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# Plant root system patterning across scales; The importance of growth

To find new water and nutrient resources, the root system of plants has to continuously grow and expand. Importantly, due to the encasing of plant cells in cell walls, no cell migration occurs. As a consequence, stem cell niches of individual roots come to ly further and further away from the hormone and nutrient sources necessary for their maintenance and growth, making the coordination of overall root tip growth with new vasculature formation of critical importance. Additionally the absence of cell migration implies that formation of new organs, i.e. lateral roots, requires the de novo formation of new stem cell niches at the appropriate locations. I will discuss how we have used computational modeling to unravel the multi-scale feedbacks between cell-level gene regulation, and tissue-level auxin transport and growth processes in root system patterning.

In case of vascular strand patterning, intriguingly, similar, seemingly random discontinuous defects in strand differentiation occur both for mutants slowing down and mutants speeding up vascular auxin transport. Using modeling, we reveal the non-random nature of these defects. Additionally, we show that both mutants, by abolishing auxin transport homeostasis, render cells vulnerable to a bistability generated by the auxin dependence of an auxin importer, explaining the intermittent failure of differentiation in both cases. Finally, we demonstrate an important role for growth processes.

Oscillations in auxin levels have been shown to spatio-temporally prepattern the sites competent for future lateral root formation. Both Turing patterns and genetic oscillators have been proposed as mechanisms for these oscillations. So far no proof for either mechanism has been reported. Instead, again, our modeling points to a critical role for growth processes combined with auxin transport in generating these oscillations.