillations in cell density, as predicted by a simple mathematical model. Further exploiting this design strategy, we have constructed a synthetic predator-prey ecosystem, where two E. coli populations regulate each other's growth and death by engineered two-way communication. Systems such as this will enable us to explore complex ecological dynamics in a well-defined experimental framework.