The Beginning of the Ends: Localization of Lipids to Bacterial Poles

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***Short Abstract* — We propose a novel equilibrium mechanism for spontaneous lipid targeting to the poles and division site of rod-shaped bacterial cells. If one of the membrane components has a large intrinsic curvature, the geometrical constraint of the plasma membrane by the more rigid bacterial cell wall counteracts the attractive interaction between like lipids and leads to microphase separation. We find that the resulting clusters of high-curvature lipids are large enough to spontaneously localize to the polar and septal regions, and could have similar utility to lipid rafts as a stage for targeting proteins involved in a wide variety of biological processes.**

***Keywords* — Bacteria, membranes, lipids, polar localization, curvature, elasticity.**

In the past decade, intracellular fluorescence microscopy has fashioned a new appreciation for the diversity of ways in which proteins organize and segregate on bacterial membranes. Though some targeting anchors are known, cellular symmetry breaking ultimately requires molecular components that self-organize. We propose a novel equilibrium mechanism, based on the two-dimensional curvature of the membrane, for spontaneous lipid targeting to the poles and division site of rod-shaped bacterial cells [1]. If one of the membrane components has a large intrinsic curvature, the geometrical constraint of the plasma membrane by the more rigid bacterial cell wall counteracts the attractive interaction between like lipids and leads to microphase separation. We find that the resulting clusters of high-curvature lipids are large enough to spontaneously and stably localize to the two cell poles and septal regions, and could have similar utility to lipid rafts as a stage for targeting proteins involved in a wide variety of biological processes. Recent evidence of localization of the phospholipid cardiolipin to the poles of bacterial cells [2,3] suggests that protein targeting may depend on the membrane's heterogeneous lipid content [4]. More generally, aggregates of lipids, proteins, and lipid-protein complexes may localize in response to features of cell geometry incapable of localizing individual molecules [5].

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