Neurons at the extremes of cell biology

Maxwell G. Heiman[a] and Leo Pallanck[b]
[a]Children's Hospital Boston and Harvard Medical School, Boston, MA 02115; [b]University of Washington, Seattle, WA 98195

Neurons are the pedestals of human consciousness, yet from a cell biological view they are little more than specialized epithelia. Indeed, as highlighted in the "Neuronal Development and Degeneration" Minisymposium, neurons inhabit conventional cell biology at an extreme: in their diversity of cell types, the specificity of their cell–cell junctions and cell–cell signaling, their degree of asymmetric polarization, their rate and volume of membrane traffic, the size and stability of their cytoskeletal assemblies, and their metabolic activity and ion flux. This extreme lifestyle requires extreme upkeep and, although neurons can be extreme in their longevity, if any of the above processes are compromised then neurodegenerative diseases can ensue. This session highlighted what can be learned by studying cell biology at the extremes, beginning with neuronal development and ending in studies of neurodegenerative disease.

Extreme cell biology in neuronal development

Karolina Mizeracka presented unpublished data from her doctoral thesis in the laboratory of Constance Cepko at Harvard Medical School showing that some newborn retinal neurons require Notch to keep them from adopting the predominant rod cell fate; while in this Notch-dependent state, they coexpress markers of several retinal cell types and resolve more quickly to a single fate after Notch is removed. **Maxwell Heiman** from Harvard Medical School presented results from his postdoctoral studies in the laboratory of Shai Shaham at Rockefeller University showing that sensory neurons of *Caenorhabditis elegans* recognize distinct contacts by attaching to extracellular matrix molecules similar to ones involved in sperm–egg binding, consistent with the chemoaffinity tags that Roger Sperry had hypothesized a half century earlier. **Tapan Maniar** presented unpublished data from his doctoral thesis in the laboratory of Cornelia Bargmann at Rockefeller University showing that sorting of cargo to axons or dendrites occurs through an active, motor-dependent mechanism guided by cytoskeletal cues which are established by UNC-33/CRMP and UNC-44/Ankyrin.

Extreme cell biology in neurodegenerative disease

Lani Keller presented unpublished data from her postdoctoral work in the laboratory of Graeme Davis at UCSF identifying an exciting new signaling system required for motoneuron degeneration in *Drosophila*. **Albert La Spada** from UCSD showed that forced overexpression of a key regulator of mitochondrial biogenesis ameliorated both oxidative stress and disease symptoms in mouse and cell culture models of Huntington's disease, suggesting that pharmacological inducers of mitochondrial biogenesis might be used to treat Huntington's disease. **Jonathon Burman** presented results from his postdoctoral studies in the laboratory of Leo Pallanck at the University of Washington, including the development of an unpublished protocol for isolating dopaminergic neurons and characterizing mitochondrial membrane potential and mitochondrial DNA mutation rates in a *Drosophila* model of Parkinson's disease.

These studies are advancing our understanding of how neurons work, but, critically, they were selected to demonstrate how much there is to gain by studying one's favorite cell biological problem at an extreme—whether it is differentiation, cell polarity, cell–cell connectivity, cell–cell signaling, metabolic burden and reactive oxygen species, or mitochondrial DNA maintenance. Surprisingly often, these extremes are best found in neurons.

DOI: 10.1091/mbc.E10-12-0965
Molecular Biology of the Cell Volume 22 Page 721
MBoC is pleased to publish this summary of the Minisymposium "Neuronal Development and Degeneration" held at the American Society for Cell Biology 2010 Annual Meeting, Philadelphia, PA, December 14, 2010.
Address correspondence to: Maxwell G. Heiman (heiman@genetics.med.harvard.edu).