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"A near-death experience during phloem cell differentiation and symplastic cell-cell communication during *Arabidopsis* vascular development "

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Abstract

Long-distance transport has an essential role for maintaining the life of multicellular organisms. Phloem sieve element (SE) cells of plant vascular tissues form a cellular network specialized for carbon allocation and transport of long-distance signaling molecules such as phytohormones, RNAs, and proteins. These photoassimilates and signaling molecules are symplastically transported through the lumen of the SE cells. Adapted for effective transport, SE differentiates as highly specialized enucleated living cells with diluted cytoplasm due to degradation of most of the cell organelles. We studied the underlying cellular remodeling mechanisms during SE differentiation. By advanced imaging of SE morphogenesis, we uncover that SE differentiation involves a novel mechanism of nucleus removal in which the nuclear contents are released and degraded in the cytoplasm and the enucleation process correlates with organelle clustering and dilution events in the cytoplasm. The enucleation and the related cytoplasmic events are specifically orchestrated by the genetically redundant transcription factors NAC45 and NAC86, downstream of APL. Among the NAC45/86 targets, a novel gene family encoding putative nuclease proteins required for priming the process of nuclear degradation. The novel enucleation mechanism underlying SE differentiation highlights the role of diversity in autolysis for establishing functionally specialized eukaryotic cells.

Since plants lack cell migration, cell identity during development mainly relies on the molecular cues received based on their relative position in developing tissues. In phloem, extensive symplastic communication occurs between SE and companion cells. In *Arabidopsis* roots a reciprocal bi-directional signaling involving inter-cellular mobility of SHORT ROOT (SHR) protein and *miRNA165/165* establishes an opposite concentration gradient of *miRNA 165/166* and their target gene *PHABULOSA* (*PHB*) that functions in dose-dependent manner. Recently, we have demonstrated that SHR and *miR165/166* moves through plant-specific nanochannels, called plasmodesmata (PD) and level of callose at PD controls molecular trafficking through PD by affecting its size exclusion limits. Furthermore, through suppressor screen, we have identified a novel sphingolipid synthase associated with PD. Thus, we propose that a specialized-membrane microdomain (membrane raft) comprising of callose, sphingolipids and PD-localized proteins are associated with PD and control PD-mediated symplastic molecular trafficking.