MS80.O02

Novel Insights into the Mechanistic Routes of Lyotropic Phase Transitions

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When mixed with water, biological amphiphiles such as phospholipids can self-assemble to form a variety of lyotropic liquid crystalline structures including 1-D flat lamellar bilayers, 2-D hexagonal phases and 3-D bicontinuous cubic structures1. The role of the lamellar phase in nature is well understood – flat bilayers maintain the fundamental integrity of all living cells. However, non-lamellar phases also play a vital role in vivo. Extended cubic phases have been directly observed in cells and in addition, the repeating pores which form the continuously accessible structure of these bicontinuous phases are very closely structurally related to membrane pores formed during membrane fusion and fission. The equilibrium phase behaviour of pure phospholipids in water and simple model membrane mixtures has been widely studied but their out of equilibrium behaviour remains poorly understood. We have addressed this knowledge gap through pioneering work looking at the kinetics of phase transitions in phospholipid/water systems and phospholipid/protein/water mixtures using the pressure jump relaxation technique in conjunction with high speed, time resolved small angle X-ray diffraction. This presentation will provide an overview of how our bottom-up approach using model membrane systems has enabled us to establish the mechanistic routes and intermediates in a number of phase transition schemes including bicontinuous cubic to lamellar, hexagonal to lamellar and inter-cubic phase transitions.

Keywords: High pressure, Lipid, Protein