The molecular regulation of stem cell quiescence in plant meristems

Ali Eljebbawi[A], Vivien I. Strotmann[A], Anika Dolata[A], Rebecca Burkart[A], Milena Twartz[A], Leonie Brüne[A], Yvonne Stahl[A,B]

[A] Institute for Developmental Genetics, Heinrich-Heine University, Düsseldorf, Germany

[B] Cluster of Excellence on Plant Sciences (CEPLAS), Heinrich-Heine University, Düsseldorf, Germany

Program theme: Cell and Vascular Physiology

Oral

Abstract

Higher plants have developed remarkable plasticity, generating new organs throughout their lifespan via pluripotent stem cells in meristems. Maintenance and homeostasis of the stem cell niche (SCN) in Arabidopsis roots are essential for growth and development of all root cell types, regulated by feedback signaling involving key transcription factors, phytohormones, peptide ligands, and receptors. However, the tight and dynamic regulation of the transition from stem cell fate to differentiation remains largely elusive.

The root SCN centers around a quiescent center (QC) maintaining stemness. Transcription factors WUSCHEL-RELATED HOMEOBOX 5 (WOX5) and PLETHORAs (PLTs) expressed in the SCN maintain the QC and regulate distal columella stem cell (CSC) fate. We found that both WOX5 and PLTs are crucial for root meristem maintenance, coordinating QC quiescence and CSC fate. Notably, PLTs, particularly PLT3, contain intrinsically disordered prion-like domains (PrDs) necessary for complex formation with WOX5 and recruitment to nuclear bodies (NBs) in CSCs. The partitioning of PLT-WOX5 complexes to NBs, possibly via liquid-liquid phase separation, plays a pivotal role in determining CSC fate.

This novel regulatory model suggests that dynamic subnuclear localization of TF complexes integrates external cues with molecular-level stem cell regulation, shedding light on plant growth and adaptability to environmental challenges.