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A positional code and anisotropic forces control tissue remodeling in Drosophila

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A major challenge in developmental biology is to understand how tissue-scale changes in organism structure arise from events that occur on a cellular and molecular level. We are using cell biological, biophysical, and quantitative live-embryo imaging approaches to understand how genes encode the forces that shape tissues, and to identify the mechanisms that modulate cell behavior in response to local forces. In many animals, the elongated head-to-tail body axis is achieved by rapid and coordinated movements of hundreds of cells. We found that in the fruit fly, these cell movements are regulated by subcellular asymmetries in the localization of proteins that generate contractile and adhesive forces between cells. Asymmetries in the force-generating machinery are in turn controlled by a positional code of spatial information provided by an ancient family of Toll-related receptors that are widely used for pathogen recognition by the innate immune system. I will describe how this spatial system systematically orients local cell movements and collective rosette-like clusters in the Drosophila embryo. Rosettes have now also been shown to shape the body axis in chicks, frogs, and mice, demonstrating that rosette behaviors are a general mechanism linking cellular asymmetry to tissue reorganization.