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Modeling the Epithelial Morphogenesis of Germ Band Retraction in Three Dimensions W. TYLER MCCLEERY, Vanderbilt Univ., JIM VELDHUIS, G. WAYNE BRODLAND, Univ. of Waterloo, SARAH M. CREWS, M. SHANE HUTSON, Vanderbilt Univ. — Embryogenesis of higher-order organisms is driven by an intricate coordination of cellular mechanics. Mechanical analysis of certain developmental events, e.g., dorsal closure in the fruit fly D. melanogaster, has been sufficiently described using two-dimensional models. Here, we present a three-dimensional modeling technique to investigate germ band retraction (GBR) – a whole-embryo, irreducibly 3D morphogenetic event. At the start of GBR, the epithelial tissue known as the germ band is initially wrapped around the posterior end of an ellipsoidal fly embryo. This tissue then retracts as an adjacent epithelial tissue, the amnioserosa, simultaneously contracts. We hypothesize that proper GBR requires maintenance of cell-cell connectivity in the amnioserosa, as well as both cell and tissue topology on the embryo's ellipsoidal surface. The exact interfacial tensions are less important. We test the dynamic interactions between these two tissues on a 3D ellipsoidal last. To speed simulation run times and focus on the relevant tissues, epithelial cells are defined as polygons constrained to lie on the surface of the ellipsoidal last. These cells have adjustable parameters such as edge tensions and cell pressures. Tissue movements are simulated by balancing these dynamic cell-level forces with viscous resistance and allowing cells to exchange neighbors. This modeling approach helps elucidate the multicellular stress fields in normal and aberrant development, providing deeper insight into the mechanical interdependence of developing tissues.

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