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Nanoparticle-Supported Hybrid Bilayers for Drug Delivery

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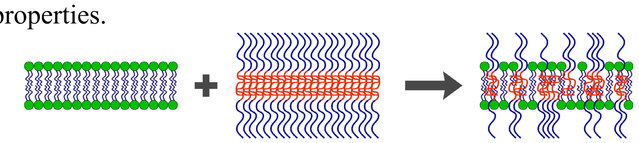
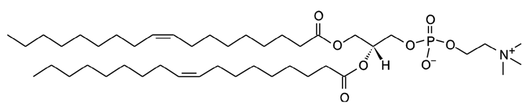
1. Motivation – Smart Delivery Vesicles

- Our aim is to design prophylactic and therapeutic delivery systems based on porous nanoparticles coated with bilayers.[1]
- Mesoporous silica nanoparticles (MSP) can load more cargo than vesicles but need a coating to keep cargo in.
- Problem of naturally occurring lipid bilayers is their poor physical and chemical stability.
- Polymer based bilayers have enhanced mechanical stability[2] and can provide chemical versatility.
- Hybrid lipid-polymer bilayers[3] are highly desirable for developing artificial organelles due to synergistic membrane properties.

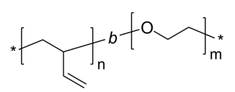


2. Experimental Method

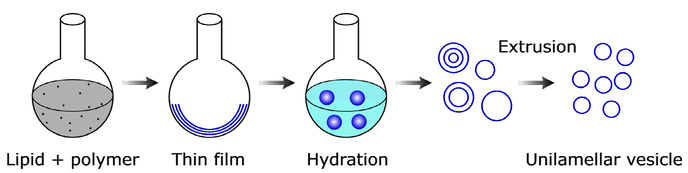
- Lipid : 1,2-Dioleoyl-*sn*-glycerol-3-phosphocholine (DOPC)



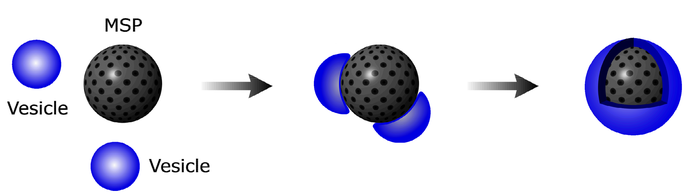
- Polymer : Poly (butadiene-*b*-ethylene oxide) (PBD-PEO)



- Mesoporous silica nanoparticle (MSP)
- Formation of hybrid vesicles via thin film hydration

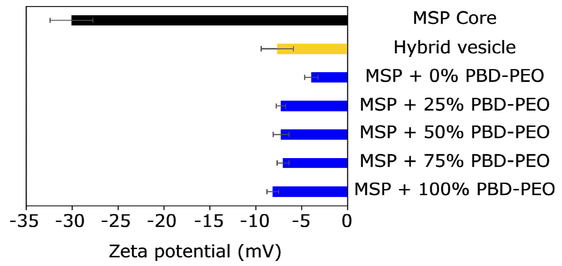


- Formation of MSP-supported hybrid bilayers by fusion

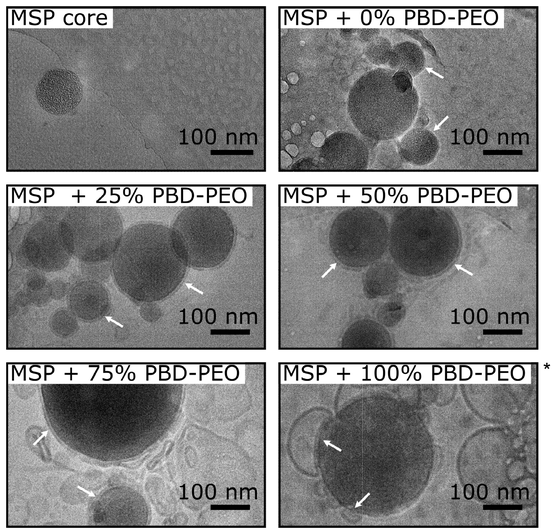


3. Result – Hybrid Bilayer Coating on Particle

- Change in zeta potential of MSP before and after vesicle fusion, indicating formation of bilayer coating on the MSP



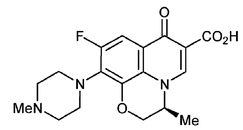
- CryoEM images showing MSP-supported hybrid bilayers



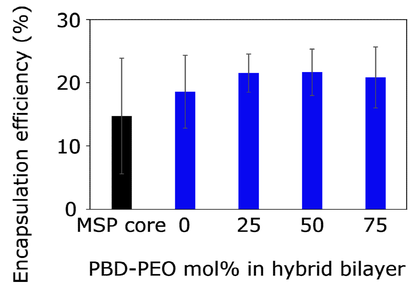
*Incomplete coating of 100% PBD-PEO bilayer due to robust polymer bilayer

4. Result – Drug Loading and Release

- Drug encapsulation efficiency of MSP with hybrid bilayer coating

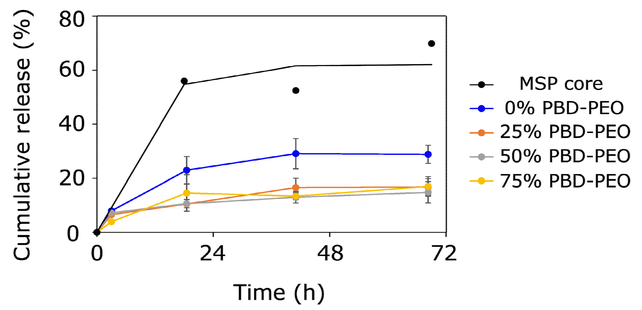


Levofloxacin
(antibiotic drug)



→ Coated MSP (21%) can be loaded with more drug than uncoated MSP (14%).

- Drug release from MSP with hybrid bilayer coating



→ MSP with hybrid bilayer coating (16%) releases drug slower than MSP with lipid bilayer coating (28%).

5. Conclusion & Future Work

- We have demonstrated formation of supported hybrid bilayers on MSP by fusion.
- MSP with bilayer coating can be loaded with more cargo than MSP without bilayer coating.
- MSP with hybrid bilayer coating releases cargo slower than MSP with lipid bilayer coating due to enhanced mechanical stability of bilayer.
- Chemical and pH stability of MSP with hybrid bilayer coating will be further investigated for drug delivery application.
- Cell cytotoxicity of MSP-supported hybrid bilayer will be studied.

6. Acknowledgement & Reference

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[1] C.J. Brinker et al. *Nat. Mat.* **2011**, *10*, 389-397
[2] D.E. Discher et al. *Science* **1999**, *284*, 1143-1146
[3] W.F. Paxton et al. *Colloids Surf. B Biointerfaces* **2017**, *159*, 268-276