Identification of a plant-specific nanomachine regulating nuclear movement

September 5 2013

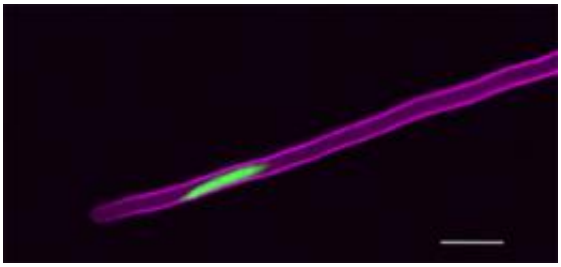

Figure 1: A nucleus (green) in Arabidopsis root hair. Cell wall is counterstained with propidium iodide (magenta). Bar = 20 μm.

A group led by Professor Ikuko Hara-Nishimura (Department of Botany, Graduate School of Science) revealed the molecular mechanism underlying nuclear movement in plants.

The cell nucleus communicates with the cytoplasm through a nucleocytoplasmic linker that maintains the shape of the nucleus and mediates its movement. In plant cells, nuclei move large distances along the actin filaments, often undergoing shape changes as they move. They move more rapidly than animal nuclei by an unknown mechanism. The group discovered that a new type of nucleocytoplasmic linker consisting of a myosin motor and nuclear membrane proteins in plants. This study was published in the online version of *Current Biology* on August 22, 2013 (US Eastern time).

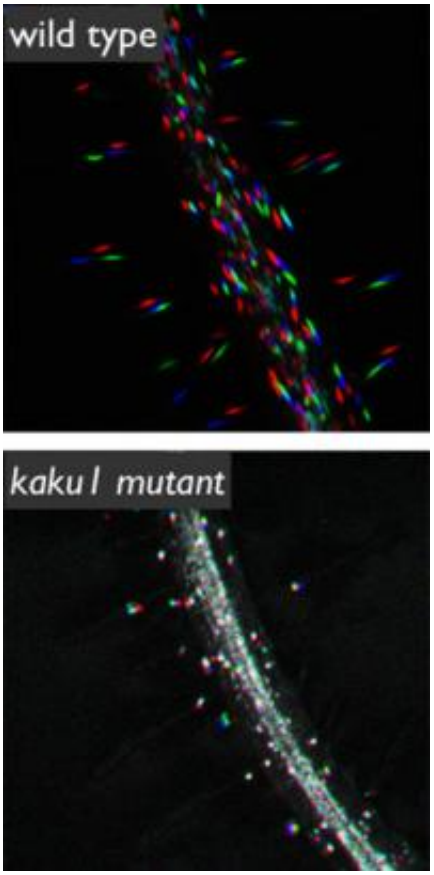

Figure 2: Nuclear movement in root of wild-type (left) and kaku1-1 mutant (right). Nuclei at 0, 22.5, and 45 min time points are stained with red, blue and green, respectively, and three images are merged.

Nucleus is the most prominent organelle and contains the cell's genetic material that directs cellular activity (Figure 1). In contrast to animal nuclei, which are moved by motor proteins (kinesins and dyneins) along the microtubule cytoskeleton, plant nuclei move rapidly and farther along an actin filament cytoskeleton. This implies that plants use a distinct nucleocytoplasmic linker for nuclear dynamics, although its molecular identity is unknown. To identify this mechanism, the group took a forward genetics approach with Arabidopsis. A mutant with abnormal nuclear shapes and a defect in nuclear movement was isolated

and designated as kaku1-1, after the Japanese word for nucleus. In the kaku1 mutant, nuclear movement was impaired (Figure 2) and the nuclear envelope was abnormally invaginated. The responsible gene was identified as myosin XI-i, which encodes a plant-specific myosin. Myosin XI-i is specifically localized on the nuclear membrane, where it physically interacts with the outer-nuclear-membrane proteins WIT1 and WIT2. Both WIT proteins are required for anchoring myosin XI-i to the nuclear membrane and for nuclear movement (Figure 3).

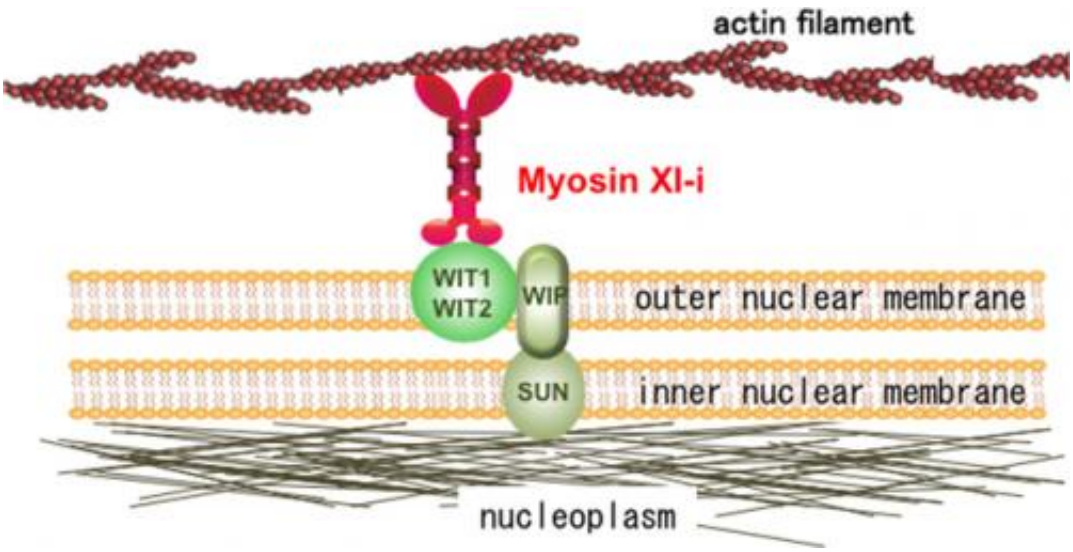

Figure 3: A plant-specific nanomachine regulating the nuclear movment. Myosin XI-i is associated with nuclear membrane proteins to control the nuclear movement.

A striking feature of plant cells is dark-induced nuclear positioning in mesophyll cells. A deficiency of either myosin XI-i or WIT proteins diminished dark-induced nuclear positioning. Notably, the plant-specific myosin XI family members, which are conserved widely in land plants, generate high motive forces. Together, these results suggest that plants have evolved a unique machinery involving actin and a myosin motor

that enables rapid and long-distance nuclear movement and nuclear positioning in response to environmental stimuli.

More information: Tamura, K. et al. Myosin XI-i Links the Nuclear Membrane to the Cytoskeleton to Control Nuclear Movement and Shape in Arabidopsis, *Current Biology*, 22 August 2013. dx.doi.org/10.1016/j.cub.2013.07.035