levels of the chemokines identified by Lusso and Gallo.

The fusin discovery may point the way not only to understanding natural resistance but also to new therapies—drugs that render cells invulnerable to HIV infection by blocking its binding to the protein. And AIDS researchers hope that by stitching the fusin gene into a small animal, such as a rabbit, they can develop a relatively inexpensive lab model for testing AIDS vaccines and studying exactly how HIV destroys the immune system.

One cautious note comes from Berger, who stresses that there are likely to be several different fusinlike cofactors. As his paper explains, the mock HIV he and his colleagues used contained the surface protein from a version of the virus that was grown in a line of T cells maintained in lab culture. Isolates from such cell lines resemble HIVs typically found in people late in the course of their disease. The more commonly found HIV isolates from infected people differ markedly. In keeping with this, experiments described in the paper suggest that fusin acts as a cofactor only for HIV that can grow in the cultured cell lines. Other fusinlike proteins might serve the same role for different HIV strains. "This is not going to be the only cofactor," predicts Hoxie.

Researchers are optimistic that they will soon begin identifying the cofactors used by a wide range of AIDS viruses. Hoxie, for example, is already hard at work hunting for fusin relatives that might play a role in infection with SIV, the simian cousin of HIV, and HIV-2. "This paper is really a beginning," he says.

–Jon Cohen

MOLECULAR EVOLUTION

Just How Old Is That DNA, Anyway?

Ancient DNA: a treasure chest for molecular evolution, or fool's gold? A handful of research groups have reported recovering DNA from insects trapped in amber, plant leaves buried in clay, and even dinosaurs entombed in coal—samples as old as 135 million years (*Nature*, 10 June 1993). The finders hope to get at evolution's nitty-gritty by tracking genetic changes over millions of years. But DNA is not the most stable of molecules, and skeptics have shot back that intact DNA from old sources is more likely to be from some modern interloper in the sample, such as bacteria. About the only thing everyone agrees on is that they need—and haven't had—an independent test of ancient DNA authenticity.

Now they have one, based on changes in the organic material from which the DNA came: insect bodies, for instance, or dinosaur bone. On page 864, an international team of researchers reports that a chemical change that converts amino acids in proteins from one mirror-image form to another—a process known as racemization—takes place at virtually the same rate as the degradation of DNA. If the amino acids show this conversion to even a modest degree, then the original DNA in the sample is likely long gone, suggesting that any remaining genetic material is a contaminant. And when the researchers then used this test on a variety of ancient DNA samples, they found that only those from insects trapped in amber appear to stand the test of time.

"It's really nice work," says Rob DeSalle, an ancient DNA expert at the American Museum of Natural History in New York City. "It's kind of seeing how nucleic acids [in DNA] break down by proxy." In addition, the test should also be "extremely useful" in preserving rare fossils: Researchers have to damage fossils to get at the DNA, and a quick scan, using the test, will let them know when such destruction isn't warranted, adds Tomas Lindahl, a biochemist at the Imperial Cancer Research Fund in South Mimms, England.

The test relies on the type of amino acids that organisms use to make proteins. Amino acids naturally occur in mirror-image pairs, like a left and right hand, but biological systems only use the left-handed versions to build proteins. Once an amino acid is in a protein, however, water and other factors drive a chemical transformation that slowly racemizes this left-handed, or L form, converting it into a right-handed, or D form.

Jeffrey Bada of the Scripps Institution of Oceanography and his colleagues had worked out the racemization rates of different amino acids. And in 1993, Bada noticed—and later published—that the conversion of amino acids occurs at virtually the same rate as the major DNA degradation process. In that process, which is called depurination, free radicals in water break the bonds that hold certain nucleic acids to the sugar-phosphate backbone of DNA, ultimately severing the DNA strand.

Bada realized these similar rates could allow him to test ancient DNA provenance. If amino acids from a 25-million-year-old insect were highly racemized, for example, then any DNA accompanying them should be damaged. Intact DNA would be recent.

Together with ancient DNA experts Hendrik Poinar, Mattias Höss, and Svante Pääbo at the University of Munich, Bada tested this notion by examining the amount of amino acid racemization in 26 different samples of organic remains ranging from 50 to 40,000 years old. Some of the samples had yielded intact DNA whose authenticity had been verified, in part, by comparing it with DNA from related living species: A DNA sequence from an ancient horse bone, for instance, looked very much like modern horse DNA. Others didn't contain any intact DNA. In the samples yielding intact DNA, almost all the amino acids were indeed of the L form. But in those where no DNA could be isolated, a higher concentration of the amino acids turned up D. For aspartic acid, which racemizes faster than other amino acids, the D/L ratio was always 0.08 or higher when no DNA was present.

G. POINAR

The great amber hope. A test indicates specimens bound in amber, like this ancient bee, are the only ones likely to yield ancient DNA.

When they looked at a variety of older samples, ranging from 17 million to 65 million years old, the scientists found that the racemization of aspartic acid remained below the magic value of 0.08 only in material embedded in amber. The D/L ratio in dinosaur bones said to have yielded ancient DNA, in contrast, was a minimum of 0.17. "That makes it unlikely they should be able to find ancient DNA in these samples," says Pääbo. Moreover, in all of the dino samples, the amount of racemization of other amino acids, such as alanine, was equal to if not higher than that of the aspartic acid. Because aspartic acid normally racemizes faster than alanine, this indicates something is seriously wrong with the entire sample, not just the DNA. Poinar calls this pattern the "red flag of contamination." The group reached similar conclusions for 17-million-year-old plant samples found in Idaho.

Amber, which is a form of fossilized tree resin, likely owes its unique ability to preserve biological molecules to its ability to seal out water, Pääbo says. As for dino DNA, "it looks bleak," acknowledges Scott Woodward, a molecular biologist at Brigham Young University in Provo, Utah, who in 1994 claimed to have found some from a bone (*Science*, 18 November 1994, pp. 1159 and 1229). He adds, however, that the new test is not a direct measure of DNA integrity but a correlation, so there is still room for hope. And hope, if not DNA, springs eternal.

–Robert F. Service