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Interplay between cell size and cell polarity

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The PAR network polarizes a broad range of cell types by localizing proteins to opposing membrane domains. Despite its abundance, we know almost nothing about how the PAR proteins adapt to this vast diversity of cell sizes and shapes. In many systems, maintenance of polarity has been described as a reaction-diffusion network of the proteins involved.

Here, by first using theoretical modelling, we show that these reaction diffusion systems break below a certain cell size, resulting in a uniform, unpolarized membrane distribution. This predicts that cells below a size threshold should be unable to maintain polarity *in vivo*. The precise nature of this threshold depends on parameters such as membrane diffusion and turnover.

Next, by combining light sheet microscopy-based 3D reconstruction of the plasma membrane with single molecule measurements of key biophysical parameters, we have revealed this size limit *in vivo*, in a developmental lineage of the *C. elegans* embryo. These findings are in remarkable quantitative agreement with our theoretical predictions.

Thus, intrinsic properties of polarity proteins impose physical limits on the ability of cells to polarize, pointing to an unappreciated link between the size of a cell and its ability to polarize and establish cell fate.

Affiliation

The Francis Crick Institute

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Primary author(s) : HUBATSCH, Lars (The Francis Crick Insititute)

Co-author(s) : PEGLION , Florent (The Francis Crick Institute); REICH, Jake (The Francis Crick Institute); GOEHRING, Nathan W (The Francis Crick Institute)

Presenter(s) : HUBATSCH, Lars (The Francis Crick Insititute)

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