Material properties of hybrid lipid co-block polymer vesicles

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Aims

Can properties of polymers and lipids be **combined** into a hybrid vesicle?

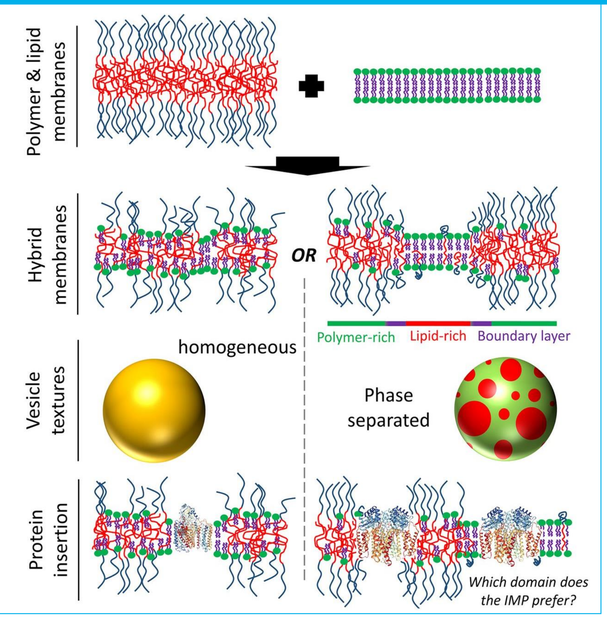
Can enzymatic activity be **maintained** in hybrid vesicles?

If so, **why**?

Hybrid Vesicles

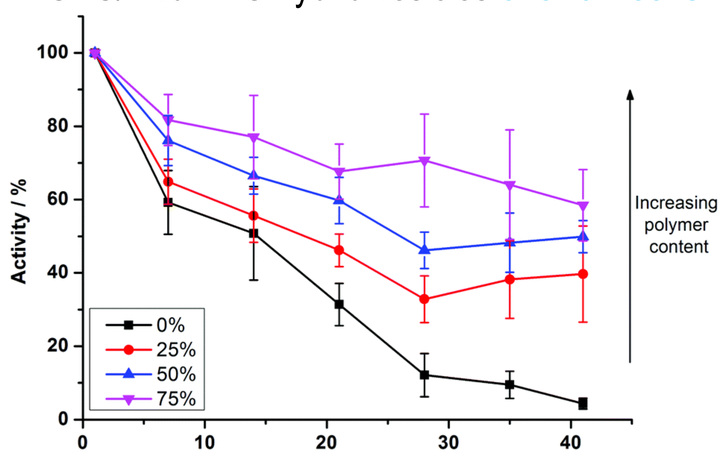
In a previous study, hybrid POPC lipid/ PBd-b-PEO polymer vesicles stabilised an enzymes' activity as well as prolong their functional lifetime[1], thus showing that desirable properties of liposomes and polymersomes can be incorporated into a hybrid vesicle.

The physicochemical properties of the membrane change as the lipid/polymer composition is increased. Understanding these properties could rationalise the behaviour of proteins in different environments and reveal the mechanism of enzyme functional stabilisation in hybrid vesicles[2].

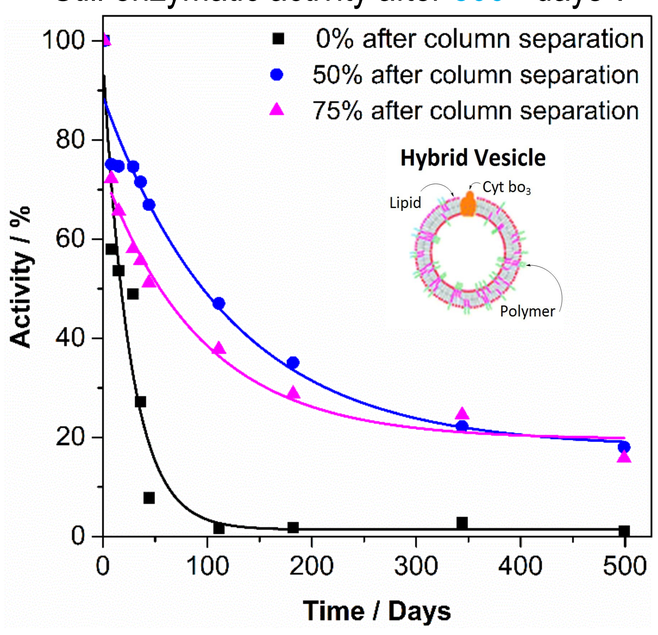


Results

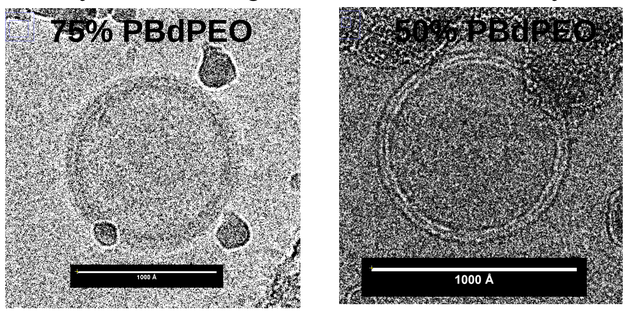
Observed enzyme activity of cyt bo_3 in POPC/PBd-PEO hybrid vesicles **over 6 weeks**[1].



Still enzymatic activity after **500+** days[3].



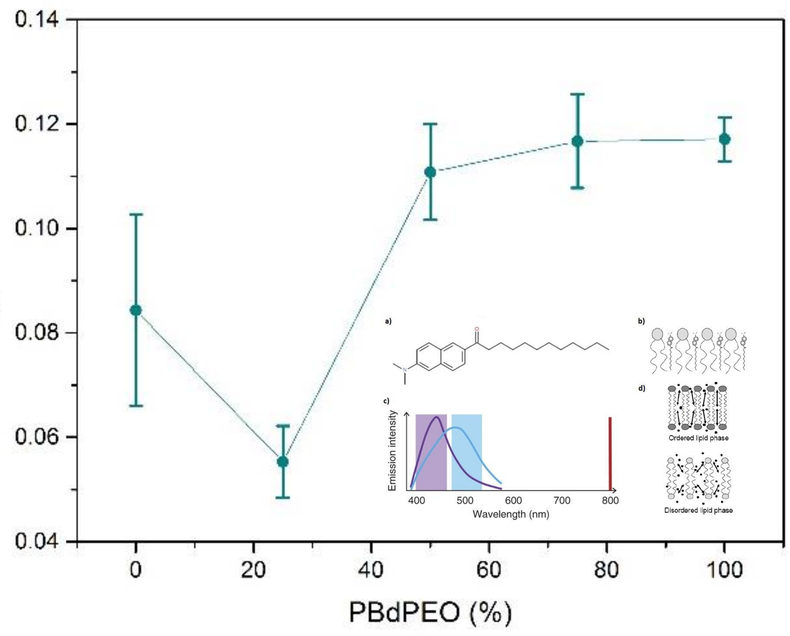
Cyro-EM images taken at **600+** days.

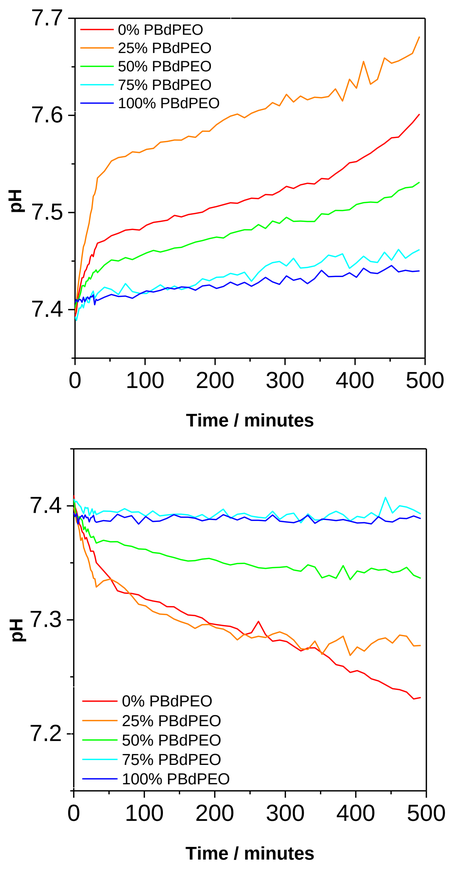


Laurdan is a fluorescent dye that is sensitive to the lipid environment and could be used to determine the membrane phase for hybrid vesicles[4].

Laurdan was included in the thin film and the red shift between lipid ordered (GP≤1) and disordered state (GP≥-1) was monitored.

As the PBd-b-PEO mol% increases the GP remains approx. the same, except for 25% PBd-PEO vesicles whose GP is **lower**.





Proton permeability is a property that could be affected by changes in membrane structure and dynamics.

HPTS is a pH-sensitive anionic pyranine fluorescent dye that is often used to observe the proton permeability of vesicles[5].

NaOH and HCl were added to vesicles with increasing mol% of PBd-PEO. In both cases, 25% PBd-PEO vesicles have the **largest** proton permeation coefficient[3].

Vesicle composition	1 M NaOH added		1 M HCl added	
PBd-PEO / mol%	$P*10^{11}$ (cm/s)	error$*10^{11}$ (cm/s)	$P*10^{11}$ (cm/s)	error$*10^{11}$ (cm/s)
0	5.5	1.4	16	6
25	11	6	29	9
50	3.3	1.8	17	8
75	1.9	0.3	10	4
100	0.8	0.6	1.8	1.7

Conclusion

- As PBd-b-PEO mol% increases the GP remains approximately the **same**.
- 50% and 75% PBd-b-PEO vesicles are the **least permeable** hybrids to protons.

Future Work

Use Cryo-electron microscopy and Small Angle Xray Scattering to determine **membrane structure** by mapping the **electron density** of hybrid lipid/co-block polymer vesicles.

Works Cited

1. Beales, Paul A., et al. "Durable vesicles for reconstitution of membrane proteins in biotechnology." *Biochemical Society Transactions* 45.1 (2017): 15-26
2. Khan, Sanobar, et al.. "Durable proteo-hybrid vesicles for the extended functional lifetime of membrane proteins in bionanotechnology." *Chemical Communications* 52.73 (2016): 11020-11023.
3. Seneviratne, Rashmi, et al. "A reconstitution method for integral membrane proteins in hybrid lipid-polymer vesicles for enhanced functional durability." *Methods* (2018) https://doi.org/10.1016/j.ymeth.2018.01.021.
4. Harris, Faith M., Katrina B. Best, and John D. Bell. "Use of laurdan fluorescence intensity and polarization to distinguish between changes in membrane fluidity and phospholipid order." *Biochimica et Biophysica Acta (BBA)-Biomembranes* 1565.1 (2002): 123-128.
5. Paxton, Walter F., et al. "Monitoring and modulating ion traffic in hybrid lipid/polymer vesicles." *Colloids and Surfaces B: Biointerfaces*159 (2017): 268-276.