Sensing their plasma membrane curvature allows migrating cells to circumvent obstacles

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Cell migration is a hallmark out-of-equilibrium process in biology. In addition to persistent self-propelled motion[1,2,3], many cells display remarkable adaptive behaviors when they navigate complex environments[4,5]. Combining theory and experiments, we find a curvature-sensing mechanism underlying obstacle avoidance in immune-like cells. The genetic perturbation of this machinery leads to a reduced capacity to evade obstructions combined with faster and more persistent cell migration in obstacle-free environments. We propose that the active polymerization of the actin cytoskeleton at the advancing edge of migrating cells is locally inhibited by the curvature-sensitive BAR-domain protein Snx33 in regions with inward plasma membrane curvature. This coupling between actin and membrane dynamics leads to a mechanochemical instability that generates complex protrusive patterns at the cellular front. Adaptive motility thus arises from two simultaneous curvature-dependent effects, the specific reduction of propulsion in regions where external objects deform the plasma membrane and the intrinsic patterning capacity due to the membrane-actin coupling that promotes spontaneous changes in the cell's protrusions. Our results show how cells utilize actin- and plasma membrane biophysics to sense their environment, allowing them to adaptively decide if they should move ahead or turn away.

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