

## LABORATORY OF PLANT ORGAN DEVELOPMENT



Director-General  
OKADA, Kiyotaka

Assistant Professor TATEMATSU, Kiyoshi

Postdoctoral Fellows TSUCHIDA, Yuhei

IGARASHI, Hisako

URAWA, Hiroko

Visiting Scientists WADA, Takuji

TOMINAGA, Rumi

Graduate Students TOYOKURA, Koichi

IWASAKI, Akira

TAMESHIGE, Toshiaki

Technical Assistant HARA, Reiko

Secretary SAKAGAMI, Mari

Plant organs - leaves, flowers, and roots - show impressive, symmetrical shapes, based on an ordered arrangement of differentiated cells. The organs are formed from a group of undifferentiated cells located at the tip of the stem or the root. In the case of leaves, the process of organogenesis starts with the formation of a leaf primordium in the peripheral zone of the shoot apical meristem at the fixed position, following an order called phyllotaxis. Cells in the primordium then proliferate and differentiate according to three spatially fixed axes: the apical-basal axis, the lateral axis (central-marginal axis), and the adaxial-abaxial (foreside-backside) axis. In the course of proliferation and differentiation, the plant cells are believed to exchange information with neighboring or separated cells in order to regulate the organ architecture. We are trying to understand the mechanism of the information exchange between plant cells during the development of lateral organs such as leaves, sepals, petals, stamens and carpels.

### I. Genetic approach

Recent studies of *Arabidopsis* mutant show that a couple of genes are involved in the axes-dependent control of lateral organ development. The adaxial-abaxial boundary in the leaf primordium is determined by the precise expression of the adaxial marker gene, *PHABULOSA* (*PHB*), and the abaxial marker genes, *FILAMENTOUS FLOWER* (*FIL*) and *YABBY3*. We showed that *PHB* is expressed in cells of the adaxial side and separated clearly from the abaxial side-specific *FIL* gene expressing cells by action of microRNA165/166, which targeted the *PHB*, *REV*, and *PHV* messenger RNAs. Using laser microdissection techniques we also revealed that specific expression of miR165/166 genes in the abaxial side is important for the adaxial-abaxial boundary formation.

### II. Biochemical approach

We are taking another approach to studying the intercellular signaling system by analyzing small peptides as candidates for intercellular signaling ligands, which are present in the apoplastic region of the shoot apical meristem (SAM).

### III. Microsurgical approach

We are also carrying out a microsurgical approach, ablating cells localized at SAM, at the peripheral zone, and at the leaf primordium, to investigate the cell-to-cell communication systems working in the leaf development by using a novel laser-ablating microscopy with UV-laser. When we ablated cells at SAM, the plant formed a filamentous leaf which lacked the adaxial-abaxial identity (Figure 1 bottom left).

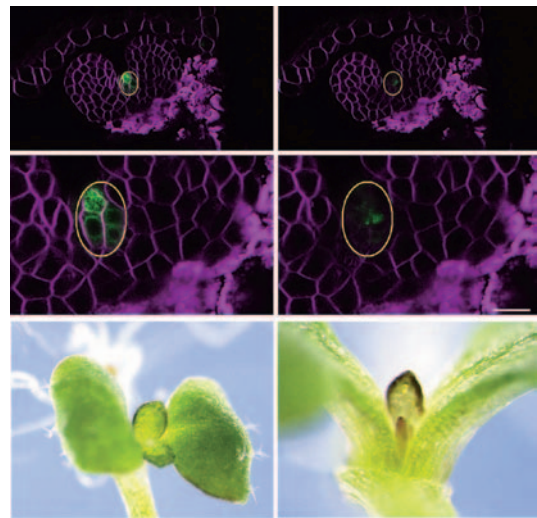


Figure 1. The disruption of cells at SAM by laser ablation system results in filamentous leaf formation. Top: Fluorescent images of SAM before (left) and after (right) the ablation. Middle: High magnification of the laser ablation point before (left) and after (right) ablation. Bottom: Leaf development of untreated control (left) and of the ablated plant (right). Laser ablated point is within the yellow circle. Scale bar: 10µm

### Publication List

#### {Original papers}

- Sakai, T., Honing, van der H., Nishioka, M., Uehara, Y., Takahashi, M., Fujisawa, N., Saji, K., Seki, M., Shinozaki, K., Jones, M., Smirnov, N., Okada, K., and Wasteneys, G. (2008). Armadillo repeat-containing kinesins and a NIMA-related kinase are required for epidermal cell morphogenesis in *Arabidopsis*. *Plant J.* 53, 157-171.
- Nagashima, A., Suzuki, G., Uehara, Y., Saji, K., Furukawa, T., Koshihara, T., Sekimoto, M., Fujioka, S., Kuroha, T., Kojima, M., Sakakibara, H., Fujisawa, N., Okada, K., and Sakai, T. (2008). Phytochromes and cryptochromes regulate the differential growth of *Arabidopsis* hypocotyls in both a PGP19-dependent and -independent manner. *Plant J.* 53, 516-529.
- Tsuchida-Mayama, T., Nakano, M., Uehara, Y., Sano, M., Fujisawa, N., Okada, K., and Sakai, T. (2008). Mapping and Characterization of the Phosphorylation Sites on the Phototropic Signal Transducer, NPH3. *Plant Sci.* 174, 626-633.
- Tominaga, R., Iwata, M., Sano, R., Okada, K., and Wada, T. (2008). *Arabidopsis* *CAPRICE-like Myb 3 (CPL3)* Controls Endoreduplication and Flowering Development in Addition to Trichome and Root-hair Formation. *Development* 135, 1335-1345.
- Shimizu, K. K., Ito, T., Ishiguro, S., and Okada, K. (2008). MAA3 (*MAGATAMA3*) helicase gene is required for female gametophyte development and pollen tube guidance in *Arabidopsis thaliana*. *Plant Cell Physiol.* 49, 1478-1483.