BIOMATERIALS

Forces in Biomolecular Systems SFB 863

How yeast cells can measure and control their own size

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Abstract:

Cell size affects many cellular processes and is controlled by coordination of growth and division. In budding yeast, size control occurs within the G1 phase. Although the key proteins involved are known, the molecular mechanism that allows cells to measure their own size has remained elusive. One major candidate for a size sensor is the unstable G1-cyclin Cln3, which phosphorylates the inhibitor of the transcription factor SBF, Whi5, and by that triggers irreversible commitment to cell division. However, the constant concentration of Cln3 in both the cell and the nucleus poses a question as to how Cln3 activity might increase in a size-dependent manner. Using live cell microscopy, we show that Whi5 is mainly produced during bud growth and the rate of Whi5 production is only weakly dependent on cell size. As a consequence, cells that are born smaller are born with a higher concentration of Whi5, and the concentration of Whi5 molecules decreases as the cell is growing during G1. Based on this observation, we propose a new model for size control, where cells enter the cell cycle once the active Whi5 concentration drops below a certain threshold. We quantitatively test our model by putting fluorescently tagged WHI5 and CLN3 under control of inducible promoters. We can then arrest cells by turning of CLN3 expression and measure the concentration of Cln3 that is needed to induce budding. Fully consistent with our model, the size dependence of the required Cln3 concentration can be quantitatively explained by the Whi5 concentration.

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