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Molecular Motors and Efficient Motion in a Viscoelastic Environment

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Molecular motors perform many critical functions for cells, including chromosome separation during mitosis, vesicle transport, and muscle contraction. In this talk, we will discuss the ways in which physics concepts and instrumentation are being used to determine the forces and efficiencies of two of these motors, kinesin and dynein, in cells. We will emphasize a) studies at Wake Forest University that focus on the force versus velocity curves (load curves) of kinesin in the neurites of live PC12 cells, and b) work at UNC-Chapel Hill that measures the forces developed by dynein motors within beating cilia on the outer surfaces of live lung cells during mucus transport. We will show how the viscoelastic properties of cytoplasm and mucus can be determined from the Brownian motion of vesicles and beads in these media.. We find that the load on these motors in vivo may exceed that in vitro by a factor of 1000, and that several motors can share the task of moving a single vesicle.