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The role of mechanics in growing tissues

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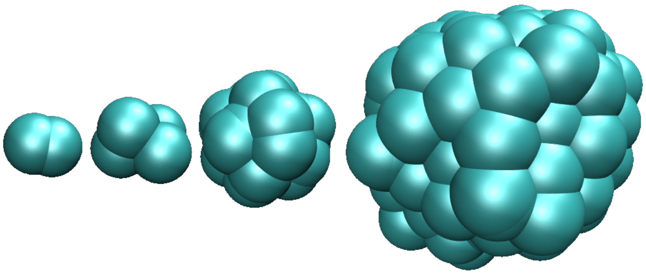
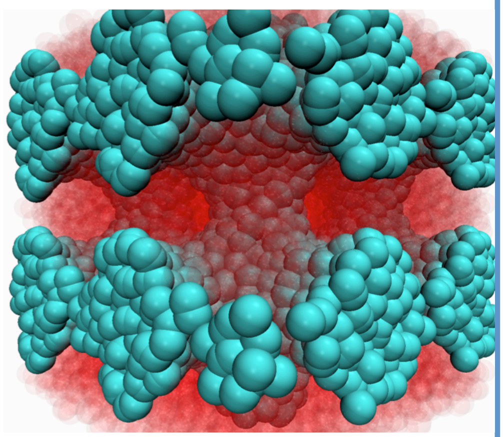


Growth implies a change in volume. In physical terms, the conjugate force to a change in volume is a pressure. Thus, in order to grow, cells must exert mechanical pressure on the neighboring tissue. In many cases – from folding of the brain to vilification of the gut – it has been speculated that it is these growth force that leads to the characteristic patterns observed.

In turn, mechanical stress influences growth, and may play a role in cell competition. This insight has led to the notion of homeostatic pressure – the pressure exerted by a tissue in homeostasis [1]. Indeed, experiments on the growth of a cancer cell line display a reduction in proliferation due to mechanical pressure [2,3,4]. This effect leads to a mechanical contribution when tissues compete for space. The tissue with higher homeostatic pressure, i.e. the pressure at which cell division and death balance, overwhelms the weaker one [1,3-6]. We use particle based computer simulations [5] to model growing tissues. In this minimal modeling approach, capturing the individual cell dynamics is of lesser importance. Instead, the goal is to attain the right meso- to macroscopic dynamics of the tissue, and extract generic properties arising from simple assumptions. I will present several examples of how this model helped to gain insight in mechanical processes underlying tissue growth, ranging from growth of cancer spheroids under pressure, to in silico competition experiments.



Coexsitence in competing tissues: Interfacial growth stabilizes a bicontinous phase

[1] Basan et al., 2009, HFSP 3, 265
[2] Montel et al., 2011, PRL 107, 188102
[3] Delanrue et al., 2013, PRL110, 138103
[4] Podewitz et al., 2016, EPL 109, 58005
[5] Basan et al, 2011., Phys. Biol. 8, 026014
[6] Podewitz et al., 2016 New J. Physics 18, 083020
[7] Ganai *et al* 2019 *New J. Phys.* **21** 063017