"Protein Crystals on Lipids: Physical Chemistry in Nature"

Alice P. Gast

Ordering and the formation of crystals have long fascinated man. The reverence bestowed on gemstones and the fantastic properties attributed to crystalline matter arise from the unique optical, geometric and physical properties of the ordered state. While most attention has been given to molecular or atomic crystals, much can be learned from the study of colloidal and protein arrays as well. Since these crystals are typically filled with 50 percent or more solvent, the interactions can be readily tuned through subtle changes in the solution chemistry rather than difficult pressure and temperature excursions. Since such macromolecular arrays often contain dissolved ions, polymer molecules, surface-active molecules and other small solutes, they are referred to as a general class of ``complex fluids''. Their complexity is ameliorated somewhat by consideration of all of the colloidal particles or aggregates as an effective single component system with the interactions between particles mediated by the small molecule solutes and solvents.

We are studying the macroscopic morphology and molecular arrangement of two-dimensional streptavidin crystals bound to biotinylated lipid monolayers at the air-water interface and in bilayer vesicles. We show how the symmetry breaking in the binding process alters crystal morphology and how changing the pH and ionic strength of the sub-phase can change the crystalline lattice structure. Then, using our understanding of the key interactions between neighboring proteins, we make point mutations to alter these interactions and change the crystal structure. Finally mixing wild-type and mutant proteins we can further tailor the crystal structure and morphology. Producing these crystals on the surface of vesicles provides analogies with protein coats on cell surfaces. We see the influence of an ordered layer of proteins on the mechanical properties of vesicles.

I would like to acknowledge collaborations from:
Channing R. Robertson, Poe Ratanabangkoon, Sammy Farah, Szu Wang, Michael Yatcilla, Andrew Ku, Michael Gropper, Rudi Merkel, Erich Sackmann, Patrick Stayton, Elizabeth Kubelek, Roger Kornberg