Crawling cell migration controlled by mechanical interaction with substratum

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Abstract

Living cells are constantly subjected to various mechanical stimulations, such as shear flow, osmotic pressure, and hardness of substratum. They must sense the mechanical aspects of their environment and respond appropriately for proper cell function. It seems that the cells adhering to substrata receive mechanical stimuli mainly from substrata in physiological conditions and decide their migration-properties.

Migrating cells generate “traction forces” at contact sites between the cell bottom and the substratum; concurrently, the cells experience reaction forces from the substratum. If the reaction force acts as a signal to regulate cell function, then cells might generate migration polarity by utilizing this force, even in the absence of exogenous signals. We found that on an anisotropic substratum, wild-type *Dictyostelium* cells migrated in the ‘soft’ direction to which they exert small traction forces, although myosin II-null cells migrated randomly. To mimic the reaction force from the substratum, cyclic stretching-recovery of substratum (CSS) is one of the most appropriate techniques. In response to CSS, *Dictyostelium* cells accumulated myosin II at the both stretching sides and migrated perpendicular to the direction of CSS, suggesting that *Dictyostelium* cells generate migration polarity in the direction of small traction/reaction forces via myosin II dependent process.

If this polarity generation of *Dictyostelium* cells in response to the force from the substrata is not limited to *Dictyostelium* cells but common for the other cell-types, the importance of this mechanosensing reaction will much increase. Thus, we applied CSS to the other fast crawling cells, neutrophil-like differentiated HL-60 cells. They also accumulated myosin II at the both stretching sides and migrated perpendicular to the direction of CSS as was the case of *Dictyostelium* cells, indicating that the polarity generation mechanism by mechanical interaction with the substratum should be common to fast crawling cell-types.

Keywords: *Dictyostelium*, HL-60, neutrophil, mechanosensing, traction forces