Totally tubular chitin

Fibers create uniform tracheal tubes by molding them around an expanding chitin filament, according to Anna Tonning, Anne Uv, and colleagues (Göteborg University, Göteborg, Sweden).

Uv’s group suspected that chitin may be involved in shaping tracheal tubes after observing that a chitin synthase mutant forms tracheal branches that look like sausages rather than uniform cylinders. Branch cell fusion junctions were always constricted, with the intervening regions always grossly expanded. Indeed, fluorescent microscopy revealed that chitin normally accumulates within tube lumens during tracheal development, forms a filamentous cable, and uniformly expands to push branch cell fusion junctions outward while preventing overdilation of the remaining epithelium.

These results are consistent with two models. The chitin filament may act as a sponge. As liquid is drawn into the lumen during development, the sponge-like cable would then expand to uniformly push the epithelial cells outward. Uv, however, favors a second hypothesis in which the filament holds back lumen expansion, much like an anchor; the resultant tension would also force any constrictions to expand. This model implies the existence of a protein complex linking to the apical surface and underlying cytoskeleton.

Tube formation is a fundamental process in many organisms, so analogous mechanisms for shaping tubes may yet be found. “Different organs,” suggests Uv, “will likely use different matrix components to create uniform luminal expansion.” JCB

Turning off flow

Both internal and external pH sensors can rotate an ion channel’s helix to turn ion flow on or off, report Byung-Il Yeh, Chou-Long Huang, and colleagues (University of Texas Southwestern Medical Center, Dallas). “These findings provide the first mechanistic example of how ion channels integrate internal and external signals for function,” says Huang.

The TRPV5 calcium channel is expressed in kidney epithelial tissue where it regulates calcium reabsorption into the blood—an important function since improper calcium control can result in kidney stone disease.

High-acid conditions inhibit TRPV5 function. Huang’s group found that when a sensor residue—an intracellular lysine (K607)—binds to protons under low intracellular pH conditions, the protein undergoes a conformational change that causes clockwise rotation of the pore helix. This reduces the pore diameter. Clockwise rotation of the pore helix is also induced when an extracellular glutamate (E522) binds to protons during high extracellular pH conditions. Pore helix rotation ultimately closes the outer selectivity filter of the protein to inhibit calcium flow.

Hence, cross-regulation of the same structure within the protein allows coordinate control of calcium ions under a variety of physiological conditions. This, says Huang, “probably represents a very general mechanism for how channel proteins regulate internal and external signals.” JCB

Tilted tubules

Researchers have long wondered how plants carry out microtubule nucleation, as they lack microtubule organizing centers. Takashi Murata, Matsuysau Hasebe, and colleagues (National Institute for Basic Biology, Okazaki, Japan) now show that γ-tubulin promotes microtubule nucleation off of existing microtubules in higher plants. Moreover, new microtubules branch off from the sides, rather than the ends, of existing microtubules.

Plant cells form ordered microtubule arrays during interphase to enable cell shaping and orientation. To understand how these arrays form, Murata’s group watched fluorescently labeled microtubules grow and shrink in live tobacco cells. They saw that all newly forming microtubules branched off either from existing tubules (at a 40° angle) or at a site where a microtubule had existed but then depolymerized only seconds earlier.

Using in vitro analysis, the team confirmed that already-established microtubules are required for new microtubule nucleation. They also found that γ-tubulin, a common component of microtubule organizing centers in other organisms, is essential for nucleation and localizes at microtubule branch points.

Murata is currently trying to identify accessory proteins that may facilitate γ-tubulin movement from the cytoplasm to the sides of microtubules, and exploring links to other systems. “Although green plants are the only organisms that exhibit this branching type of microtubule nucleation so far, the branching pathway of microtubule nucleation may be found in other eukaryotic cells since cytoplasmic γ-tubulin is found even in animal cells,” he says. JCB

Reference: Murata, T., et al. 2005. Nat. Cell Biol. 10.1038/ncb1306.