Unveiling the three-dimensional structure of proteins thrills scientists. While the potential for understanding the folding and function of enzymes is truly exciting by itself, exploring macromolecule structures also satisfies a more fundamental urge: to see the invisible.

Scientists are sometimes so moved that they aspire to turn their discoveries into works of art. Rockefeller University professor Rod MacKinnon, for example, believes his potassium ion channel structure would make a great lamp.

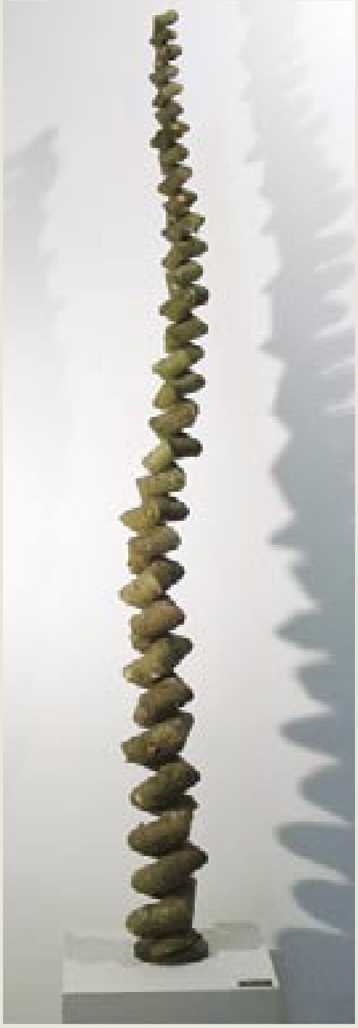
While many scientists recognize the artistry of Nature within this sub-microscopic realm, artists less often embrace biochemical entities as a subject for art. Julian Voss-Andreae is one who does. A sculptor with roots in physics, he creates art inspired by the three-dimensional structures of proteins.

Voss-Andreae first learned about proteins as a graduate student in physics. In 2000 he left his native Germany for Oregon, changing careers to pursue his interest in the mechanisms of the world through art rather than science. He gravitated to proteins as a subject matter, intrigued by how fundamental and universal they are to life. He has noticed that most artists focus on anthropocentric subjects, but he endeavors to "take that attitude out of art and use a more scientific view." He adds, "Proteins were built before we were."

The beauty of proteins first seduced Voss-Andreae. He chose subjects that appeal to his aesthetics, like Bovine Pancreatic Trypsin Inhibitor (BPTI) or Green Fluorescent Protein (GFP). He now prefers proteins with functions that interest him. When intrigued by protein in a research or news article, he will look up the structure in the protein data bank to see what it looks like—structures that often come from x-ray crystallography experiments such as those done at the Stanford Synchrotron Radiation Laboratory. Often his artistic choices reflect the protein's function. His sculpture of a light-harvesting complex has light in the center, and the heart of his hemoglobin sculpture holds a shiny red orb, inspired by the oxygen it carries.

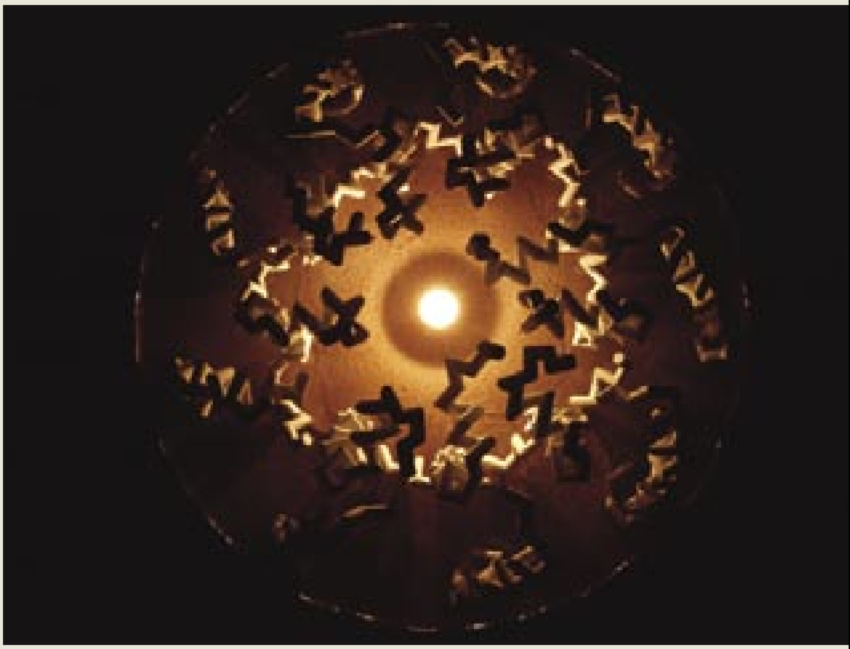
Creation of the sculptures has some similarities to the folding of proteins. Voss-Andreae starts with an essentially, one-dimensional material, like a steel tube or a tree trunk. He uses the entire length of the material, making 3-dimensional structure through mitered cuts, in which bends are created by rotating segments around a cut angle. He wrote a computer program that deciphers what cut angles will create a particular protein structure.

Hand-fitting the cut pieces together requires alterations to the original designs. Voss-Andreae says he was bothered by the inaccuracy, but now embraces it as part of his art. Often imperfections will inspire him to delve further into the artistic process. His goal is not to depict a perfect



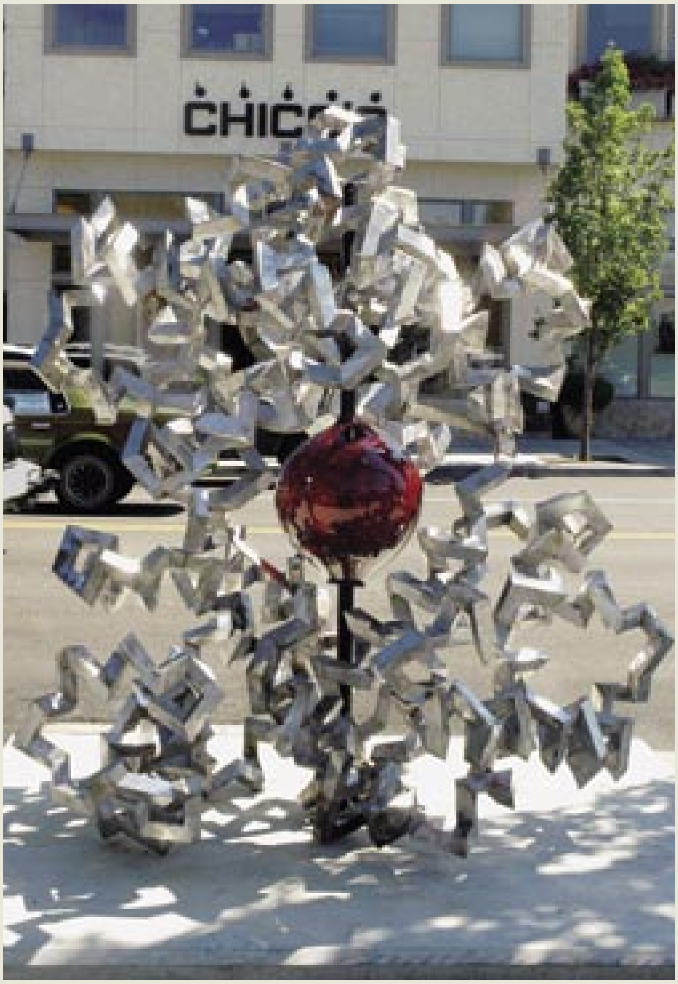
Tall Fir Alpha Helix
2003, Douglas fir and steel, height 10' (3 m)

To turn a 26-foot Douglas fir tree into an alpha helix required over 100 cuts. Voss-Andreae decreased the length of the pieces proportionally to the tapering top. He appreciates the association of the emergent S-curve shape with a human spine.



Light-Harvesting Complex
2003, wood, particle board, casting resin, diameter 25" (64 cm), top view

A realization of the importance of light to almost all life inspired the artist to turn 850 wood dowels into a light-harvesting complex. A candle in the center causes shadows on the wall to sway, like plants in the breeze.



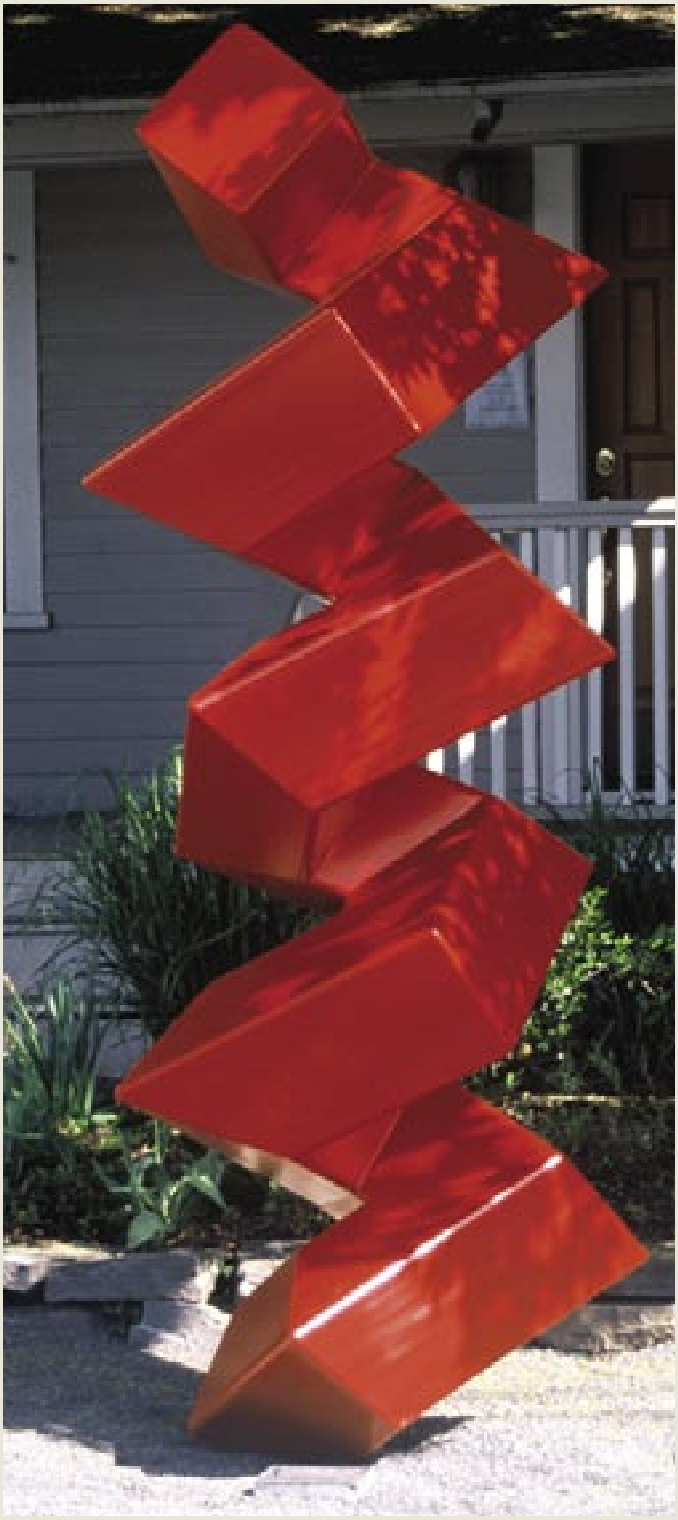
Heart of Steel Hemoglobin
2005, Weathering steel and glass, height 5' (1.6 m)
Location: 1st Street/A Avenue, City of Lake Oswego, Oregon

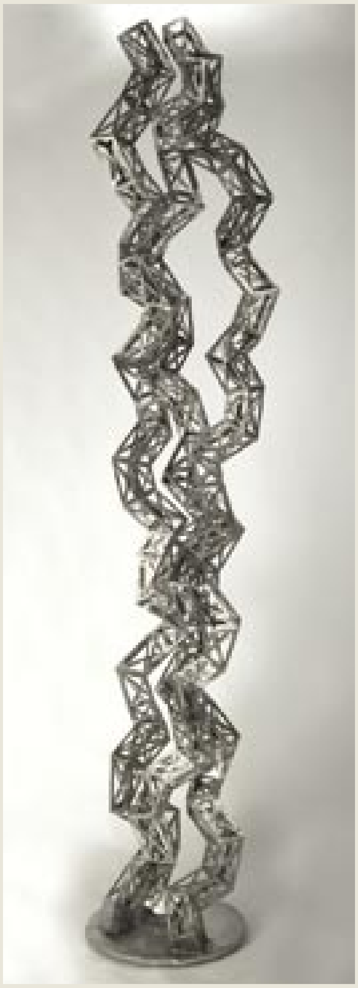
The four subunits of hemoglobin carry four oxygen atoms. The artist has chosen to represent the oxygen-couriering function of hemoglobin as a red, glass sphere in the center of the structure. The 170 feet of coiled steel tubing trembles when touched, suggesting molecular movement.

Alpha Helix for Linus Pauling
2004, powder-coated steel, height 9'3" (2.80 m)
Location: Hawthorne Boulevard, Portland, Oregon

Outside the boyhood home of Linus Pauling stands Voss-Andreae's homage to the discovery of a fundamental substructure of proteins. As the story goes, Linus Pauling discovered the structure of the alpha helix by fiddling with a piece of paper while sick in bed.

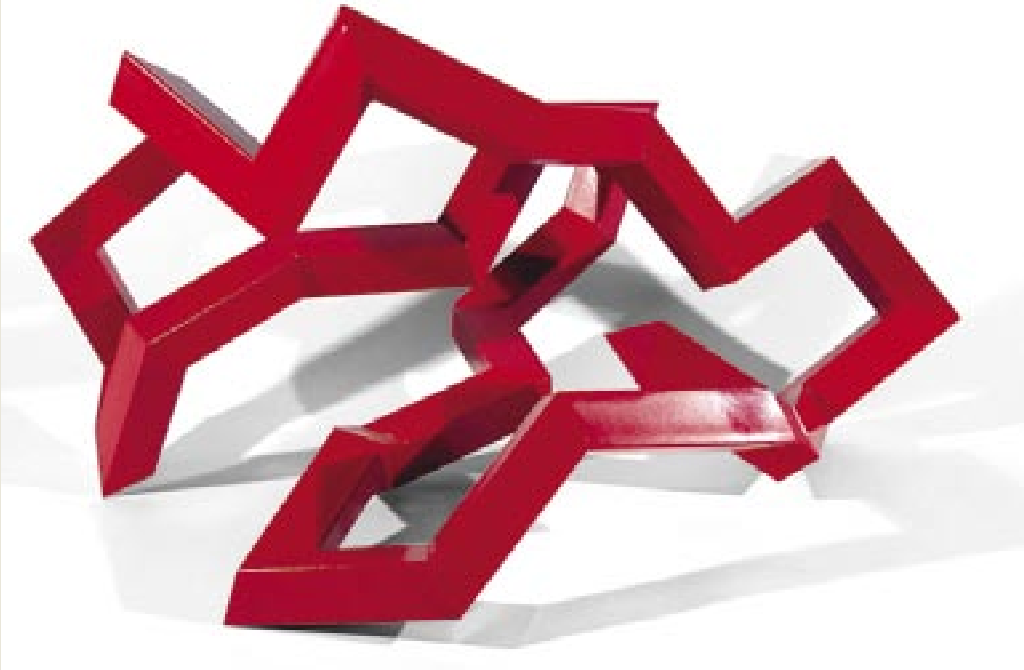
Voss-Andreae cut a single 20-foot steel beam into 15 pieces to create this 9-foot 3-inch tall structure. He colored this sculpture in primary red—reminiscent of the Lego blocks of his youth. Like Lego blocks, you can build proteins, perhaps, into anything.





Unraveling Collagen
2005, Stainless steel, height 11'3" (3.40 m)
Current location: *The Convergence of Art and Science* exhibition, Museum for Contemporary Art, Fort Collins, Colorado

Voss-Andreae highlights collagen's structural role in skin by cutting out the steel tubes in a pattern reminiscent of modern architectural structures. The most abundant protein in humans, collagen is also responsible for wrinkles as it degrades during the aging process. The artist symbolically shows this connection by loosening the top of the structure.



model, but to add his own subjective interpretation. He colored a sculpture red to evoke associations of protein building blocks with Lego building blocks and used hydrochloric acid on bronze, making a protein that is associated with disease look unhealthy.

Voss-Andreae hopes his sculptures will attract other artists to subjects inspired by science. He hopes to reverse what he sees as a general reluctance among artists to explore those aspects of nature that can only be viewed with scientific techniques. While many artists paint flowers, few paint molecules. He is actively trying to change this trend by lecturing to art students on science and its many opportunities for artistic interpretation.

He also hopes his sculptures will engage non-scientists, that people passing by his sculptures will be drawn into the micro-scale world and, perhaps, become interested in the fundamental building blocks of life. "I believe that my sculptures allow a glimpse of a world that is amazing and we take for granted," he says. "There's a lot of amazing stuff in science that has meaning for everybody."

Raven Hanna

Kalata
2002, painted steel,
length 3' (90 cm)

The kalata protein is the main active ingredient of an African medicine used to accelerate childbirth. This protein has a cyclic topology similar to a Möbius strip. Professor David Craik, who researches kalata at the University of Queensland, Australia, displays a copy of this sculpture next to the source of the protein, the plant *Oldenlandia affinis*.

Sculptures and photos: Julian Voss-Andreae

Raven Hanna is a freelance science communicator and artist based in San Francisco.