
# Postdoc Innovation seminar

## *ABSTRACT*

*"Modelling hormone-regulated plant root growth"*

**Dr Leah R Band**

**Centre for Plant Integrative Biology**
**School of Biosciences and School of Mathematical Sciences**
**University of Nottingham**
**Loughborough**
**Leicestershire**
**UNITED KINGDOM**

Mathematical modelling can be a powerful tool to improve our mechanistic understanding of plant growth. In this talk, I shall describe two recently developed models that investigate hormone regulation within the Arabidopsis root: the first example considers how gibberellin controls root elongation and the second investigates how auxin regulates root gravitropism.

In the first example, I focus on growth within the root elongation zone, where cells undergo rapid elongation, increasing their length by approximately 10-fold over 5h while maintaining a constant radius. Although progress is being made in understanding how this growth is regulated, little consideration has been given as to how cell elongation affects the distribution of the key regulating hormones. By developing a multiscale mathematical model and analysing the cell growth dynamics, we investigate the distribution of the hormone gibberellin. The model quantifies how rapid cell expansion causes gibberellin to dilute, creating a significant gradient in gibberellin levels. By incorporating the gibberellin signalling network, we simulate how gibberellin dilution affects the downstream components, including the growth-repressing DELLA proteins. Considering wild-type, chemically treated and genetically modified plants, we analyse how the gibberellin and DELLA dynamics relate to the observed growth dynamics and gain understanding of the different root phenotypes.

In the second example, I investigate the auxin dynamics at the root tip using mathematical models in conjunction with the new auxin sensor, DII-VENUS. DII-VENUS is rapidly degraded by auxin via a network of interactions; developing a parameterized model of this network enables us to use DII-VENUS to quantify auxin distributions and dynamics. We first consider auxin redistribution after a 90º gravitropic stimulus. Our quantitative approach reveals that (i) auxin is rapidly redistributed to the lower side of the root within minutes of the gravity stimulus and (ii) auxin asymmetry is rapidly lost as bending root tips reached an angle of 40º. We hypothesise that roots use a 'tipping point' mechanism that operates to reverse the asymmetric auxin flow at the midpoint of root bending. Using our parameterised DII-VENUS network model, we also investigate the auxin distribution at the root tip by developing a multi-cellular model of auxin transport and DII-VENUS degradation. Analysing confocal images using the CellSet segmentation software enables us to quantify the differences between the predicted and observed DII-VENUS distributions, providing insights into the role of the auxin transporters during a gravitropic response.