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Cell competition in a hybrid mechanochemical model

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Mechanics-based models for cellular tissues often assume that cell growth and division directly depend on physical variables such as pressure. However, biologists understand these processes as being organized by the cell cycle. While both approaches have had successes, they have so far not been properly unified. In a first step, we developed a hybrid model for tissue growth that combines a regulatory cell cycle with a physical model. We studied this model in particle-based simulations and continuum analysis, investigating the expansion of non-motile colonies in quasi-1D channels and on 2D substrates. The model reproduces a range of experimental observations, including faithful pressure, volume and speed regulation. We then studied the competition of two colonies with different rates of programmed cell death (apoptosis) rates and characteristic cell-cycle control pressures. Synchronisation of cell division/apoptosis events can emerge, causing oscillations in cell number, pressure and cell-cycle activity.

References: Li J, Schnyder SK, Turner MS, Yamamoto R, PRX (2021) & PRR (2022).