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(I) Principles of resource allocation under the active control of ribosome synthesis in bacteria

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Bacteria are often assumed to allocate cellular resources to maximize their exponential growth rate. This postulate, derived from studies of Escherichia coli, is commonly interpreted as an economic principle, in which the cell balances supply of and demand for "metabolic currencies"such as amino acids during steady-state growth. However, testing these predictions has been a major experimental challenge. Here, we show that Bacillus subtilis, another model bacterial organism, deviates from this growth maximization paradigm. To this end, we modulated the rate of rRNA and ribosome synthesis by controlling the cellular GTP concentration. In nutrient-limited conditions, perturbations to ribosome production always reduced the growth rate. In stark contrast, under inhibition of translation with antibiotics, increased ribosome production led to faster growth. Using proteomics and LC/MS, we trace this submaximal growth to a reduction in GTP level upon translation inhibition, which leads to overproduction of metabolic enzymes at the expense of ribosomal proteins. We conclude that different organisms follow organism-specific resource allocation principles, perhaps as a consequence of evolution.

Keyword-1

Cell size homeostasis

Keyword-2

Resource allocation

Keyword-3

Quantitative biology

Author: Dr JUN, Suckjoon (University of California, San Diego)

Presenter: Dr JUN, Suckjoon (University of California, San Diego)

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