IN BRIEF

Sticking the Landing: Probing the Roles of LORELEI in Pollen Tube Reception

A tiny, dry ball comprising two sperm cells and a vegetative cell protected by a tough layer of sporopollenin (otherwise known as a pollen grain) lands on a stigma. Upon hydration, the vegetative cell gives rise to a pollen tube, which travels through the style to the micropyle, a minute opening in the ovule. Given the proper signals from the synergids in the waiting embryo sac, the pollen tube initiates double fertilization. During this process, the synergids facilitate pollen tube burst (to release the two sperm cells), as well as the fusion of one sperm cell with the egg cell and one with the central cell to form the embryo and endosperm, respectively. The filiform apparatus (FA) is an impressive group of finger-like projections at the micropylar ends of synergids that extend back into the synergid cytoplasm. The FA increases the area of contact between the synergids and pollen tube to facilitate the release of a suite of signaling peptides, which we are only beginning to identify (Qu et al., 2015). One such peptide, LORELEI (LRE), appears to function in pollen tube reception at the FA together with FERONIA (FER), a receptor-like kinase that it chaperones from the endoplasmic reticulum (ER) (Li et al., 2015), although the precise mechanisms are unclear. LRE might also play a separate role at the synergid surface.

Through clever structure-function analysis of LRE in Arabidopsis thaliana, Liu et al. (2016) obtained experimental evidence for the roles of LRE in the synergid cell. Previous predictions indicated that LRE is a glycosylphosphatidylinositol (GPI)-linked protein. These ubiquitous eukaryotic proteins contain a signal sequence directing them to the ER lumen. After this sequence and a hydrophobic tail are removed, a GPI anchor is linked to a specific site on the protein, allowing it to stick to the cell surface. Through sequence analysis, the authors confirmed that LRE is a GPI-anchored surface protein with a conserved eight-cysteine motif (8CM) required for structural stability, although this motif is modified (M8CM), a feature found in many plants. LRE localizes to both the FA and synergid cytoplasm, as shown using LRE fused to citrine yellow fluorescent protein (LRE-cYFP; see figure). Transformation with an LRE-cYFP construct restored seed set in lre mutants to wild-type levels and rescued transmission of the lre mutation through the female gametophyte. Deletion of putative GPI anchor addition domains affected the localization but not the functionality of LRE-cYFP. Analysis of gpi8, a mutant defective in GPI attachment, indicated that attachment of GPI to LRE helped localize LRE-cYFP to the FA. Surprisingly, this mutant showed wild-type pollen tube reception and seed set, suggesting that the GPI anchor addition domains in LRE are not required for its function. However, a modified LRE containing a typical 8CM instead of the M8CM failed to rescue lre mutant phenotypes and exhibited altered localization, indicating that the modification in M8CM is critical for LRE’s role in pollen tube reception.

The authors then supplied LRE-cYFP directly to the synergid cell surface of lre by ectopically expressing it in pollen tubes where endogenous LRE was not expressed. Even though LRE-cYFP was not delivered to the FA, it rescued the impaired female gametophyte phenotype of the mutant, indicating that LRE plays a role at the interface of the pollen tube and synergid cell independent of its intracellular role in the synergid. By contrast, such pollen harboring LRE-cYFP failed to rescue the pollen tube reception and reduced seed set defects in lre fer double mutants, indicating that both LRE and FER are required at the pollen tube/synergid cell interface to induce pollen tube reception.

Similar structure-function studies of other signaling peptides should provide further insights into the fascinating processes that occur when a pollen tube approaches its target cells in the ovule.

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REFERENCES

