UC SANTA BARBARA

THE Current

December 12, 2001
Gail Gallessich

Bone Strength Probed by Scientists

The December 13 issue of the journal Nature reports on unique properties of bone revealed in experiments, by scientists at the University of California, Santa Barbara, with the atomic force microscope (AFM).

Collagen, the most abundant protein in the human body -- serving as a structural component of a variety of tissues including bone, tendon and skin -- reveals special properties which allow it to "bounce back" when pulled or stressed in laboratory experiments. The AFM operates by tapping and pulling with a tiny needle.

"We learned that the collagen in bone contains sacrificial bonds that rupture as collagen is stretched, and then they reform or heal," said James B. Thompson, first author and a graduate student at UC Santa Barbara.

"These sacrificial bonds provide a mechanism for dissipating mechanical energy in collagen molecules. The time scale required for sacrificial bonds to reform in collagen correlates to the time needed for bone to recover from microscopic indentations."

Besides stretching the collagen from bones, the scientists made small indentations in bone, and like foam rubber that is pressed down, discovered that the bone returns to its original shape. They found that this takes a stiffer force probe, or more force, to indent a bone than to stretch a collagen molecule.

"The surface can recover back to its original shape," said Thompson. "It takes about 30 seconds."

Like the sacrificial bonds in the very tough abalone shell, which has also been studied extensively in the lab of Paul K. Hansma, professor of physics, "these sacrificial bonds found within or between collagen molecules may be partially responsible for the toughness of bone," according to the article.

The article also states that "The longer the delay before the next pull, the more energy dissipation observed when pulling the collagen molecule(s) again."

For the stretch experiments the group used purified cow tendon, and for the indentation experiments they used collagen from the femur bone of a rat. Early, initial results came from studies of the bone of a t-bone steak.

Thompson said it is too early to tell what impact this study will have on human health and how the study might affect technology or medicine.

Hansma developed the atomic force microscope while at UC Santa Barbara in the 1980s.

All of the co-authors on the paper are based at UC Santa Barbara, and besides Paul Hansma they include: Johannes H. Kindt, Barney Drake, Helen G. Hansma, and Daniel E. Morse. Morse is chair of the Interdisciplinary Graduate Program in Biomolecular Science and Engineering, as well as professor of molecular genetics and biochemistry, molecular, cellular and developmental biology.

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.