Viscoelastic instabilities and tissue development

Abstract

Cell-generated mechanical forces drive many of the tissue movements and rearrangements that are required to transform simple populations of cells into the complex three-dimensional geometries of mature organs. However, mechanical forces do not need to arise from active cellular movements. Here, I will describe recent studies that have illuminated the roles of passive mechanical forces resulting from mechanical instabilities between epithelial tissues and their surroundings. These mechanical instabilities cause essentially one-dimensional epithelial tubes and two-dimensional epithelial sheets to buckle or wrinkle into complex topologies containing loops, folds, and undulations in organs as diverse as the brain, the intestine, and the lung. Our work, combined with that of other groups, suggests a new class of tissue development - buckling or wrinkling morphogenesis - and that this morphogenetic mechanism may be broadly responsible for sculpting organ form. Harnassing these mechanical instabilities represents an intriguing strategy for engineering organs ex vivo.