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Cellular active transport along lipid nanotube networks

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Introduction

Nanofluidic active transport within cells is governed largely by cytoskeletal structures. Molecular motors like kinesin build inter- and intracellular nanofluidic “highways” that move vesicles, organelles, and other molecular species. The action of certain intracellular systems, such as the ER and the Golgi body, can be simulated *in vitro* through lipid nanotube networks (LNTs) made of microtubules (MTs). The LNT is composed of MTs, which are guided by surface-bound kinesin and limited predominantly by available ATP, and soft source unilamellar vesicles coated with a lipid bilayer. We are interested in examining various factors in these tubular systems such as the direction and rate of microtubule growth. These aspects have diverse applications to controlled cellular substance delivery.

Materials and Method

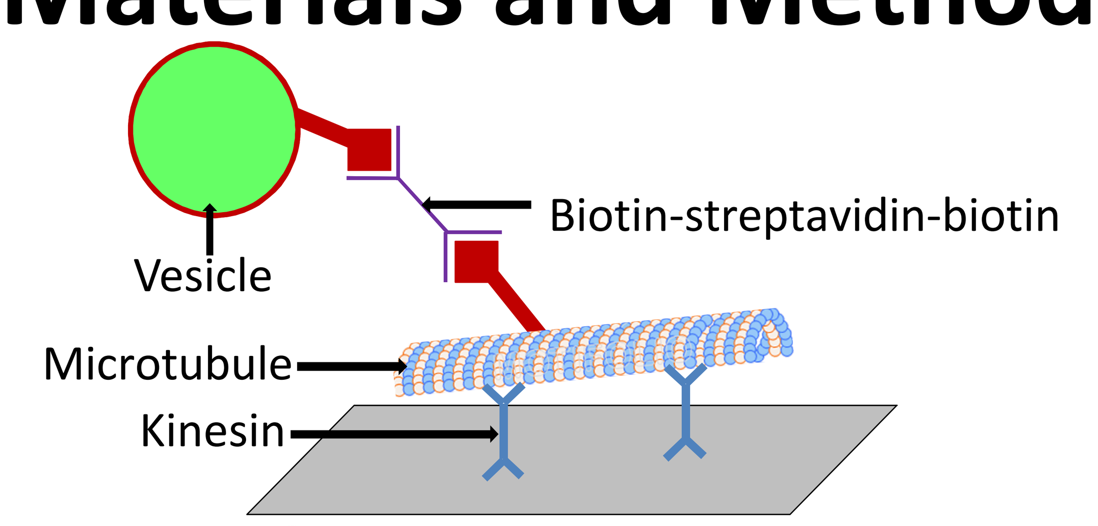


Fig: Schematic of microtubule-kinesin-substrate complex

Small unilamellar vesicles (SUVs) were synthesized from fluorescent dyes, POPC (a phosphatidylcholine), and cholesterol.

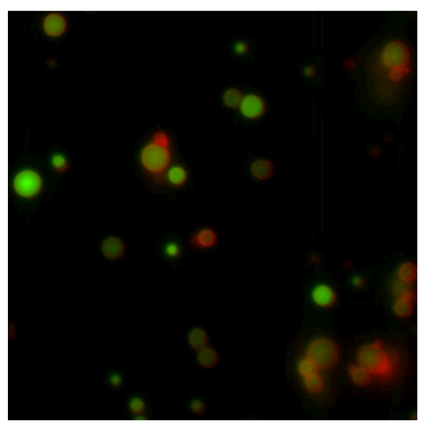
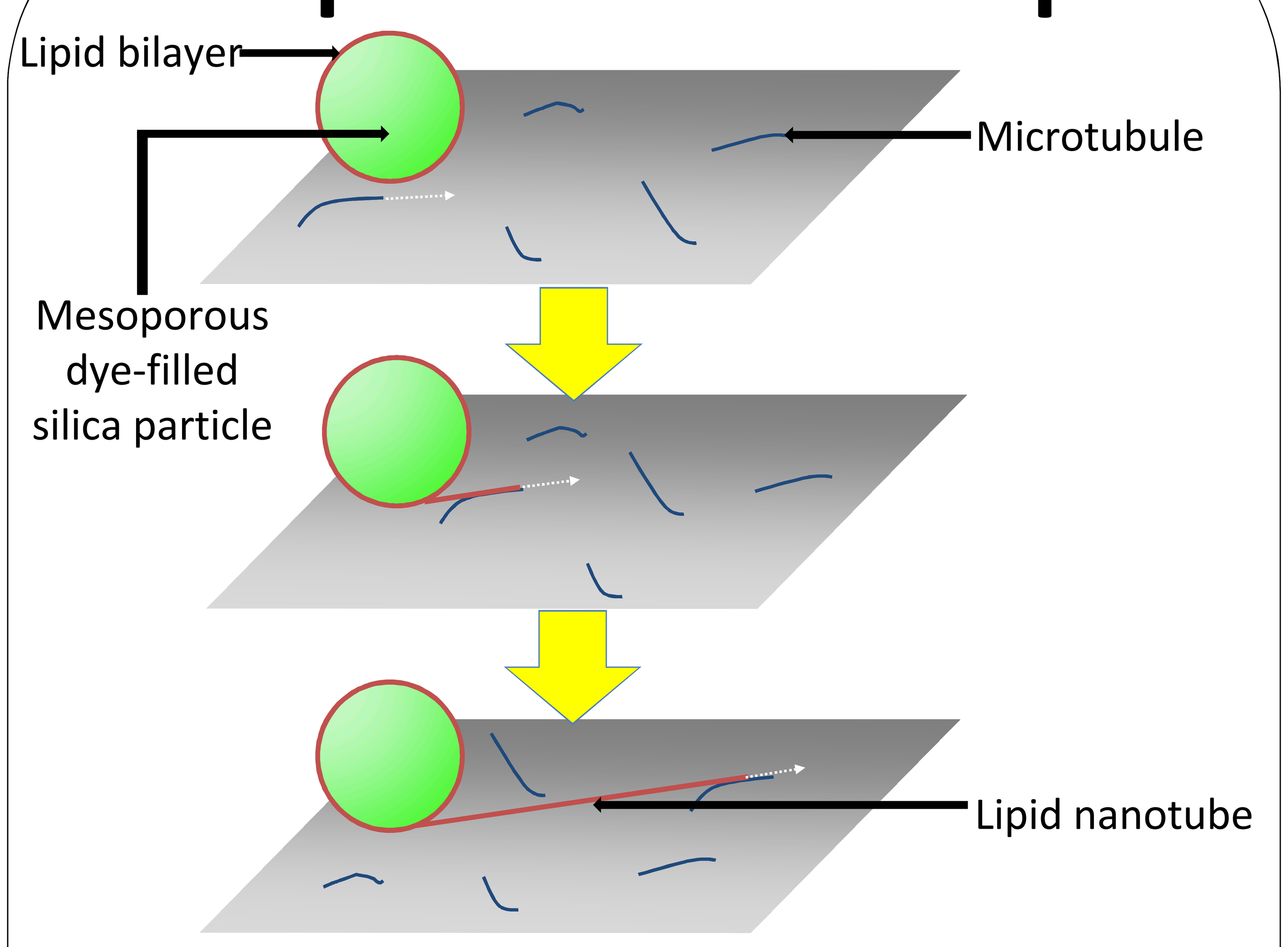


Image: GFP and TRITC filters used to illuminate fluorescent dye in particle (green) and lipid bilayer (red)

Giant unilamellar vesicles (GUVs) were synthesized by electroformation of films of fluorescent dyes, cholesterol, DPPC (dipalmitoylphosphatidylcholine), and DPhPC (diphytanoylphosphatidylcholine).

Experimental Setup



Mesoporous dye-filled silica particles coated with vesicles grow extended microtubules, guided by kinesin. The fluorescent dye within these particles moves along the LNT as it forms, allowing us to image and examine the growth rate and preferred direction of MT movement.

Discussion and Future Work

Nanofluidic cellular transport can be applied to a wide variety of novel materials and functions. For example, these assemblies can model chemical “factories” on the nanoscale, in which reaction products from one vesicle are moved to other reactions in other vesicles. This transport can move hydrophobic molecules, through the lipid bilayer, and hydrophilic molecules, through the aqueous interior of the nanotube.

References

Bouxsein, Nathan F., Amanda Carroll-Portillo, Marlene Bachand, Darryl Sasaki, and George D. Bachand (2013). A continuous network of lipid nanotubes fabricated from the gliding motility of kinesin-powered microtubule filaments. *Langmuir* 29 (9), 2992-2999.

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