Human Genetic Origins Go Nuclear

A new method of "absolute genetic dating," announced by scientists last week, promises to rejuvenate molecular studies of the evolution of humans and other animals. While it has not yet resolved disputes over humanity's origin, the technical advance has undoubtedly shifted the terms of the debate.

David B. Goldstein of Pennsylvania State University in University Park and his colleagues devised a way to measure genetic variation between populations at certain sites in nuclear DNA. This enabled them to calculate that an initial split in human evolutionary development probably occurred between Africans and non-Africans about 156,000 years ago.

"Our genetic data suggest that modern humans originated in Africa and spread from there to the rest of world sometime during the last 150,000 years or so, lending strong support to the out-of-Africa theory of modern human origins," Goldstein and his coworkers conclude in the July 18 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

Most prior studies of genetic evolution used mitochondrial DNA, which is found outside the cell nucleus. Although this approach often supported the out-of-Africa model, statistical flaws undermined it (SN: 2/22/92, p.123).

Supporters of multiregional evolution argue instead that *Homo sapiens* evolved simultaneously in different parts of the world, beginning 1 million or more years ago (SN: 6/20/92, p.408).

Goldstein's group studied nuclear DNA segments called microsatellites. Nuclear DNA consists of 23 pairs of strandlike chromosomes, built up from structural units called nucleotides. At microsatellite sites, chromosome pairs carry repeated nucleotide sequences; these sites often contain between two and five nucleotide repeats, but the number can reach 40 or more.

Several thousand microsatellites have been identified over the past decade. No one understands their functions fully. Because nucleotide repeat sequences often get added or deleted as a unit, the researchers theorize that the extent of population differences at microsatellite sites marks the passage of time since groups halted consistent interbreeding.

They applied a new statistical method for measuring the extent of multiple microsatellite differences to 30 microsatellite sites in 14 native populations from around the world. The entire sample consisted of 148 individuals.

An evolutionary tree reconstructed from the microsatellite evidence shows an initial split between Africans and non-Africans, the researchers contend. If the time span between ancient human generations averaged 27 years, the observed microsatellite differences indicate that the split occurred about 156,000 years ago, they maintain. That number may range from 75,000 to 287,000 years ago, depending on the accuracy of their estimate for microsatellite mutation rates.

It also remains unclear whether small, isolated groups of prehistoric people evolved independent microsatellite mutations that further complicate attempts to date human genetic origins, writes Penn State's Masatoshi Nei in an accompanying comment. Still, Nei suspects that the genetic split of Africans and non-Africans dates to around 115,000 years ago if, as he suggests, an average of only 20 years separated succeeding prehistoric generations.

Goldstein's new measure of microsatellite differences represents a significant advance, says Alan R. Templeton of Washington University in St. Louis. But Goldstein uses the measure to help date an assumed split between Africans and non-Africans, which other genetic data indicate never occurred, Templeton holds (SN: 9/25/93, p.196). His earlier mitochondrial DNA analysis indicates that human populations grew separately within continents for nearly 1 million years, with occasional interbreeding across continents. *— B. Bower*

What makes gold such a noble metal?

A glorious, glistening metal well known to jewelers, bankers, and thieves, gold enchants artisans while mystifying scientists. So malleable is the precious metal that a craftsman can hammer an ounce of gold into a 300-square-foot sheet.

But why, chemists wonder, does gold remain tarnishfree? How does it manage to resist corrosion, shrugging off even the most highly reactive gases?

In an effort to shed light on gold's distinctive qualities, Jens K. Norskov and B. Hammer, both physicists at the Technical University of Denmark, studied the effects of hydrogen gas on a gold surface and compared them to similar interactions on surfaces of copper, platinum, and nickel—gold's neighbors on the periodic table.

The physicists found that gold's surface structure provides little freedom for bonding. Molecules hold only loosely onto the metal and fail to form long-lasting molecular or electronic attachments. Consequently, even reactive molecules tend to slide away without bonding or affecting gold's chemically unreactive surface, the researchers report in the July 20 NATURE.

"The unique role that gold plays in society is to a large extent related to the fact that it is the most noble [unreactive] of all metals," the scientists state. "It is the least reactive metal towards atoms or molecules at the interface with a gas or a liquid." Yet gold's inertness "does not reflect a general inability to form chemical bonds," since it does form stable alloys with other metals.

The physicists examined the way hydrogen molecules (H_2) dissociate, or break loose, at gold's surface. They measured, for instance, the energy necessary for chemical adsorption and the height of activation barriers, which determine how much energy is needed to prompt a reaction.

In their experiments, they distinguished between gold atoms' ability to break and form bonds and the ease with which they form new compounds, such as gold oxides. The two qualities are related: To make a compound, gold atoms must bond with other atoms, yet they cannot do so until they have sundered their bonds with neighboring gold atoms.

As a result, the scientists find that gold's nonreactivity rests on the inability of molecules adequately to fill gaps in the orbits of a gold atom's electrons.

Since gold and similar metals play such a major role in catalysts and microelectronics, studying the surface bonds of these metals has enabled scientists to fabricate more efficient devices, says Donald R. Hamann, a physicist at AT&T Bell Laboratories in Murray Hill, N.J.

"There's a legitimate, long-range goal driving research on metal and semiconductor surfaces," he says. *— R. Lipkin*