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Robust regulation of oscillatory Min-protein patterns¹

JACOB HALATEK, ERWIN FREY, Arnold Sommerfeld Center for Theoretical Physics and Center for NanoScience, Department of Physics, Ludwig-Maximilians-Universität München — Robust spatial patterning was crucial just from the beginning of cellular evolution, and is key to the development of multicellular organisms. In *E. Coli*, the oscillatory pole-to-pole dynamics of MinCDE proteins functionality prevent improper cell divisions apart from midcell. Min-oscillations are characterized by the remarkable robustness with which spatial patterns dynamically adapt to variations of cell geometry. Moreover, adaption, and therefore proper cell division, is independent of temperature. These observations raise fundamental questions about the underlying core mechanisms, and about the role of spatial cues. With a conceptually novel and universal approach to cellular geometries, we introduce a robust model based on experimental data, consistently explaining the mechanisms underlying pole-to-pole, striped and circular patterns, as well as the observed temperature-dependence. Contrary to prior conjectures, the model predicts that MinD and cardiolipin domains are not colocalized. The key mechanisms are transient sequestration of MinE, and highly canalized transfer of MinD between polar zones. MinD channeling enhances midcell localization and facilitates stripe formation, revealing the potential optimization process from which robust Min-oscillations originally arose.

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