

Ladders and ropes: Active transport inside the stereocilia and other cellular protrusions

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CELLULAR protrusions are typically driven by the polymerization of a large actin bundle near the membrane. Such structures require a high level of regulation and coordination in order to develop and maintain its shape. Various proteins and molecular motors inside cellular protrusions show highly localized behavior. We use a reaction-advection-diffusion model in order to describe the active transport of motors and cargo inside the protrusion and calculate the resulting concentration profiles in different scenarios. We then demonstrate the relation between the localized concentration profiles and the regulation of several significant processes inside such cellular protrusions, namely actin polymerization and degradation. We present results regarding the stereocilia, where the active transport of actin-regulating proteins explains two long-standing puzzles; the distinct narrow base and the height-dependence of the rate of actin polymerization. Recent experiments provide further verification of this model in filopodia. Finally we demonstrate how this model may explain the intriguing observation of myosin "wave-trains" within filopodia.