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Interface mechanics explains cell shapes in the *Drosophila* retina

SASCHA HILGENFELDT, ESAM and Mechanical Engineering, Northwestern University, SINEM ERISKEN, Biomedical Engineering, Northwestern University, RICHARD CARTHEW, BMBCB, Northwestern University — When biological cells form a functional tissue, their membranes adhere to each other via adhesion molecules such as cadherins. It has long been conjectured that adhesion strength and distribution of cadherins determines cell segregation and overall organization in epithelial and other tissues. For the first time, we combine cadherin adhesion with a rigorous model of cell mechanics to obtain a physical model for a cell membrane energy functional, predicting cell shapes in quantitative detail. This theory is tested using experimental results describing the extraordinarily well-defined geometry of cell clusters in the *Drosophila* eye [1]. We show that a model using no more than two physically motivated parameters identifies the adhesion strengths of both E- and N-cadherins, reproduces the wild-type geometry to a few percent of accuracy, and is also consistent with the shapes of various mutants. Beyond comparison of membrane lengths and angles, Surface Evolver simulations achieve realistic modeling of the entire shape of the cell clusters. The *Drosophila* retina is thus identified as a biological system dominated by surface energy terms only, amenable to a surprisingly simple description by thermodynamics and continuum mechanics. [1] T. Hayashi & R. W. Carthew, *Nature* **431**, 647 (2004)

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