One of the major discoveries in cell biology from the past decade was the finding that forces associated with actin polymerization are strong enough to propel bacteria such as *Listeria* and *Shigella* within eukaryotic host cells and even to drive animal/mammalian cell motility by pushing the plasma membrane at their advancing fronts. This actin polymerization-driven ‘pushing of the cellular envelope’ is tightly coupled to both signal-perception and signal transduction at the plasma membrane. The coupling of signaling at the plasma membrane to actin dynamics is valid also for plant cells [1,2]. However, until recently, plant cells did not seem to fit into the emerging scheme in which the dynamic machinery associated with the process of actin polymerization is implicated in signaling-mediated navigation required for cell polarity and motility. Obviously, this might have something to do with the unique features of plant cells – which are all enclosed by rigid cell walls. The latter feature precludes cellular motility, and a long-standing dogma holds that the ultimate force behind cellular growth in plant cells is the high internal turgor pressure generated within plant cells.

But recent studies reveal that this long-lasting belief might be incorrect for apices of tip-growing plant cells, such as root hairs and pollen tubes, and partially incorrect even for rapidly elongating plant cells. A breakthrough in our understanding of processes driving the growth of plant cells came with the use of highly efficient inhibitors of actin polymerization known as latrunculins. Latrunculin B at low-nanomolar concentrations perturbs the organization of actin filaments in the tip of growing pollen tubes, and this rapidly inhibits their tip growth [3]. Moreover, at the level of the whole plant, long-term depolymerization of F-actin allows cell division and development to continue but prevents rapid cell elongation, resulting in dramatic seedling dwarfism [4]. Importantly, extremely low levels (<10 nM) of latrunculin B stop the tip growth of pollen tubes without affecting intracellular motilities and cytoplasmatic streaming [3]. These intriguing results were confirmed in a more extensive study documenting that actin polymerization is the rate-limiting process for growth of the pollen tube tip [5]. In accordance with this, actin polymerization has been shown to be essential also for the tip growth of root hairs [6]. Moreover, dense meshworks of dynamic F-actin, supported by abundant profilin [6] and actin-depolymerizing factor (ADF) [7] molecules, are closely associated with tips of rapidly growing root hairs (Figs 1,2).

Now, another unexpected finding on tip-growing pollen tubes has just been published. cAMP is identified as a hot candidate for a second messenger in pollen tube tip growth and navigation [8]. As cAMP signaling is closely related to signal-mediated dynamics of the actin cytoskeleton in non-plant cells [9], it might turn out that elements of cAMP signaling impinge directly on the machinery driving actin polymerization in plant cells too.

**References**


7. Jiang, C-J. et al. (1997) The maize actin-depolymerizing factor, ZmADF3, redistributes to the growing tip of elongating root hairs and can be induced to translocate into the nucleus with actin. *Plant J.* 12, 1035–1043


**Fig. 2.** Actin visualized in living root hairs of *Arabidopsis* seedlings transformed with the actin-binding domain of talin linked to green-fluorescent protein (GFP). Note actin-enriched tips of growing root hairs. For further details, see Ref. [6]. Bar, 90 μm.

**Fig. 1.** Actin visualized in root hairs using a monoclonal antibody against actin and chemically fixed plant material. Note actin-enriched tips of growing root hairs (arrows). For further details, see Ref. [6]. Bar, 20 μm.

**Pictures in cell biology**

**Actin-driven polar growth of plant cells**

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