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On the growths laws of cell sheets

Some of our experiments on the growth dynamics of circular cell sheets show that the radius $R(t)$ of the sheet increases linearly with time, which means that the area $A(t)$ of the sheet and - if the thickness remains constant - also the number $n(t)$ of cells increase quadratically with time.

Let us assume that the effective rate with which the number of cells grows is a (possibly frational) power of the cell number already present :

$$\frac{d}{dt}\,n = r_{eff}(t) \propto n^b.$$

The case $b = 1$ would correspond to an exponential increase of cell number with time, which would mean that all cells continue to divide at a fixed rate, independent from their position within the sheet. This is not what we observe.

In the cases $b \in [0, 1[$, the solution would be $n(t) \propto t^{\frac{1}{1-b}}$. In order to get the experimentally observed $n(t) \propto t^2$, the exponent in the growth law must be $b = 1/2$. So, when the effective growth rate is

$$r_{eff}(t) \propto n^{1/2} \propto A^{1/2} \propto 2\pi R(t),$$

this could mean that only the cells in a thin layer at the circumference of the sheet contribute to the proliferation, perhaps because this is the only place in the sheet where direct contact to the underlying substrate is possible - a hypothesis that can be tested.

For a short history of tumor growth models in 3D and the similar ideas in that domain of science see *The model muddle: in search of tumour growth laws*.

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