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Bleb Statics, Dynamics, Adaptation and Directed Cell Migration

Cellular blebs are spherical cell membrane protrusions powered by cytoplasmic flow. To understand the dynamics of cellular blebs, we develop a quantitative model to study how a bleb develops when a portion of the cell membrane detaches from the underlying cortex. From the model, we calculate the minimum cytoplasmic pressure and minimum unsupported membrane length for a bleb to nucleate and grow. We also show how a bleb may travel around the periphery of the cell. We find that the traveling speed of the bleb is governed by the speed of the pressure pulse induced by local cortical contraction and we construct a phase diagram for bleb existence and motion. Finally, we propose a bleb-based mechanism for directed migration during chemotaxis based on adaptation of the variance of blebbing. This adaptation is shown to be robust and is insensitive to perturbation within a wide range of parameters.