<Further Development 17_09>

Primer on the Molecular Anatomy of the Growth Cone

The growth cone was found to have two major compartments. The central domain of the growth cone contains microtubules that extend the axon shaft and support mitochondria and other organelles (see Figure 17.23C). The peripheral domain contains two types of actin-associated membrane protrusions: the lamellipodia, broad membranous sheets containing short, branched actin networks, that act as the migratory network of the growth cone; and the filopodia, membranes extended by long bundles of filamentous actin, that act as the sensory network. A transition zone between the central and peripheral regions may coordinate actin and tubulin growth (Rodriguez et al. 2003; Lowery and Van Vactor 2009). Lone “pioneer” microtubules from the central zone’s core of microtubule bundles protrude through the actin arc that defines the transition zone and extend into the periphery of the growth cone. These pioneer microtubules dynamically associate with the actin filaments, and together the microtubules and actin filaments grow and shorten to perform the fingerlike movements characteristic of filopodia (Mitchison and Kirschner 1988; Sabry et al. 1991; Tanaka and Kirschner 1991, 1995; Schaefer et al. 2002). The microtubule- and actin-based membrane protrusions, coupled with selective adhesion and membrane recycling, provide the force that drives axon movement and directionality.

Literature Cited

Lowery, L. A. and D. Van Vactor. 2009. The trip of the tip: Understanding the growth cone machinery *Nature Rev. Mol. Cell Biol.* 10: 332–343.
PubMed Link

Mitchison, T. and M. Kirschner. 1988. Cytoskeletal dynamics and nerve growth. *Neuron* 1: 761–172.
PubMed Link

Rodriguez, O. C., A. W. Schaefer, C. A. Mandato, P. Forscher, W. M. Bement and C.M. Waterman-Storer. 2003. Conserved microtubule-actin interactions in cell movement and morphogenesis. *Nature Cell Biol.* 5: 599–609.
PubMed Link

Sabry, J. H., T. P. O'Connor, L. Evans, A. Toroian-Raymond, M. Kirschner, and D. Bentley. 1991. Microtubule behavior during guidance of pioneer neuron growth cones in situ. *J. Cell Biol*. 115: 381–395.
PubMed Link

Schaefer, A. W., N. Kabir, and P. Forscher. 2002. Filopodia and actin arcs guide the assembly and transport of two populations of microtubules with unique dynamic parameters in neuronal growth cones. *J. Cell Biol*. 158: 139–152.
PubMed Link

Tanaka, E. M. and M. W. Kirschner. 1991. Microtubule behavior in the growth cones of living neurons during axon elongation. *J. Cell Biol*. 115: 345–363.
PubMed Link

Tanaka, E. and M. W. Kirschner. 1995. The role of microtubules in growth cone turning at substrate boundaries. *J. Cell Biol*. 128: 127–137.
PubMed Link