Chemistry

Untangling a protein's omega loops

The molecular backbones of globular proteins have an intricate structure. Segments of these chains may be coiled in the form of a helix or folded into parallel strands. The rest is sometimes classified as "random coil," but generally, it is neither random nor coiled. Recently, Jacquelyn F. Leszczynski and George D. Rose of Pennsylvania State University's Milton S. Hershey Medical Center in Hershey took a closer look at one group of random-coil segments often loosely described as "loops." Their systematic study reveals that compact loops, shaped like the Greek letter omega (Ω), are common and may play an important role in the way protein molecules function. Their report appears in the Nov. 14 SCIENCE.

For their computer-aided survey of 67 proteins with known structures, the researchers established three criteria for defining omega loops. Such segments contain between 6 and 16 amino acids, they have no other regular structure, and the distance across the gap where the loop necks is less than 10 angstroms.

Leszczynski and Rose found 270 omega loops, about four per protein molecule. Only six of the smallest proteins studied have no loops. Most of the loops are highly compact because loop side-chain atoms appear to pack tightly within the loop core. Nearly always, the loops sit at the molecule's surface.

These surface loops may be involved in processes like antibody binding or molecular recognition, the researchers say. If the loops function as integral units, they could be useful in bioengineering experiments that involve "clipping and swapping" protein segments. Such swapping processes may have occurred naturally as part of evolutionary change.

Oscillating to a copper beat

Start with an alkaline potassium-thiocyanate solution, mix it with hydrogen peroxide and add a pinch of copper sulfate. The result is a solution that oscillates in color between dark yellow and pale yellow or colorless. This recipe is the most recent addition to the growing family of oscillating chemical reactions. It may represent, says Hungarian chemist Miklós Orbán of L. Eötvös University in Budapest, "a member of a fundamentally new group" of oscillating reactions. His report appears in the Oct. 29 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY.

Simple chemical oscillators are of interest because they provide insight into biochemical systems that regulate the heartbeat and other periodic biological processes. Until a few years ago, all of the known, nonbiological oscillators involved iodate, bromate or chlorite compounds (SN:9/19/81,p.188). "It was a little confining that these were all oxyhalogen systems," says Irving R. Epstein of Brandeis University in Waltham, Mass. In 1984, two chemists at the University of Montana in Missoula found an oscillator using only sulfide and sulfite ions with methylene blue as a catalyst. Later, Epstein and Orbán reported a simple oscillating system involving only sulfide ions and hydrogen peroxide. The new thiocyanate oscillator, says Epstein, "extends that work into another sulfur-based system."

The new system is noteworthy because it is one of the few that oscillates while sitting around in a stirred beaker. "The vast majority of oscillators now known require a flow in order to keep them oscillating," says Epstein. Fluctuations are seen in the color, the potential at a platinum electrode and the amount of oxygen produced.

Even in a flow system, in which fresh reactants are continually fed into a reaction chamber while products are removed, the thiocyanate oscillator shows unusual behavior. Depending on the flow rates of the different incoming solutions, the system may take on one of two steady states or an oscillating state. Moreover, slight perturbations can shift the system out of any one state into either of the remaining two.

Earth Sciences

Stefi Weisburd reports from San Antonio, Tex., at the meeting of the Geological Society of America

Keeping an eye on what was once afoot

One would think that remote sensing techniques would have little chance of detecting traces of prehistoric humanity in the land around the Arenal volcano in northwestern Costa Rica. The region, soaked by high rainfall, is covered by a lush tropical forest. And because the Indians who inhabited the area 4,000 to 500 years ago were few in number, their roads and villages were small and far between. Moreover, Arenal has erupted more than 10 times in the last 4,000 years, each time smothering the region with layers of ash.

But in spite of these obstacles, anthropologist Payson D. Sheets at the University of Colorado in Boulder and Tom Sever, NASA's only anthropologist, have shown that conventional remote sensing methods do indeed work in such an environment. They've seen their way clear to identify 62 archaeological sites, including villages, campsites and cemeteries. The researchers' most impressive accomplishment, however, is in using aerial black-and-white and infrared photographs to detect half-meter-wide buried footpaths, some of which have been traced for a few kilometers.

During the time they had been used, these paths were eroded down into trenches. Later, they were filled in with sediments that were better suited for plant growth than were the surrounding soils. As a result, grass growing above the paths is slightly greener than the grass on either side, a difference detected by the infrared data. And where a faint depression at the surface mirrors the shape of the footpath below, the researchers can detect shadows with the black-and-white photos. In nearly all cases, excavations have corroborated their interpretations of the remote sensing data.

The discovery of the footpaths is enabling Sheets and Sever to take a big step toward understanding the societal structure, rituals and resource use of the people who made them. "The paths tell us where to excavate and where to follow, literally in their footsteps, to the places that were of interest and of value to them," says Sheets. "And for the first time we can relate sites to other sites." Heavily used footpaths between a high-status cemetery and a spring, for example, indicate that people spent a considerable amount of time at the graveyard. Sheets hopes the paths will connect this cemetery to a village so they can find out what kinds of people ranked burial in the cemetery.

Sensing the voids underground

Geoscientists and engineers sometimes need to know if there are cavities buried in the ground. Forgotten shafts left in old coal and salt mines, for example, could collapse and damage overlying buildings if they are not filled in. One method used to detect underground voids is called electrotelluric sounding. This technique exploits the fact that an electric field penetrates into the earth to depths that depend on the field's frequency and the electrical resistivity of the ground. Because a cavity has a higher resistivity than the surrounding soils, its location and dimensions can be measured by monitoring the frequencies of naturally occurring electric fields that travel into the ground.

Recently Arnon Sugar, Michael Birkos and their colleagues at Geophysics International in Dallas demonstrated that electrotelluric sounding is a useful tool for archaeologists, who consider underground tunnels and caverns buried treasures. With the technique, the researchers were able to detect a 7-meter-high cavity in the tomb of the Ming dynasty Emperor Wan Li, who died in 1620. This tomb is part of a larger network of buried chambers, tunnels and tombs of 13 Ming emperors located near Beijing. Wan Li's tomb is the only one in this network that has been excavated. Sugar says the group plans to go to Guatemala in a few months to help archaeologists hunt for a system of tunnels made by the Maya.