Hidden particles

Particles within microtubules cannot hide from Garvalov et al. (page 759). Using cryo electron tomography, the authors get a close look at these elusive luminal residents.

Nearly half a century ago, early microscopic evidence suggested that some sort of particle resided inside microtubules. Many researchers, however, considered them possible artifacts of fixation or staining procedures.

Cryo electron tomography bypasses most of these problem inducing steps. With just a quick freeze of intact neuronal cells, tomograms at 5-6 nm resolution revealed globular densities about the size of several tubulin subunits within neurite microtubules.

The globules contact the luminal face of the tubulin subunits, but higher (10-20 nm) resolution will be needed to identify precise interaction sites. The particles were found more often in depolymerizing microtubules and thus might increase microtubule dynamics. So far, densities have only been seen in the microtubules of astrocytes, neurons, and neuronal precursors, which have particularly long and dynamic microtubules.

As the internal face is predicted to harbor domains that can be acetylated, the authors suggest that the particles might be acetyltransferases or deacetylases. Other possibilities remain, however. Perhaps they are proteins or mRNAs that are transported or simply stored within microtubules, to be released upon the filament’s depolymerization. To identify these globules, intact neuronal microtubules will first have to be isolated. JCB

Sizing up actin fences

In some cell types, membrane molecules roam around in bigger fields than they do in others. On page 851, Morone et al. show that the size of their roaming area is set by the density of an actin cytoskeleton meshwork just beneath the plasma membrane.

This membrane-adjacent skeleton (or MSK) is revealed in fine detail by the authors 3D reconstructions of large slices of the plasma membrane and its associated proteins. The images uncover a vast meshwork of mostly actin filaments lying within a nanometer of —and possibly directly against—the membrane. Gaps in the filamentous network occur only where caveolae, clathrin-coated pits, or surface membrane indentations lie.

The group also compared the distribution of mesh sizes in two cell types. A kidney fibroblast line had mesh holes that were almost five times larger than those of a keratinocyte. The sizes correspond well with previous measurements of the diffusion range of phospholipids and transmembrane proteins within those same two cell types.

The correlation lends credence to the picket fence model, which proposes that the actin network locally pens membrane molecules, which occasionally move longer distances by hopping between compartments. Hopping might occur when actin filaments are briefly severed or dissociate from the membrane.

An estimated 25% of the MSK surface is bound by transmembrane proteins, which help to link the actin to the membrane. Corralling signaling proteins probably helps to localize a signaling response. Oligomerization of receptors upon ligand binding should make hopping even more difficult. JCB

Stealing histones

A parasitic plasmid poaches a centromeric protein from its host, as shown by Hajra et al. on page 779. The protein helps the plasmid segregate during mitosis.

The plasmid is a benign yeast parasite, called the 2 um plasmid, that replicates and segregates precisely to maximize its numbers while restricting itself to nontoxic levels. The plasmid’s segregation locus, STB, contains chromatin-remodeling proteins, suggesting that STB’s architecture is different from that of the rest of the plasmid—much as the centromere is unique within a host chromosome.

The new results reveal how the plasmid makes the STB locus distinctive: it marks it with the same histone H3 variant, Cse4p, that its host uses to tag centromeres. Cse4p is a rapidly degraded protein but is somehow protected from the proteasome at the STB locus, as it is at yeast centromeres. Plasmid mutants that do not bind this core histone do not load the remodeling proteins or yeast cohesin and thus missegregate.

Spindle microtubules are required for plasmid Cse4p loading, although just how they participate is not clear. Perhaps they position the plasmid at its known locale near host centromeres at spindle poles—a prime spot for poaching some Cse4p and cohesin. As STB lacks other true kinetochore proteins, the plasmid might need to hitchhike on yeast chromosomes rather than grab onto the spindle directly. JCB