The Transportation System Inside a Living Cell

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***Short Abstract* — A living cell has an infrastructure much like that of a city. We will describe the transportation system that consists of roads (filaments) and molecular motors (proteins) that haul cargo along these roads. We will give an example showing how pigment cells regulate this transport.**

***Keywords* — intracellular transport, actin, myosin-V**

I. BACKGROUND

THE transportation system of a living cell has roads (filaments) and trucks (motor proteins) that haul cargos. Such intracellular transport is realized is present in all cells with a nucleus (eukaryotic cells). The filaments consist of microtubules that extend radially away from the nucleus (like the interstate highway system) while actin filaments form a random network (like local surface streets). Cargos have molecular motors that carry the cargo along these filaments. These motors are myosin-V, kinesin, and dynein. The breakdown of intracellular transport in neurons has been associated with neurodegenerative diseases such as Alzheimer's and Huntington's disease, while disruption of intraflagellar transport can lead to polycystic kidney disease, blindness (retinitis pigmentosum), and developmental defects such as Situs Inversus where organs are misplaced on the wrong side of the body [1,2]. The principles regulating cargo motion are still not well understood.

II. THIS WORK[3]

While there have been *in vitro* studies of how motors function at the single molecule level, and *in vivo* studies of the structure of filamentary networks, studies of how the motors effectively use the networks for transportation have been lacking. Some animals are able to change their color by using special skin cells (melanophores) in which pigment granules (melanosomes) are spread throughout the cell or gathered back to the center. We investigate how the combined system of Myosin-V (M-V) motors plus actin filaments is used to transport pigment granules in Xenopus Melanophores. Experimentally, we characterize both the actin filament (AF) network, and how this transport is altered in response to external signals. In particular the rms displacement of the pigment granules after a given amount of time (50 sec, say) is larger when they are spreading out than when the pigment granules are gathered back toward the vicinity of the nucleus. We developed a theoretical formalism using the solution to the Langevin equation as well as Monte Carlo simulations to explain these changes.

III. CONCLUSIONS

We show that cells regulate transport by controlling the probability that a granule switches from one filament to another, rather than by altering individual motor activity at the single molecule level, or by relying on structural changes in the network. We are currently working to explain how a cell can alter the probability of switching.

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