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Extrusion of unilamellar lipid nanotubes by kinesin-powered microtubule filaments

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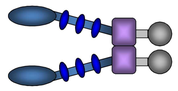
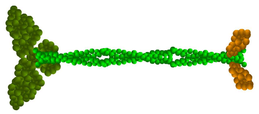
Introduction

Cytoskeletal filaments and motor proteins (kinesin and myosin) are involved in lipid vesicle transportation and membrane reorganization.

Myosin II (muscle myosin) linear motor

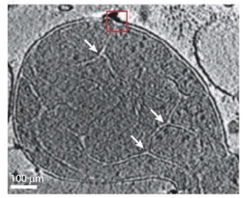


Kinesin (conventional) linear motor



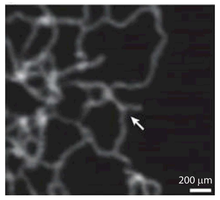
Lipid nanotubes in Nature

Mitochondria



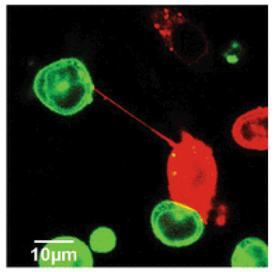
Voeltz et al., (2007) *Nat. Rev. Mol. Cell Biol.*

Endoplasmic Reticulum



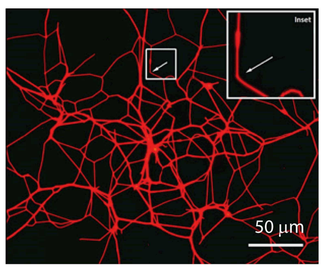
Voeltz et al., (2007) *Nat. Rev. Mol. Cell Biol.*

Lipid nanotubes in murine B-cells



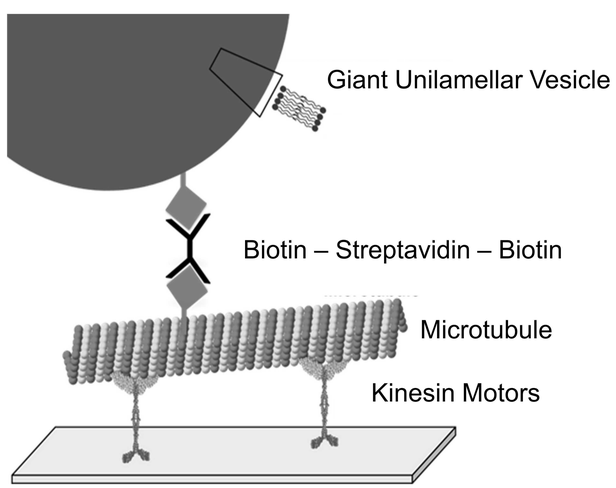
Molnár et al., (2016) *Cell and Mol. Life Sciences*

Lipid nanotubes in vitro



Bouxsein et al., (2013) *Langmuir*

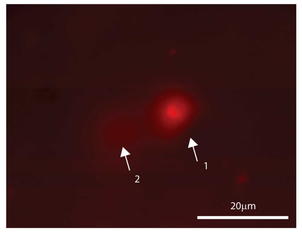
Methods



Results

Can lipid nanotube networks be fabricated from GUVs?

t=0s



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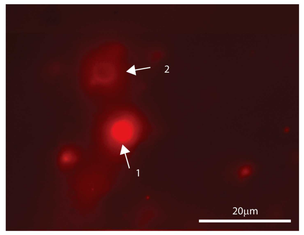

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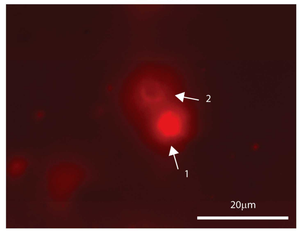

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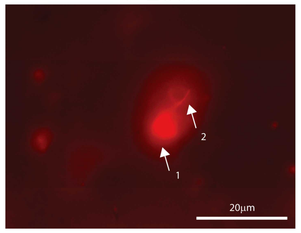

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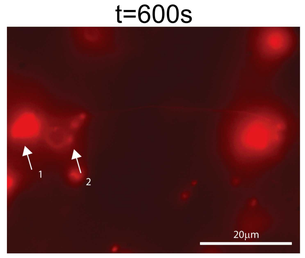
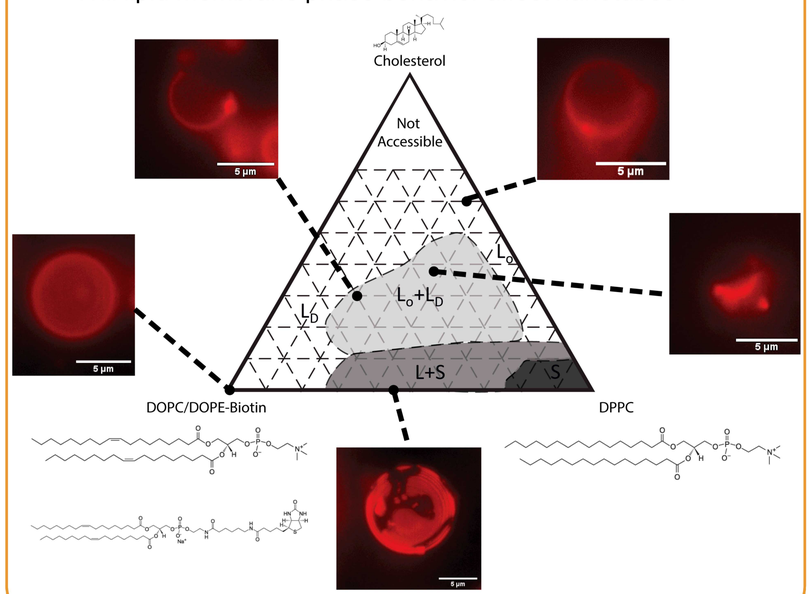


Microtubule motility drives aggregation of GUVs to form Lipid nanotube networks

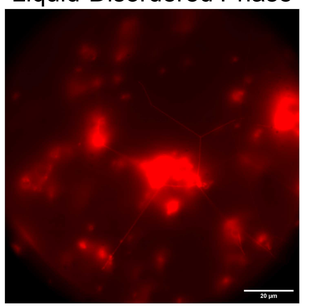
Will lipid membrane phase behavior affect nanotubes?



Results

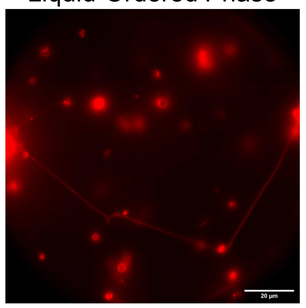
The phase-behavior of the lipid membrane changes the phenotype of nanotubes. Liquid and liquid disordered phase Tubes are thin and branched, while liquid-ordered phase tubes Are thick and straight.

Liquid-Disordered Phase



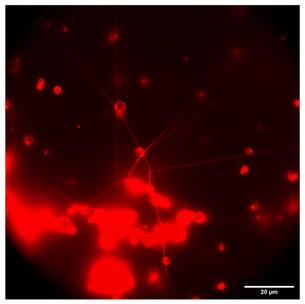
95% DOPC

Liquid-Ordered Phase



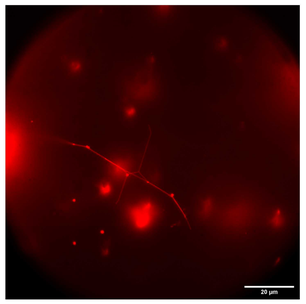
60% Cholesterol

L_o-L_D Phase-Separated



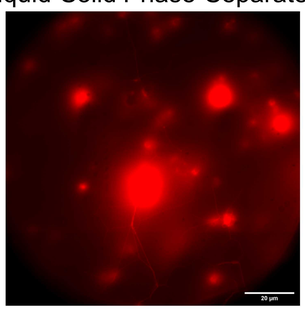
45% DOPC

L_o-L_D Phase-Separated



19% DOPC

Liquid-Solid Phase-Separated



50% DOPC

Conclusion

- Large lipid nanotube networks observed in liquid phase membranes.
- Liquid-disordered phase nanotubes were observed to be thin.
- Liquid-ordered phase nanotubes were observed to be thick approximately 3 times thicker than liquid-disordered tubes.

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