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Control of prokaryotic cell division by Turing patterns

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Cell division requires the precise placement of the division ring at mid-cell to ensure both daughter cells are viable. However, the mechanisms behind this localization remain poorly characterized. There are a limited number of known ways to identify the centre of the cell. One such mechanism is a Turing pattern. One intracellular Turing pattern has been identified, that produced by the Min protein system. In *Escherichia coli*, the Min protein system plays a role in establishing the division ring position. Membrane-bound Min proteins form an oscillating spatial pattern where the proteins are concentrated at one pole of the cell and then another, leaving a barezone at the centre of the cell where the FtsZ ring will form. Based on molecular interactions of the Min system, we have formulated a mathematical model that reproduces Min patterning during cell growth and division. This model provides a platform to explore how the Min system functions and what characteristics are likely to be shared with other Turing patterning systems, should they exist. We examine the general characteristics of Turing patterns produced by the Min system. In particular, patterning approximates a harmonic of the cell shape and selects the dominant harmonic in a predictable manner. This shows what alternative intracellular Turing patterning systems are likely to appear and how they would behave in relation to cell shape. The oscillations of the Min system are shown to be translated into a mid-cell localization signal via the harmonics generated by non-linear interactions of the system. We show that division plane orientation in the pleomorphic archeon *Haloferax volcanii* can be predicted from cell shape by assuming that it is dictated by a Turing mechanism. This work makes progress towards understanding how the Min system functions to regulate cell division. More generally it develops tools to identify alternative Turing patterning systems and to understand how patterning can be translated into localization signals.

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