NAIST® Research Highlights

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Plant science

Key propagation protein identified

A key protein required for embryonic development and growth in plants has been uncovered

The development of an embryonic plant from a fertilized seed follows a programmed pattern of cell divisions. This allows the differentiation of cells into specific cell types, which enables healthy growth of tissues and the correct development of the plant.

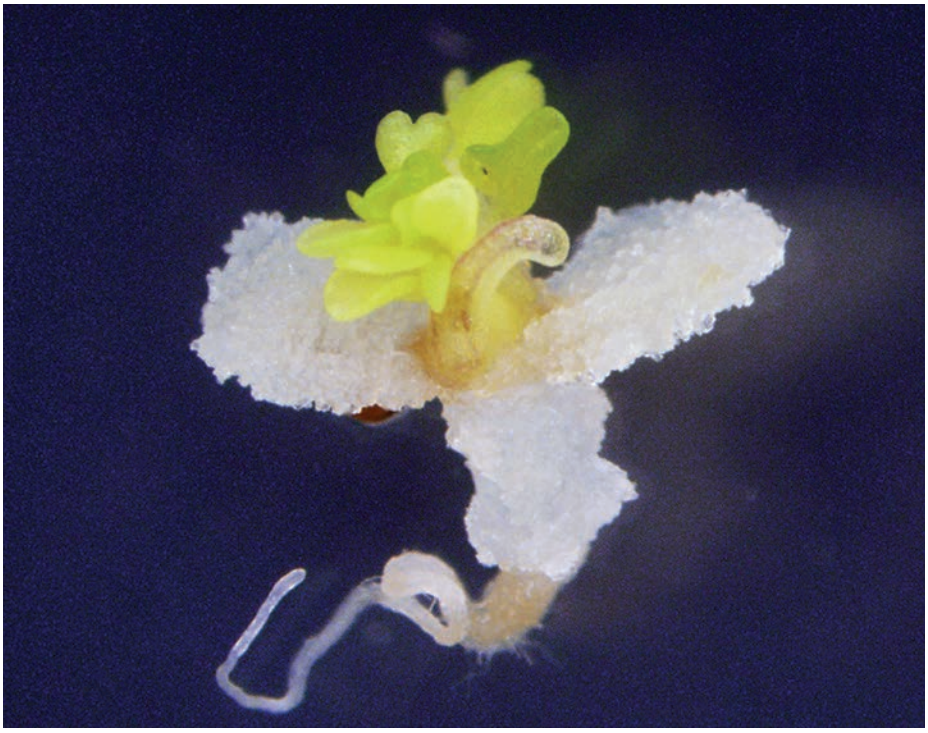
A small number of transcription factors contribute to this process, but little is known about the mechanisms and genes that control the complex organisation of cells over time in seed plants (a process known as pattern formation). NAIST researchers have uncovered the critical role of protein RKD4, and the genes that respond to it, in the early development of *Arabidopsis* plants[1].

> **"When we stopped the overexpression, we thought it might result in new shoots or root formation; instead we found embryos appearing a week later."**

"We originally began genetic screening to isolate a patterning regulator for post-embryonic roots," explains Keiji Nakajima, from the NAIST Graduate School of Biological Sciences, who worked on the study with his colleagues. "Instead, we uncovered a mechanism responsible for embryogenesis rather than root patterning. The protein RKD4 seems to be even more important than simple patterning regulators, because it can actually reprogram cells in the earliest stage of plant growth."

It took the NAIST team some time to understand what they had stumbled across, because at first they were focusing on the plant roots. It was only when Nakajima analyzed microarray data from RKD4 overexpressing plants, that they uncovered the role of RKD4.

The researchers found that RKD4 preferentially accumulates in developing seeds. Mutant strains without RKD4 showed severe germination defects — many plants simply did not grow, and those that did had truncated roots with disrupted cell structure or no roots at all.



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The protein RKD4 triggers embryogenesis in *Arabidopsis* plants: knocking out RKD4 means the plant does not develop properly, whereas overexpressing RKD4 can lead to the reprogramming of cells and the creation of new embryos (above).

However, the overexpression of RKD4 had an unexpected effect, as Nakajima explains: "We created transgenic seedlings with high levels of RKD4, which resulted in the overproliferation of young leaves and root tissues, as well as triggering the expression of early-embryo-specific genes. When we stopped the overexpression, we thought it might result in new shoots or root formation; instead we found embryos appearing a week later."

The overexpression of RKD4 essentially reprogrammed differentiated cells and gave them the potential to produce embryonic, or undifferentiated, cells. The team concluded that RKD4 is an important regulator, which primes cells to activate embryogenesis, and promotes the expression of genes required for kick-starting the correct growth and patterning of plant embryos (see figure).

The discovery may prove useful for applications such as controlling the propagation of endangered plant species. Nakajima's team is currently extending the research to investigate evolutionary processes in plants.

Reference

1. Waki, T., Hiki, T., Watanabe, R., Hashimoto, T. & Nakajima, K. The *Arabidopsis* RWP-RK protein RKD4 triggers gene expression and pattern formation in early embryogenesis. *Current Biology* **21,** 1277–1281 (2011).

More information about the group's research can be found at the Laboratory of Plant Developmental Signaling webpage:
http://bsw3.naist.jp/nakajima/English/