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Three-dimensional excitable wave dynamics depend on the cell geometry in Dictyotelium cells

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Phosphatidylinositol (3,4,5)-trisphosphate (PtdInsP3) is known to propagate as waves on the plasma membrane and is related to the membrane protrusive activities in *Dictyostelium* and mammalian cells. While there have been a few attempts to study their three dimensional dynamics, most of these studies focused on the dynamics extracted in one dimensional sections along the membrane in a single focal plane. However, the relation between the dynamics and three-dimensional cell shape remain elusive due to the lack of signalling information on the remaining non-observed part of the membrane. Here, we show that PtdInsP3 wave dynamics are directly regulated by the three-dimensional geometry - size and shape - of the plasma membrane. By introducing an analysis method that extracts the three-dimensional spatiotemporal activities on the entire cell membrane, we show that PtdInsP3 waves self-regulate their dynamics within the confined membrane area leading to changes in speed, orientation and pattern evolution following the underlying excitability of the signal transduction system. Our findings emphasize the role of the membrane topology in reaction-diffusion driven biological systems and indicate the importance of the plasma membrane topology in other mammalian systems.

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