A theoretical model for tissue growth in confined geometries

Abstract

It is known that cells proliferate and produce extracellular matrix in response to biochemical and mechanical stimuli. Constitutive models considering these phenomena are needed to quantitatively describe the process of tissue growth in the context of tissue engineering and regenerative medicine. In this paper we re-examine the theoretical framework provided by Ambrosi and Guana (2007) and Ambrosi and Guillou (2007). We show how a volumetric growth rate term can be obtained (both in a large and small strain setting), which is consistent with the laws of thermodynamics and then apply the model to a simple geometry of tissue growth within a circular pore. The model, despite its simplicity, is comparable with experimental measurements of tissue growth and highlights the contribution of the mechanical stresses produced during tissue growth on the growth rate itself.

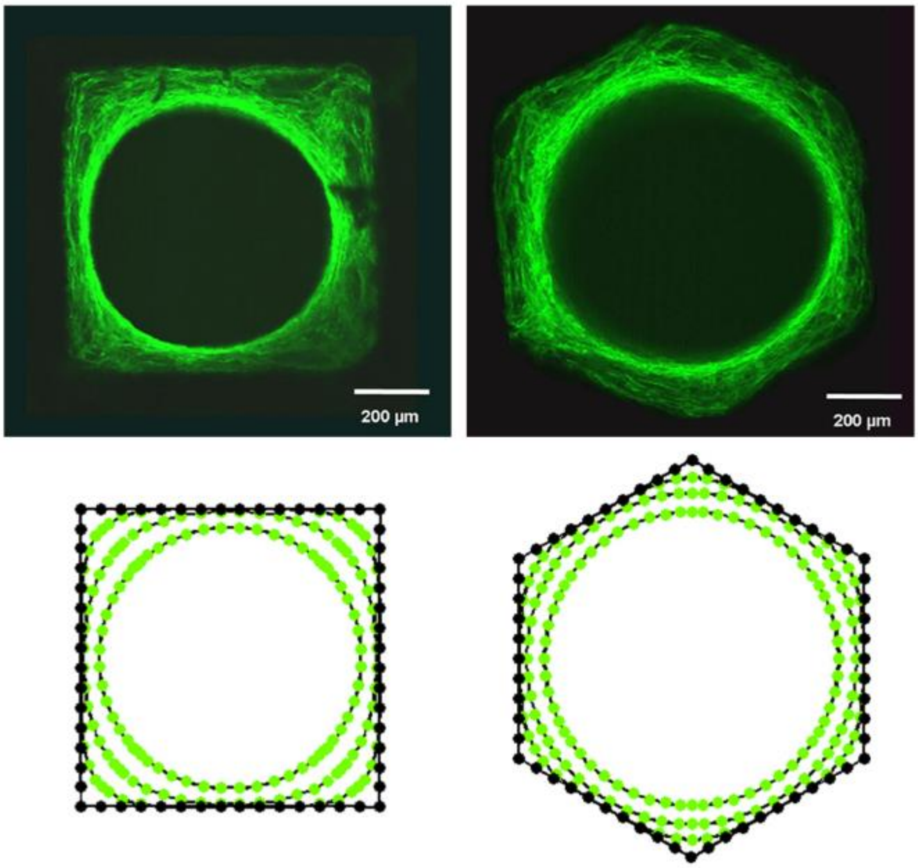

Fig. 1. After Rumpler et al. (2008), tissue imaged by actin staining (upper row) and tissue growth described by a simple model (growth-rate proportional to local curvature of the surface) (lower row).