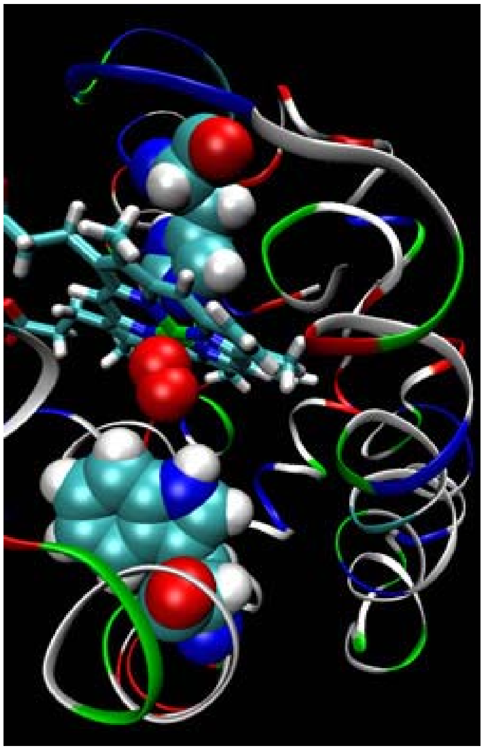
Chemistry & Materials

an overview of nsf research





**A computer simulation of protoglobin, an oxygen-carrying molecule recently discovered in single-cell microbes that live in hot springs and other extreme environments. Protoglobin appears to be a primitive form of the hemoglobin molecule found in the blood of humans and other mammals.**
Credit: © James Newhouse, Maui High Performance Computing Center; Maqsudul Alam, University of Hawaii

## Learning from Biology

Until recently, humankind's skill at molecular manipulation was nothing compared to nature's. Witness the precisely fabricated tissues of the human body, the intricate chemical control system of the genome, or the hair-like locomotive structure of a paramecium -- each a tour de force of biological complexity and precision.

Now, however, chemists and materials researchers have begun to learn some of nature's tricks, and are adding a few of their own.

Broadly speaking, their research is proceeding along two fronts: mimicking nature's *products*, and mimicking nature's *methods*. A good example of the first type is the work of Nicholas Kotov and his colleagues at Oklahoma State University, where they have developed a material similar to the mother-of-pearl lining found in seashells. Also called nacre, the natural form of this iridescent, white substance is renowned by materials scientists for its strength and flexibility, which derive from a structure that is densely layered at the nanoscale. The artificial nacre shows promise for use in the manufacture of lightweight, rigid composites for aircraft parts, body armor or artificial bone.

Another good example is the work of Samuel Stupp and his team at Northwestern University, where they have developed a series of molecular scaffolds resembling the structures of bone, nerves and other tissues. Each type of scaffold starts out as a gel of nanoscale molecular fibers that can be injected into the site of a broken bone, say, or a severed nerve. Once in place, the fibers will spontaneously assemble themselves into a biocompatible matrix that will speed and guide the body's natural healing process.

Meanwhile, in the effort to mimic nature's methods, we clearly have a lot to learn. Our current industrial methods for making molecules and materials typically involve some combination of heat, pressure, exotic raw materials, dangerous solvents and undesirable by-products. Yet living organisms can usually make what they need at ambient temperature and pressure using little more than air and water, plus some organic compounds derived from their food. Can we do as well?

Among the leaders in the effort to answer this question are Angela Belcher and her colleagues at MIT, who are trying to emulate the biological processes that give rise to materials like shell and bone. To do this, they create a matrix of natural or artificial protein molecules, which in turn provide a template for inorganic compounds, such as calcite, to deposit themselves in a precisely ordered array of crystals at the nanoscale. Depending on the precise composition, this nanostuctured material can then be used in a wide variety of electronic, magnetic and structural applications.

**Getting Greener [Next]**



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