SYNTHETIC REGULATION AND GENETIC CONTROL OF ECOLOGICAL STRATEGY

Thesis by

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ABSTRACT

The construction of synthetic gene regulatory circuits inside living cells has illuminated how organisms process environmental signals, and has suggested that biological systems can be engineered for useful purposes. However, these lines of inquiry are limited by a lack of technologies for programming gene expression and an understanding of the adaptive or ecological consequences of manipulating gene expression. Here, I describe the design of noncoding RNA regulators of gene expression in *Saccharomyces cerevisiae*. These regulators are able to regulate gene expression in response to a small molecule ligand, which offers the ability to tailor control devices for a variety of applications. In light of this, an open question is the dependence of organism fitness on the levels of a regulator, which has seldom been measured. I found that the expression level of a transcriptional regulator of nitrogen metabolism mediates a trade-off between growth in resource abundant and resource limited environments in *S. cerevisiae*. Redundancy in the metabolic pathways of ammonia assimilation allowed noise, or random fluctuations in the amount of protein present, to dictate whether cells specialized in maximizing fitness in abundant or limiting environments. These results show how gene expression may be programmed via noncoding RNA regulators, and that the manipulation of regulator levels can affect the strategy by which organisms adapt to their environments.

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