Modeling of epithelial sheet deformation under external force applied by a migrating cell

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Mechanics of living cells and tissues play a central role in many phenomena, from morphogenesis to cell migration [1][2]. One prominent example is the epithelia – a sheet of cells tightly attached to one another[3]. In the *Drosophila* embryo, immune cells migrate along the inner (basal) side of an epithelial layer during their invasion into the germband [4] and during this process exert a force on the epithelial sheet that deforms it. The mechanical properties of epithelial cells, in particular, surface tension and stiffness influence deformability of the sheet and, thus, the speed of migrating cells. Computational models can help to dissect how the tissue mechanics emerges from mechanical properties of individual cells.

We constructed a finite-element model of an epithelial sheet using COMSOL Multiphysics software. The cell cortex, modeled as an elastic shell, is divided into 3 domains with distinct properties (apical, lateral and basal)[3]. Force exerted by a migrating cell is applied to examine apparent stress-strain behavior of the sheet. Our model shows that similar shifts in tension of the different cortex domains distinctly affect sheet deformability, with the highest contribution from the basal domain. This study contributes to understanding how a mutual mechanical balance is achieved in tissues to allow for robust mechanical events, such as cell translocation[5].

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