Abstract

Compartmentalization in the cellular organization is essential for the efficient working of cellular processes. It is a characteristic feature of eukaryotes but also observed in prokaryotes under specific metabolic conditions. In prokaryotes, they are involved in concentrating the substrate and enzymes locally, thus enhancing enzyme efficiency and turnover number, preventing cross-talk between spatially isolated processes and isolating the harmful intermediates. These prokaryotic organelles are referred to as bacterial microcompartments and are subcategorized as Carboxysomes and Metabolosomes. They are entirely protein bodies made by the assembly of 18000-20000 protein units of 10 to 20 different types. They have an enzymatic core with a signature enzyme wrapped within a peripheral shell protein boundary. These shell proteins are unique as they have evolved by horizontal gene transfer and comprises of bacterial microcompartment domain protein and bacterial microcompartment vertex protein. Mutational variations in the shell proteins followed by growth studies, along with their X-ray crystallization, have been performed for the better knowledge of these vast complex macromolecular assemblies. All these studies to date supported complexity because of shape complementarity and similar genetic origin. This makes it difficult to understand the functions in vivo for individual components. This thesis primarily concentrates on the understanding of the organizational assembly of one such MCP, i.e., 1,2-Propanediol bacterial microcompartment and also its components. Based on a simple spectroscopic method, the complexity, organizational assembly, and composition of Pdu BMC are dissected. Protein compartments are fabricated from these self-assembling shell proteins to understand the functional role of individual shell protein in vitro. These protein shells are investigated for their stability and their capability to transport substrates and co-factors across the conduit channels. The Pdu BMC is also explored as a novel substrate for the development of bio-nano hybrids where gold nanoparticles are fabricated in 3D on its scaffold with having inorganic catalysis, as well as the core enzyme, showed bio-organic catalysis.