Preface

Nanotechnology is a collective term describing a broad range of relatively novel topics. Scale is the main unifying theme, with nanotechnology being concerned with matter on the nanometer scale. A quintessential tenet of nanotechnology is the precise self-assembly of nanometer-sized components into ordered devices. Nanotechnology seeks to mimic what nature has achieved, with precision at the nanometer level down to the atomic level.

Nanobiotechnology, a division of nanotechnology, involves the exploitation of biomaterials, devices or methodologies in the nanoscale. In recent years a set of biomolecules has been studied and utilized. Virus particles are natural nanomaterials and have recently received attention for their tremendous potential in this field.

The extensive study of viruses as pathogens has yielded detailed knowledge about their biological, genetic, and physical properties. Bacterial viruses (bacteriophages), plant and animal eukaryotic viruses, and viruses of archaea have all been characterized in this manner. The knowledge of their replicative cycles allows manipulation and tailoring of particles, relying on the principles of self-assembly in infected hosts to build the base materials. The atomic resolution of the virion structure reveals ways in which to tailor particles for higher-order functions and assemblies.

Viral nanoparticles (VNPs) serve as excellent nano-building blocks for materials design and fabrication. The main advantages are their nanometer-range size, the propensity to self-assemble into monodisperse nanoparticles of discrete shape and size, the high degree of symmetry and polyvalence, the relative ease of producing large quantities, the exceptional stability and robustness, biocompatibility, and bioavailability. Last but not least, the particles present programmable units, which can be modified by either genetic modification or chemical bioconjugation methods.

Viruses have been utilized as scaffolds for the site-directed assembly and nucleation of organic and inorganic materials, for the selective attachment and presentation of chemical and biological moieties for in vivo applications, as well as building blocks for the construction of 1D, 2D, and 3D arrays. Here we have been fortunate to assemble a volume containing contributions by the leaders in the field, one that is marked as much by collegiality and good humor as it is by excellent science.

The chapters by E. Strable and M.G. Finn and by N.F. Steinmetz et al. address the fundamental means for performing chemistry on virion substrates and multilayered arrays. N.G. Portney et al. expand on this theme by generating hybrid virus-particle networks. The chapter by M.L. Flenniken et al. addresses the use of virus-like protein cages to generate novel materials that can be used for biomedical applications, and G. Destito et al. carry on this theme by describing the use of plant and insect viruses for biomedical imaging and vaccine purposes. Finally, P. Singh discusses harnessing the inherent tumor-targeting properties of certain viruses to achieve specificity in vivo.

Together, viruses harbor so many natural features that may be exploited for nanobiosciences. To date, it has not been feasible to synthetically create nanoparticles of comparable beauty and utility. Now there exists an unprecedented opportunity to capitalize on the vast knowledge of these VNPs and their material properties.

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