***GETTING to the ROOT OF SYMBIOTIC ROOT NODULE DEVELOPMENT***

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Legumes grow specialized root nodules to host beneficial nitrogen-fixing bacteria that provide the plant with ammonia in exchange for carbon. These symbiotic nodules are distinct from lateral roots in morphology and function as they comprise of cells that can accommodate nitrogen-fixing rhizobial bacteria intracellularly and provide favorable conditions for the biological nitrogen fixation process.

Nodules initiate from the inner tissue layers in response to the perception of rhizobial bacteria at the root surface via cytokinin-mediated upregulation of the nodulation-specific transcriptional regulator *NODULE INCEPTION (NIN)*. Our previous findings that the initiation of lateral roots and nodules converges at a common developmental program [1] led to the hypothesis that an additional nodule-specific program is required to determine nodule organ identity on top of the shared root-like initiation program.

Recently, we have shown that two members of the *LIGHT SENSITIVE SHORT HYPOCOTYL (LSH)* transcription factor family (*MtLSH1* and *MtLSH2*), predominantly known to define organ boundaries and meristem complexity in the shoot, function as regulators of nodule organ identity [2]. *MtLSH1*/2 are upregulated during early stages of nodule development in a cytokinin- and *NIN*-dependent manner and are expressed in dividing cells. Our loss of function analysis of *lsh1/2* demonstrated that these regulators are required for the development of functional nodule primordia that can support the intercellular cortical infection, the intracellular colonization, and nitrogen-fixation by the bacteria.

Furthermore, molecular functional analysis revealed that *LSH1/2* control components of the auxin-cytokinin cross talkand function upstream of and together with the previously identified nodule organ identity genes nuclear factor *Y*-*A1* (*NF-YA1)* and *NODULE ROOT1/2 (NOOT1/2)* to recruit a program with pleiotropic functions in the shoot to differentiate nodules from lateral roots and to determine nodule organ identity. The principal outcome of *LSH1/LSH2* function is the production of cells able to accommodate nitrogen-fixing bacteria, the unique nodule feature.

These findings provide a framework at molecular and cellular level to investigate how the coordinate recruitment of pre-existing organ development and identity programs can underpin the morphological and functional divergence between lateral roots and nodules, in parallel to a root initiation program.

**REFERENCES:** [1] Schiessl et al., Curr Biol (2019). [2] Lee, Orvosova et al., Curr Biol (2024).