IN BRIEF

On the Origin of Cortical Microtubules

Epidermal hypocotyl cells are characterized by a highly structured cortical microtubule array, consisting of bundles of polarized, parallel microtubules that gradually migrate across the cortex in a rotary fashion (Chan et al., 2007). In animal cells, microtubules arise from centrosomes; however, plant cells lack centrosomes, and microtubules are thought to self-organize in structured arrays (reviewed in Dixit and Cyr, 2004). In a study using green fluorescence protein (GFP)-tubulin, Murata et al. (2005) demonstrated that new microtubules branch off preexisting microtubules in the cortex of plant cells. However, this capacity for branching seems at odds with the tendency of microtubules to form parallel bundles.

Chan et al. (pages 1-16) hypothesized that cortical microtubule arrays persist because some of the newly formed microtubules grow along the preexisting microtubules on which they form. To test this hypothesis, they analyzed the origin of microtubules in the cortex of Arabidopsis interphase hypocotyl cells using fluorescently tagged Arabidopsis End binding 1 protein (Pro35S:AtEB1a-GFP). In contrast with GFP-tubulin, which labels entire microtubules and does not readily distinguish between neighboring microtubules, AtEB1a-GFP predominantly labels the fast-growing plus ends of microtubules and thereby allows individual microtubules, of known polarity, to be tracked. Apart from labeling the plus end comets of emerging microtubules, AtEB1a-GFP also labeled the positions on the mother microtubules from which new microtubules arose. To confirm that the EB1a foci on mother microtubules indeed represent microtubule-nucleating sites, the researchers transiently coexpressed in Nicotiana benthamiana Pro35S:AtEB1a-GFP and RFP-NEDD1, which labels the centrosome in animal cells (Fant et al., 2009) and the spindle poles in plant mitotic cells (Zeng et al., 2009). Since new microtubules were found to emerge from foci labeled with both of these probes, EB1 was considered to be a faithful marker of microtubule nucleation.

The authors generated kymographs, which track the origin and fate of fluorescently labeled microtubules, from sets of time-lapse confocal images. Most new microtubules were found to branch forward, toward the plus end of the mother microtubule, and branching occurred on both sides of the mother microtubule. However, in support of the researchers’ hypothesis, 38% (n = 165) of new microtubules grew along the axis of the mother microtubule (see figure). Few emerging microtubules grew backward, toward the minus end of the mother microtubule. Furthermore, new microtubules frequently arose from points where two microtubules crossed, and most of these microtubules followed the axis of one of the preexisting microtubules.

These results were confirmed in seedlings expressing ProAtSPR1:GFP-AtSPR1, another marker of microtubule plus ends in plants.

Thus, cortical microtubules were found to persist because a population of new microtubules grows along the tracks of existing microtubules.

REFERENCES


