A088-04-250823 **Lipid Self-assembly and the Design of Lipidic Materials**

Interactions of biliary micelles with polar lipids and digestion products from milk

Andrew J. Clulow[1,2], Patrick Tai[3,4], Malinda Salim[2], Thomas Eason[2], Susanne Seibt[1], Timothy M. Ryan[1], David W. Everett[3,5] and Ben J. Boyd[2,6]

[1]Australian Synchrotron, ANSTO, 800 Blackburn Road, Clayton, VIC 3168, Australia; [2]Monash Institute of Pharmaceutical Sciences, 381 Royal Parade, Parkville, VIC 3052, Australia; [3]Riddet Institute, Palmerston North, New Zealand; [4]School of Food and Advanced Technology, Massey University, Palmerston North, New Zealand; [5]AgResearch, Palmerston North, New Zealand; [6]Department of Pharmacy, University of Copenhagen, Universitetsparken 2, 2100 Copenhagen, Denmark

Corresponding author email: clulowa@ansto.gov.au

Keywords: Milk, lipid self-assembly, lipid digestion, bile

Milk or milk-like emulsions are our sole source of nutrition for the first six months of life and milk lipids carry fat-soluble nutrients through the gut as well as providing most of the energy we consume from milk. The digestion and absorption of milk lipids and entrained nutrients is therefore crucial for infant survival and growth. Triglycerides make up 98% of milk lipids, with the remainder comprising polar lipids including sphingomyelins.[1, 2] Bile salts and phospholipids in the intestinal fluids combine to form a colloidal sink into which the poorly-soluble lipid digestion products can partition and be absorbed at the intestinal walls.[3] This work describes small angle X-ray scattering (SAXS) studies into how the structures of biliary micelles change when they absorb milk polar lipids and triglyceride digestion products under intestinal conditions (**Figure 1**).

Firstly, mixtures of fatty acids and monoglycerides were prepared that mimic the digestion products of human and bovine milk.[4] Structural changes occurring when biliary micelles were mixed with these milk-mimicking digestion product mixtures were found to be dictated primarily by the type of lipid chains present, with a secondary effect observed on varying the pH between 6.3 and 7.7 to simulate passage down the intestinal tract.

In a second study, the solubilisation of milk sphingomyelin-based vesicles by bile was investigated. It was found that incorporation of increasing amounts of cholesterol led to the formation of multilamellar vesicles that were increasingly stabilised against absorption into the biliary micelles. This was observed through both retention of diffraction features from the multilamellar vesicles and commensurately reduced increases in the radii of gyration of the biliary micelles upon mixing with vesicle dispersions of higher cholesterol content.

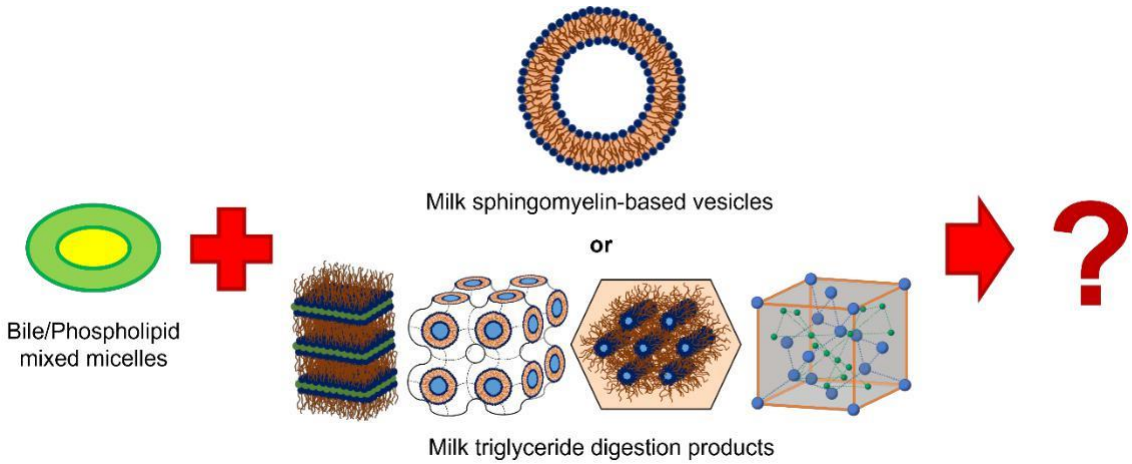

Figure 1 Bile salt/phospholipid mixed micelles self-assemble with milk polar lipids and triglyceride digestion products to form a variety of structures based on the lipid composition

[1] Jensen, R. G.; Bitman, J.; Carlson, S. E.; Couch, S. C.; Hamosh, M.; Newburg, D. S., Chapter 6 - Milk Lipids: A. Human Milk Lipids. In *Handbook of Milk Composition*, Academic Press: San Diego, **1995**; pp 495-542.

[2] Jensen, R. G.; Newburg, D. S., Chapter 6 - Milk Lipids: B. Bovine Milk Lipids. In *Handbook of Milk Composition*, Academic Press: San Diego, **1995**; pp 543-575.

[3] Carey, M. C.; Small, D. M., (1972) *Arch. Internal Med.* ***130***, (4), 506-527.

[4] Clulow, A. J.; Salim, M.; Hawley, A.; Boyd, B. J., (2021) *Food Hydrocolloids* ***110***, 106126.