Emergence of elasticity in adherent cells

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All adherent cell types actively exert forces to their substrates, as demonstrated by traction force microscopy [1]. On the molecular scale, forces are generated and propagated by supramolecular complexes with typical turnover times of seconds. On larger length scales, these molecular processes are expected to lead to viscoelastic behaviour, as observed for e.g. lamellipodia or the actin cortex. In the context of mature adhesion, however, cells build systems of contractile bundles that can maintain high forces in a seemingly static and elastic manner [2]. Experimentally, the mechanics and stabiliy of these systems can be challenged by e.g. laser cutting [3] or optogenetic activation of contractiliy [4]. In both cases, data analysis based on mathematical models provides strong evidence for an effectively elastic behaviour of cell mechanics. Strikingly, this elastic behaviour can be switched to viscoelastic behaviour by blocking the repair protein zyxin [4], suggesting that continuous repair is required to keep the system effectively elastic. The importance of elastic effects can also be demonstrated in a non-invasive manner by analyzing cell shape in 3D-scaffolds with a mathematical model [5]. This suggests that cells use elastic effects to generate higher forces than would be possible by contractility alone.

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