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From Global Stresses to Local Cell Packing During Development[1]

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To perform their functions, cells in epithelial tissues must often adopt highly regular packings. It is still not fully understood how these ordered arrangements of cells arise from disordered, proliferative epithelia during development. I will use experimental and theoretical studies on an attractive model system, the cone cell mosaic in fish retina, to illustrate some ways that mechanical forces and cell signaling can interact to produce this transformation. Experiments examining the response to surgical lesions suggest that the correct mechanical environment at the tissue scale is essential to induce cone cells to rearrange into a rectangular lattice. Starting from this observation, I will argue that large-scale mechanical stresses naturally couple to and orient cell polarization and that this coupling can lead cells to line up in regular rows, as observed in the fish retina. This model predicts that cells in the rows will adopt characteristic trapezoidal shapes and that fragments of rows will persist even in tissue where the mosaic pattern is disrupted by lesions; these predictions are borne out by an analysis of cell packings at the level of the zonula occludens in wildtype and lesioned retinas.

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