1. A Brief History of Developmental Biology
2. Invertebrate Embryology & Genetics

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Biography:
Dr. Van Vactor is a Professor in the Department of Cell Biology at the Harvard Medical School (HMS) and a member of the Program in Neuroscience and the DFCI/Harvard Cancer Center. From 2007-2014 he was Director of the Graduate Programs in Biological and Biomedical Sciences (BBS) in Harvard's Division of Medical Sciences. He is founding Director of the Curriculum Fellows Program at HMS. He is also Director of Basic Science Partnership (BSP), an educational outreach program for middle and high school children. Dr. Van Vactor received his B.A. in Behavioral Biology at the Johns Hopkins University, and went on to receive his Ph.D. from the Department of Biological Chemistry at the University of California, Los Angeles (UCLA). He has been an instructor for Neurobiology courses at the Marine Biology Laboratories in Woods Hole, Massachusetts, a course Director at Cold Spring Harbor Laboratories on Long Island, and is co-Director of DNC. Dr. Van Vactor has been the recipient of a Medical Foundation New Investigator award, as well as Scholar awards from the Klingenstein Foundation, the McKnight Foundation and the Leukemia and Lymphoma Society. He is currently a Partner in Research with Nikon Instruments, and a visiting Professor at Okinawa Institute of Science and Technology (OIST).

Research Focus:
Tyrosine Kinase Control of Cytoskeletal Dynamics in the Axon: The accurate navigation of axons along stereotyped pathways in vivo requires coordination of the key effector systems that control growth cone motility. The Abl family of conserved intracellular tyrosine kinases act downstream of multiple classes of axon guidance factor receptors. Genetic screens for Abl effectors in Drosophila identified the both actin regulatory factors and the microtubule plus-tip interacting protein (MT+TIP) CLASP as a protein required for Abl function in vivo. Our subsequent biochemical and functional studies showed that CLASP associates with and is phosophorylated by CLASP in mammalian cells, suggesting conservation in the guidance machinery. We have used genetic and proteomic tools to define a network of functional partners for CLASP, and find not only additional MT+TIPs, but also MT-actin cross-linking factors suggesting that CLASP and Abl are involved in the coordination of the two major polymer systems.

The Formation and Growth of Functional Synaptic Connections: After a growth cone reaches the appropriate destination, it must construct a specialized cellular junction or synapse in order to communicate with its target cell in a functional circuit. Our studies of the LAR receptor phosphatase led us to the discovery that the LAR pathway regulates synaptic growth and the morphogenesis of the active zone – a structure that orchestrates neurotransmitter release at chemical synapses. We have defined factors upstream and downstream of LAR in this context, and the machinery appears to be highly conserved. Upstream, LAR interacts with synaptic heparan sulfate proteoglycans that control distinct aspects of synapse morphogenesis or function. Downstream, LAR activity is mediated by a pathway linking the phosphatase cytoskeletal remodeling. In addition, we find that this pathway is under the regulation of genes linked to human mental retardation, suggesting a molecular model for disorders of cognitive dysfunction.

MicroRNA Regulation of Synapse Specificity and Morphogenesis: Much has been learned about the signaling pathways and networks of proteins that function together to build and modulate synaptic connections. This rich molecular landscape is under the control of multiple classes of regulatory factors. MicroRNA are versatile posttranscriptional regulators capable of tuning levels of gene expression across a large number of target genes. Through genetic screens in Drosophila, we have discovered that synapse formation and growth are controlled by conserved microRNA genes that orchestrate different stages of synapse development through distinct sets of direct and indirect targets. Having recently created a means of selectively inhibiting the function of any microRNA with spatio-temporal precision in vivo, we are now equipped to survey the functions of all microRNAs in Drosophila in many aspects of neural development, connectivity, behavior, and neurodegeneration. Once this regulatory landscape has been mapped through comprehensive screens in this model organism, it will be possible for us to test the conservation of these mechanisms in mammalian neurons and circuits.

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