HIERARCHICAL ASSEMBLY OF VIRUS-BASED NANOREACTORS

Trevor Douglas

Department of Chemistry, Indiana University, Bloomington IN 47405

ABSTRACT

Viruses have emerged as useful platforms for synthetic manipulation with a range of applications from materials to medicine. Synthetic manipulation can impart new function to virus derived protein architectures, combining the best of evolution and directed synthetic design. An appreciation of these properties has resulted in a paradigm shift from the study of viruses as disease causing agents to investigations of them as supramolecular assemblies, which can be chemically and genetically modified.

The virus like particles (VLP) derived from the bacteriophage P22 provides an opportunity for constructing catalytically functional nanomaterials by directed encapsulation of enzymes into the interior volume of the icosahedral capsid. Directed enzyme encapsulation has been genetically programmed allowing biosynthesis and directed self-assembly of desired enzymes within the roughly 60 nm diameter P22 capsid. The resulting nano-reactors encapsulate multiple copies of the cargo enzymes, densely packaged within the capsid at local concentrations that mimic predicted high intracellular macromolecule concentrations. Using enzymes derived from many different organisms, we have encapsulated multi-enzyme pathways within the P22 capsid through a process of directed self-assembly. The resulting nanoreactors demonstrate the bioengineering of robust and complex coupled catalytic nanomaterials.

Using these nanoreactors, having single or multi-enzymes encapsulated within them, as individual building blocks we can extend the utility of the system towards complex materials fabrication. Through the directed hierarchical assembly of P22 nanoreactors we can create materials with long-range order that exhibit complex coupled catalytic behavior through communication of individual P22 nanoreactors.