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Unveiling the molecular mechanism of microautophagy in plants

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Plants are essential organisms for human life and societies not only as food but also as producers of plant-specific secondary metabolites in the industrial and medical fields. Understanding the basal survival strategy obtained in plants can contribute to increasing crop yields through the improvement of breeding and cultivation methods. Since plants cannot escape from undesired environmental change, they have developed flexible and sophisticated strategies to counteract against the stresses during evolution. Under environmental changes, plant organelles flexibly rearrange their metabolisms, morphology, and positions to adopt the change inside and outside cells.

To understand how plant survives in stress conditions, we focus on autophagy. In recent years, autophagy has received increasing attention by scientists and the general public and the reports related to autophagy are increasing rapidly. It is now clear that autophagy is involved in cellular homeostasis and various physiological phenomena. In many cases, the term “autophagy” is used to indicate macroautophagy, in which the cellular components are isolated by a lipid membrane in the cytoplasm and degraded after transported to the vacuole. On the other hand, microautophagy, in which the vacuole directly captures cytoplasmic components by protruding or invading the vacuolar membrane, has also been reported in yeast. Although microautophagy is required for maintaining various organelles and survival in nutrient depletion, research about microautophagy is not progressing compared with macroautophagy. Especially in plants, only a few publications describe microautophagy, and its molecular mechanism is unclear.

In the previous studies, we found that microautophagy is induced in plant root cells in response to carbon depletion. In addition, we established a simple observation system of microautophagy with specific-staining of the vacuolar membrane concomitant with the inhibition of degradation activity in the vacuole. This technique can accelerate the analysis of obscure microautophagy in plants.

The aim of this project is understanding the molecular mechanism of microautophagy in plants. We will clarify what genes and pathways are involved in microautophagy using mutant plants defective in candidates of microautophagy-related genes. In addition, mutant screening approach will be employed to identify novel microautophagy-related genes. Subsequent analysis at the protein, cell and plant level will allow us to gain spatiotemporal information of formation, transportation and degradation of microautophagy.

In summary, these studies will provide a detailed understanding of how microautophagy is regulated, lead to the understanding of physiological importance of microautophagy in plant life and give us a wider knowledge of strategies for using various types of autophagy.