How to make a helix

Plant stems twist and turn with the help of aberrant microtubule structures, according to results from Siripong Thitamadee, Kazuko Tuchihara, and Takashi Hashimoto (Nara Institute of Science and Technology, Ikoma, Japan).

The insights come from studies of Arabidopsis thaliana, which normally grows straight. Hashimoto’s team isolated lefty1 and lefty2—which have left-handed helical growth—as suppressors of an existing right-handed helical growth mutant. The new mutants have an identical change in either TUA6 or TUA4—two of the plant’s α-tubulin genes.

The change is near the interface with β-tubulin. The disturbed interface may produce the altered angle of microtubules seen in the mutants. Cortical microtubules are normally found running directly across the cells, but the mutant microtubules form in a skewed right-handed helix. This should alter the direction of growth, as cellulose-forming enzymes are thought to use microtubules as train tracks to lay down new cellulose fibers, and these circumferential fibers then constrict lateral growth and force all growth in a perpendicular direction.

Although the microtubule bending might determine the direction in which helical growth twists, the extent of helical growth is probably determined by the instability of the aberrant microtubules. Hashimoto has previously shown that treatment with antimicrotubule drugs affects the growth of inner cells disproportionately, leading to more rounded growth in these cells. Normal growth continues in outer cells, however. To prevent these more elongated cells from getting too far ahead of the inner cells, the outer cells skew their growth pattern to form a helix. Thus, two aspects of microtubule behavior determine both the direction and extent of helical growth.

Reference: Thitamadee, S., et al. 2002. Nature. 417:193–196.

Cadherins jump into the pool

Pools of motor neurons use cadherin combinations to sort themselves into discrete units, say Stephen Price, Thomas Jessell (Columbia University, New York, NY), and colleagues.

Differential expression of cadherins has been seen in the brain, so Jessell looked to see which cadherins are made in chick spinal cord. He studied defined motor pools, each of which innervates a single limb muscle, and found 15 cadherins, 7 of which were expressed in different subsets of the motor pools. Combinations of these cadherins could easily account for the 40 pools needed to innervate the 40 muscles in one limb.

Two of the pools—EF and A—were well suited to further analysis. These two pools shared expression of three different cadherins, but only the A pool expressed the additional MN-cadherin. When Jessell eliminated this difference in cadherin profile by expressing either MN-cadherin in the EF pool or a dominant–negative version of MN-cadherin in the A pool, the cells from the two pools intermixed. The effect was pool and cadherin specific.

But pool identity probably does not start with cadherin expression, or even with a geographical code. “The pools are not organized in any clear inside-out or dorsal-ventral pattern,” says Jessell. “I think it’s related to the birth date of the motor neurons.”

In this scheme, earlier-born neurons could instruct the identity of later-born neurons as they arise. The later-born neurons then migrate outwards through the older neurons, and it is here that cadherin expression may be important in keeping the two populations distinct as they slip past each other. Further subdivision of pools occurs after the initial migration, although Jessell does not yet know if cadherins are important in this second process.

Even the need for pools is a bit of a mystery. The motor neurons link to sensory neurons, which function perfectly well despite being jumbled and intermixed in various ganglia outside the spinal cord. Clustering may help the motor neurons to fire a coordinated movement signal, as the neurons in a pool are electrically coupled. Jessell plans to test this idea by globally disrupting all cadherin interactions. Existing evidence suggests that this will scramble the motor neuron pools but allow the individual cells to maintain the transcription factor mix that defines their identity.

Reference: Price, S.R., et al. 2002. Cell. 109:205–216.