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Mechanics and Stability of Healthy and Cancerous Tissues

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We study the stability of the interface between a multilayered epithelium and its adjacent stroma. Treating the epithelium as a viscous fluid with cell division, we find a novel hydrodynamic instability that leads to the formation of fingering protrusions of the epithelium into the stroma [1]. Coupling cell division in the epithelium to the local concentration of nutrients diffusing from the stroma enhances the instability by a mechanism similar to that of the Mullins-Sekerka instability in single-diffusion processes of crystal growth [2]. This instability provides physical insight into a potential mechanism by which interfaces between epithelia and stroma undulate, and potentially by which tissue dysplasia leads to cancerous invasion. Later in the process of cancerous invasion, mechanics may also play an important part. We have recently proposed that one aspect of homeostasis is the regulation of tissues to preferred pressures, which can lead to a competition for space of purely mechanical origin and be an underlying mechanism for tumor growth. Surface and bulk contributions to growth lead to the existence of a critical size that must be overcome by metastases to nucleate macroscopic secondary tumors [3]. This property qualitatively explains the observed size distributions of metastases. Following these ideas, the influence of an externally applied osmotic stress on the long-term growth of cellular spheroids has been experimentally demonstrated [4].

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