Modeling intracellular transport by multiple kinesin and dynein motors

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Intracellular transport is essential for the functionality of the cell. Microtubule-based transport is carried out by opposite-directed kinesin and dynein motors. How the cell regulates bidirectional transport by multiple dynein and kinesin motors remains an open question. Motor number, ATP or roadblock concentrations [1], as well as the cargo itself might regulate bidirectional cargo transport. By developing mathematical kinesin and dynein models, which are based on known single motor properties [2], we use Monte Carlo simulations to understand the underlying processes of the experiment. We found that motor type and number determine the transport direction in bidirectional gliding assays, while ATP or roadblocks have no effect [1].
Intracellular cargos often have a membrane composed of a lipid-bilayer, on which motors can diffuse [3]. How the membrane diffusion influences cargo transport is not well understood. Experimental data of membrane-bound cargo transport (see abstract by Rahul Grover et al.) shows directed motion with frequent pausing events. The simulation predicts that pausing comes from some passive motors. These passive motors could be a result of a) non-functional motor heads or b) the geometry of the experimental assays, which might interrupt the mobility of motors on MT.

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