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A multi-scale analysis of the influence of hormonal cross-talk: cell-fate determination in *Arabidopsis thaliana* root development

Root growth and development in *Arabidopsis thaliana* are sustained by a specialised zone termed the meristem, which contains a population of dividing and differentiating cells that is functionally analogous to a stem cell niche in animals. The size of the meristem is regulated by the balance between cell division and cell differentiation, and this balance is controlled antagonistically by the hormones auxin and cytokinin. Local accumulation of auxin promotes cell division, whereas high cytokinin concentrations promote differentiation. The cross-talk between these two hormones is controlled by a genetic regulatory network.

As a first step of our analysis, we propose and compare with experimental observations a single-cell, deterministic mathematical model of this regulatory mechanism. We show that, although genetic mutations can reproduce qualitatively the effects of varying auxin and cytokinin supply on their response genes, the general response of the network is different and an analysis based on the ratio between these two hormones may be misleading.

Recently, gibberellin has been shown to be relevant in determining the adult size of the meristem by interacting with auxin and cytokinin. We propose a multi-scale model of this interaction and we validate the results of our simulations with experimental data. We conclude that a multi-scale investigation can provide insight into the signalling network controlling meristematic activity, by enabling the study

of the dynamical response of the network in different tissues and the identification of potential missing components.