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MODELS OF SIMPLE CELL AGGREGATES

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En-face cross-section of simple biological tissues such as planar epithelia resembles polygons that tile the plane. We show that the structure of such tissues can be explained by an equilibrium model where energy degenerate polygons in an entropy-maximizing tiling are described by a single geometric parameter reduced area a measuring their roundedness [1]. Tilings found numerically are in good agreement with experimental patterns observed in Drosophila, Hydra, and Xenopus. The geometric constraint demanding that polygonal cells must tile the plane without gaps or overlaps prevails over other mechanisms that mold a tiling, suggesting that there may be a universal mechanism that controls its structure. To explore this idea, we extend our analysis to other biological tissues as well as geological formations, supermagnetic froths, soap foams, and patterns seen in tabletop experiments. We characterize the tilings by their distributions of polygon reduced area and show that the structure of a random two-dimensional cellular partition, encoded by the frequencies of polygon classes, can be parametrized by its median reduced area alone.

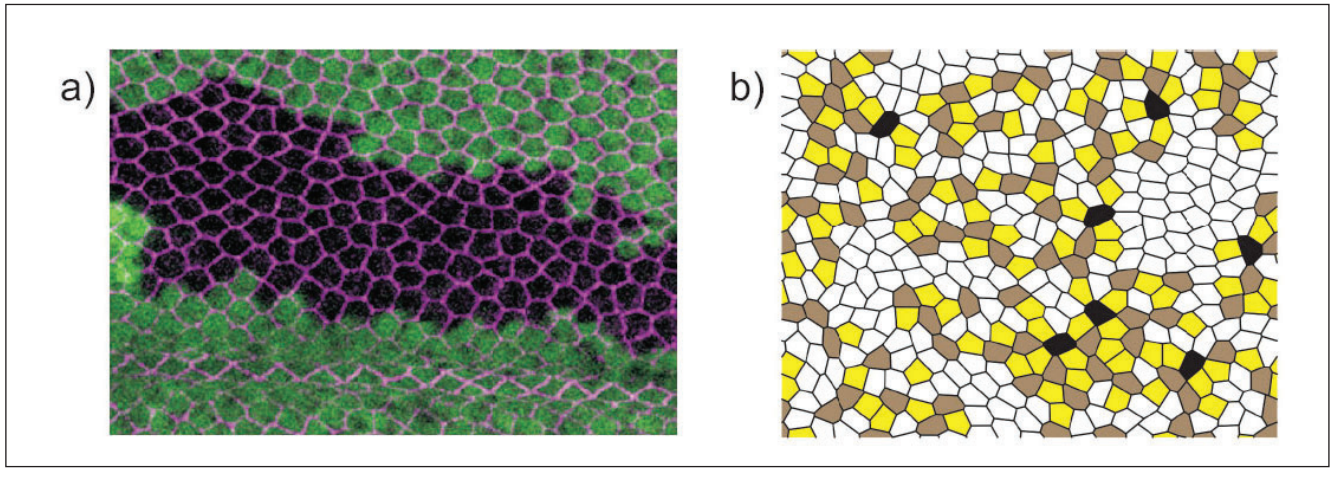

Figure 1: Panel a) illustrates a Drosophila wing epithelium [2]. A simulated tiling at reduced area a = 0.82 is shown in panel b). Different colors represent different polygon classes

References

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