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How do bacteria couple growth to division?[1]

MANUEL CAMPOS, Microbial Sciences Institute / Yale Unibersity

Cell size control is an intrinsic feature of the cell cycle. In bacteria, cell growth and division are thought to be coupled through a cell size threshold. Here, we provide direct experimental evidence disproving the critical size paradigm. Instead, we show through single-cell microscopy and modeling that the evolutionarily distant bacteria Escherichia coli and Caulobacter crescentus achieve cell size homeostasis by growing on average the same amount between divisions, irrespective of cell length at birth. This simple mechanism provides a remarkably robust cell size control without the need of being precise, abating size deviations exponentially within a few generations. This size homeostasis mechanism is broadly applicable for symmetric and asymmetric divisions as well as for different growth rates. Furthermore, our data suggest that constant size extension is implemented at or close to division, implying that the initiation of DNA replication or the formation of the FtsZ cytokinetic ring are unlikely to dictate the timing of division. Altogether, our findings provide fundamentally distinct governing principles for cell size and cell cycle control in bacteria.

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