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A theoretical framework for jamming in confluent biological tissues

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For important biological functions such as wound healing, embryonic development, and cancer tumorogenesis, cells must initially rearrange and move over relatively large distances, like a liquid. Subsequently, these same tissues must undergo buckling and support shear stresses, like a solid. Our work suggests that biological tissues can accommodate these disparate requirements because the tissues are close to glass or jamming transition. While recent self propelled particle models generically predict a glass/jamming transition that is driven by packing density φ and happens at some critical φc less than unity, many biological tissues that are confluent with no gaps between cells appear to undergo a jamming transition at a constant density (φ =1). I will discuss a new theoretical framework for predicting energy barriers and rates of cell migration in 2D tissue monolayers, and show that this model predicts a novel type of rigidity transition, which takes place at constant φ =1 and depends only on single cell properties such as cell-cell adhesion, cortical tension and cell elasticity. This model additionally predicts that an experimentally observable parameter, the ratio between a cell's perimeter and the square root of its cross-sectional area, attains a specific, critical value at the jamming transition. We show that this prediction is precisely realized in primary epithelial cultures from human patients, with implications for asthma pathology.