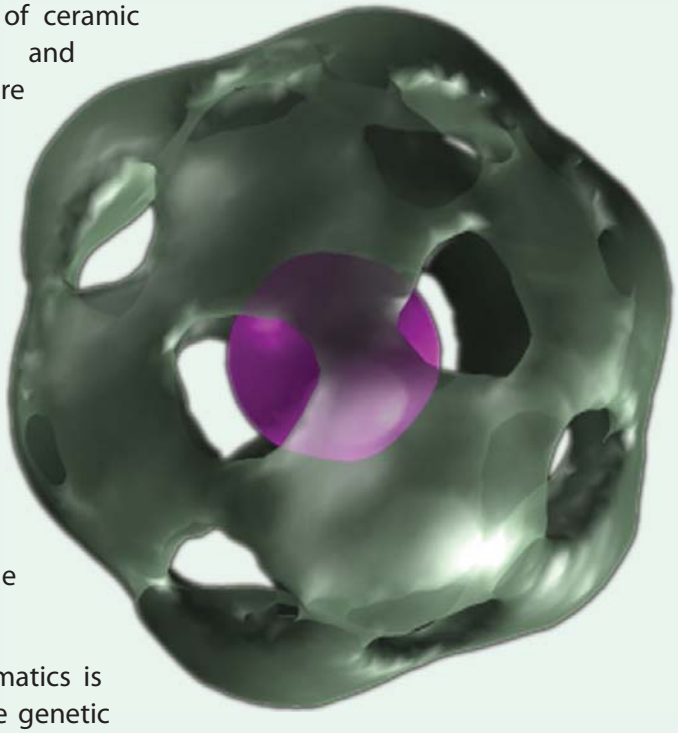
Letting Nature Do the Work

Nanobiotechnology

Interested Agencies: CSREES, DOD, DOE, FDA, NASA, NIH, NSF

A key challenge for nanotechnology is the fabrication and assembly of nanometer-scale materials, devices, and systems. Biology performs these functions in living cells, which in many respects act as integrated nanomanufacturing factories. A cell includes nanomaterials (proteins, membranes, etc.), nanodevices (motor proteins, ion channels, etc.), and even functional nanosystems (e.g., mitochondria) that are created from individual molecules by hierarchical self-assembly. Biological capabilities can be harnessed directly, borrowed, or taken as inspiration for future nanomanufacturing.

Naturally occurring nanostructured organisms such as diatoms have been converted from silica into a range of ceramic nanomaterials with new properties. Cells and viruses can also be engineered to manufacture or assemble nanomaterials. Certain bacteria naturally produce magnetic nanoparticles and have already been engineered to produce nanoparticles coated with specific proteins. Researchers have used biological methods to discover viruses that can be used as scaffolds for selective attachment and growth of semiconductor nanoparticles, and have produced the first virus-assembled nanoelectrode and virus-assembled battery. Scientists are also learning from processes organisms use to create complex inorganic nanostructures, including those with unique chemical, optical, and mechanical properties.



An image, reconstructed from transmission electron micrographs, of a biologically inspired complex composed of a semiconductor quantum dot encapsulated in a protein shell. Reproduced by permission from *Nano Letters*, © 2006 American Chemical Society.

Progress in genomics, proteomics, and bioinformatics is rapidly expanding our understanding of how the genetic code enables cells to turn molecules into nanostructures and nanosystems. Harnessing this biological knowledge will enable flexible, scalable, and affordable nanomanufacturing for the pharmaceutical, biochemical, nanoelectronics, and materials industries.