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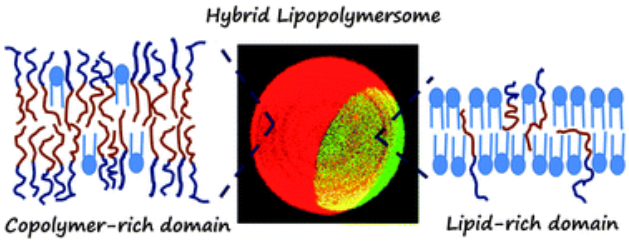
This proposal is representative of the projects currently on offer in our group. For more details of active research projects, please visit the Research and Publications sections of our webpage at: http://www.chem.leeds.ac.uk/paul-beales

Hybrid vesicles for biotechnology applications

Biology utilises membrane-bound vesicles as nanoscale reaction vessels and transport systems. They are composed of a thin spherical membrane shell that encapsulates an internal aqueous environment that is isolated from it surrounding environment. Synthetic vesicles are of interest in nanomedicine, synthetic biology, biosensing and nanoreactor systems, among other applications. Vesicles formed from natural lipids (liposomes) have high inherent biocompatibility and biofunctionality but their mechanical robustness and stability can be a potential drawback for many biotechnology applications. Amphiphilic block copolymers can also self-assemble into vesicle architectures (polymersomes) that have much greater stability and durability however they lack the biofunctionality of lipid-based systems. Therefore there has been a drive to develop hybrid lipid – block copolymer vesicles with the aim of synergistically combining the best features of these two systems (1, 2).



We are developing hybrid vesicle systems for several target applications:

- *Stabilisation of membrane protein function*. Membrane proteins are functional biological nanomachines that reside within the membranes of cells and can carry out a variety of tasks including substrate transport, signal transduction and targeted adhesion. There is great potential for the repurposing of membrane proteins in biotechnologies however these proteins are difficult to handle and lack long-term stability. This challenge might be overcome using hybrid vesicles where we have already demonstrated that hybrid vesicles can significantly extend the functional lifetime of membrane proteins (3) and we are planning to further develop and characterise these tools for membrane protein biotechnologies.
- *Controlled release nanomedicine formulations*. We are interested in using hybrid vesicles to formulate pharmaceutically active compounds to control their stability in biological fluids and circulation as well as control drug release rates to extend the timescale of therapeutic effect from a single delivered dose.
- *Protocells and nanoreactors*. We are encapsulating enzymatic reaction networks in the lumen of these vesicles to develop nanoscale reaction vessels and artificial cell-like materials. We are particularly interested in methods to make complex multicompartment architectures to facilitate multi-step reactions and communication between reactions in different sub-compartments. We are also interested in understanding the effects of encapsulation and confinement in feedback-responsive enzymatic reactions towards reconstitution of chemical oscillations, clocks and bistability.

Projects can cover any one of the above areas or a more fundamental understanding of the material properties of hybrid vesicles.

A project on hybrid vesicles for biotechnological repurposing of membrane proteins is available through the BBSRC DTP (https://www.findaphd.com/search/ProjectDetails.aspx?PJID=49346&LID=735; deadline 05/01/17). All areas are potentially available through application to the School of Chemistry.

Please contact Dr Paul Beales (p.a.beales@leeds.ac.uk) for further details about this opportunity.

References

(1) Nam J., Vanderlick T.K. and Beales P.A.; Formation and dissolution of phospholipid domains with varying textures in hybrid lipo-polymersomes. Soft Matter 8, 7982-7988 (2012)
(2) Nam J., Beales P.A. and Vanderlick T.K.; Giant Phospholipid/Block Copolymer Hybrid Vesicles: Mixing Behavior and Domain Formation. Langmuir 27 (1), 1-6 (2011)
(3) Khan S., Li M., Muench S.P., Jeuken L.J.C. and Beales P.A.; Durable Proteo-Hybrid Vesicles for the Extended Functional Lifetime of Membrane Proteins in Bionanotechnology. Chem. Commun. 52, 11020 - 11023 (2016)