A cellular Potts model of germband retraction and dorsal closure

M. SHANE HUTSON, JASON ROHNER, SARAH CREWS, W. TYLER McCLEERY, W. BRADLEY ROBINSON, Vanderbilt University — Germband retraction and dorsal closure are critical morphogenetic events in fruit fly embryogenesis. Both involve the coordinated reshaping of two epitheloid tissues—germband (GB) and amnioserosa (AS). The GB is initially curled into a U-shape with the AS between the arms of the U. Retraction leaves the embryo’s dorsal surface covered by AS cells which then contract to pull lateral parts of the GB up to cover the dorsal surface. We have simulated these events using a cellular Potts model. The model is 3D with several generalized cell types: a central yolk; a surrounding monolayer of AS and GB cells with epithelial polarization; and an outer vitelline membrane enclosing the cells and a perivitelline fluid. The model also incorporates several critical cell behaviors: polarized apical constriction of AS cells; controlled relaxation of stretched GB cells; and differentiation of GB cells at the GB-AS interface so that these cells then contract a supracellular purse-string and extend filopodia that reach across the AS and zip together the GB’s approaching lateral flanks. We will discuss how all of these components are necessary to reproduce normal tissue motions and those observed during laser microsurgery experiments.

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