## Oscillations and waves in populations of cells which tend to homeostasis

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To achieve homeostasis, i.e. maintain a uniform and constant density in a whole organ, living cells need to balance cell death with cell proliferation in an active and relatively controlled way. If they proliferate too much, they can leed to a tumour, then cancer. If they don't proliferate enough, at the right place and at the right time, the function of the tissue will be impaired and the organ will be defective. Therefore, cell proliferation must exactly compensate, in the long term, cell death or cell loss, while responding as quickly as possible to disturbances like (relatively small) injuries.

In the case of oligodendrocyte precursor cells (OPC), which build up the most abundant proliferating cell population in the adult brain and are believed to trigger some of the brain tumours, it has recently been showed experimentally that homeostatis is achieved through several phenomena including induction of cell death in regions where cells are too dense and induction of cell prolieferations in the boundaries of regions where cells have been lost. In some circumstances, this can lead to detectable oscillations in the local density of cells.

We model quantitatively these phenomena in an ideal population of identical cells thanks to a cellular automaton, both in discrete and continuous space, in 2D and in 3D. In the case of almost uniform conditions, we observe oscillations of the cell number during relaxation to homeostasis. Using a simple mean-field like analytical approach, we are able to reproduce these collective oscillations and understand how their features (notably their period) are related to parameters of the cells' individual behaviour.

In the case of non-uniform conditions, we observe intriguing phenomena such as propagating waves, spiral waves, large transient oscillations, and even population extinction. They depend sometimes in counter-intuitive ways on parameters like the rate of proliferation and the rate of apoptosis. We verify that they are robust against changes of dimensionality or even space structure (lattice or free space). This shows that achieving homeostasis is not a straightforward task.

[l] E.G. Hughes, et al., Nat. Neurosci. **16**, 668 (2013).

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[3] G. Ascolani, et al., Phys. Rev. E **87**, 012702 (2013).