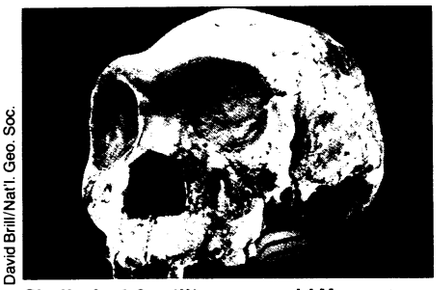
Human Ancestors Make Evolutionary Change

Some scientists believe that *Homo erectus,* the species directly ancestral to modern humans, is a model of evolutionary stability and a prime example of the theory of "punctuated equilibrium," which holds that individual species have a clear beginning and end (SN: 7/25/81, p. 52). This view was fostered by a recent study indicating that for nearly 1.5 million years these precursors of *Homo sapiens* remained largely the same, rapidly changing in form and developing larger brains only when a new species was about to appear.

Several lower forms of life are undoubtedly marked by long periods of relatively little change followed by rapid transformations into new species, a cornerstone of punctuated equilibrium theory, but this pattern clearly does not apply to *H. erectus,* contends an anthropologist who recently trekked throughout the world to survey all known *H. erectus* specimens. "It appears that there are significant evolutionary changes within a conservatively defined sample of *H. erectus,*" says Milford H. Wolpoff of the University of Michigan in Ann Arbor.

Wolpoff, whose research itinerary included stops in China, Indonesia and North America, took a variety of skull, jaw and dental measurements from 92 of these "prehumans." He divided the specimens, which date from about 1.4 million years old to 400,000 years old, into early, middle and late *H. erectus* groups. Averages of the measurements for each group were compared across the 1-million-year span.

With only a few exceptions, he found pronounced differences between the early and late *H. erectus* samples. The changes are in the direction of a modern profile, reports Wolpoff in the just-released Fall 1984 PALEOBIOLOGY; cranial capacity expands while jaw and tooth size shrinks. The few skull and jaw features that remain stable do not detract from the evidence that two major "adaptive systems" of the *H. erectus* lineage changed substantially over time, he says.



David Brill/Nat'l. Geo. Soc.

Skull of a 1.6-million-year-old H. erectus *youth, discovered after Wolpoff's survey.*

Wolpoff also studied 13 individuals who are either late *H. erectus* or early *H. sapiens.* There is no distinct boundary between the two species, he says, again suggesting that in this case punctuated equilibrium theory does not apply. That theory, as proposed in 1977 by Stephen J. Gould of Harvard University and Niles Eldredge of the American Museum of Natural History in New York City, assumes that there are clear demarcations between successive related species, and that evolutionary changes are often spontaneous responses to unexpected environmental demands. The continuous, although not necessarily constant, rates of change within *H. erectus* do not reflect this assumption, adds Wolpoff.

Gould and Eldredge first used *H. erectus* as an example of their theory following a 1981 report by G. P. Rightmire of the State University of New York at Binghamton. He studied 65 individuals designated as *H. erectus* and concluded that the species did not significantly evolve over time.

But Rightmire's study is seriously flawed, says Wolpoff. Up to 16 of the specimens he used may not be *H. erectus,* and his statistical analysis was not adequate to uncover evolutionary changes.

Rightmire acknowledged to SCIENCE NEWS that he would take a different statistical approach if he conducted a new study. "But it's difficult to see [Wolpoff's study] as a coherent statement on the entire species," he argues. "Wolpoff is hardly following a conservative approach to defining *H. erectus.*"

When two specimens that may not be *H. erectus* are taken out of Wolpoff's early sample and another is removed from the late sample, there is no statistically meaningful difference between the cranial capacities of the two groups, says Rightmire. "There are signs of rapid evolutionary change, especially in brain size, as *Homo erectus* gave way to *Homo sapiens,* although this does not necessarily mean there was a branching of species as punctuated equilibrium theory predicts."

"[Rightmire] is absolutely wrong," re-

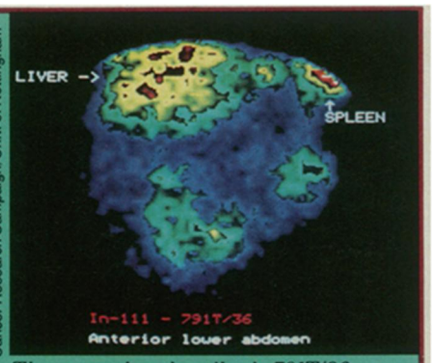
Aiming at cancer

What do you do with a semipowerful guided missile? Monoclonal antibodies, the proteins produced by immune system/cancer cell hybrids, have become important seek-and-bind weapons in diagnosing cancer and other illnesses (SN: 5/7/83, p. 296). But the missiles are not as good at search-and-destroy missions — researchers have had only limited success in using monoclonal antibodies alone against cancer (SN: 8/22/81, p. 117). Now, others are arming the antibodies with radioactivity, drugs or toxins. Clinical trials of immunotoxins — antibodies linked to drugs or toxins — are just beginning.

The first step in the process is getting a good antibody (see photo). Robert W. Baldwin and his colleagues at the University of Nottingham in England have hooked an antibody called 791T/36 to methotrexate, a widely used anticancer drug. The antibody is the product of a mouse spleen cell fused to a long-lived mouse tumor cell. It seeks out certain types of cancer cells, though it is not completely specific and will bind to some normal cells. In conjunction with the Xoma Corp. of Berkeley, Calif., Baldwin will begin human testing of the immunotoxin in September, he said at the recent American Cancer Society seminar for science writers in San Diego.

In a separate study begun last October, researchers from the University of California at San Francisco and Xoma Corp. initiated what they believe to be the first trials of immunotoxins in humans. They are using melanoma antibodies hooked to a fragment of the potent plant toxin ricin. Safety trials on several patients with melanoma have been completed and efficacy trials will begin soon, says Xoma spokesperson Carol DeGuzman.

Hooking a drug to an antibody can improve drug penetration — with the methotrexate-antibody conjugate, more drug is pushed into the cell than if the drug alone were used. Still, Baldwin says, "There are enormous problems to be solved," among them the body's potential to produce antibodies to the antibody. "But I think it will develop into a usable approach." —*J. Silberner*



Cancer Research Campaign/Univ. of Nottingham

The monoclonal antibody 791T/36, labeled with radioactive indium to reveal its location, attaches to cancer cells as well as to healthy liver and spleen. Here it shows a recurrent tumor (at bottom) and an unsuspected tumor (middle right).

sponds Wolpoff. There is no justification for removing the three specimens from the study, he says, but even without them the sample is large enough to be unaffected by the loss of a few individuals.

"The more interesting issue now is to examine the speed and direction of evolutionary change in *Homo erectus*," says Wolpoff.

Adds Philip D. Gingerich, director of the Museum of Paleontology at the University of Michigan: "I think Wolpoff was quite conservative in his definitions of which specimens are *Homo erectus*. We always want more details, but his study is a step above anything that has been done before." —*B. Bower*

Standby storage for nuclear waste

A cleared construction site near the Clinch River in Tennessee is the preferred location for temporarily storing high-level radioactive waste until a permanent repository is ready, Department of Energy (DOE) officials announced last week. This "monitored retrievable storage" (MRS) facility, costing about $1 billion to build, would process, package and store up to 15,000 tons of spent nuclear fuel from the nation's licensed nuclear power plants (SN: 1/7/84, p. 5; 1/5/85, p. 6).

The Clinch River site, abandoned since late 1983 when Congress killed the breeder reactor project that was to occupy the land (SN: 11/19/83, p. 329), is near enough to most of the nation's nuclear power plants to reduce the distance spent nuclear fuel must be shipped to get it to a storage facility, says Ben C. Rusche, director of DOE's Office of Civilian Radioactive Waste Management. DOE's two alternative storage sites are also in Tennessee: one on federal land near Oak Ridge and the other at the Tennessee Valley Authority's canceled Hartsville nuclear plant site northeast of Nashville.

"Siting, construction and operation of an MRS can be based on available technologies," says Rusche. "Facilities essentially identical to the proposed MRS have been built, licensed and operated safely over the last 30 years. For this reason, we are confident that we can adhere to the strictest safety standards."

Next January, DOE will submit to Congress a detailed proposal including environmental assessments and two facility designs for each location. This will allow Congress to choose one of the six possible combinations of design and site. If approved by Congress, the MRS facility could begin operating as early as 1996. DOE is obligated on Jan. 31, 1998, to begin accepting shipments of spent fuel for final disposal, whether or not a permanent geological repository, already behind schedule, is completed and able to accept radioactive waste by then. —*I. Peterson*

Stringing together a unified theory

Physicists are eagerly pursuing a unified field theory that will explain everything in physics, even though the search has frustrated Albert Einstein and a number of other intellects over the years.

The latest approach, which promises to overcome some of the difficulties of the others and to be unique where they are troublesomely multiple, leads to what are called superstring theories. They get their name from the change they make in the basic mathematical way in which fundamental particles are represented. The fundamental particles in all these unified theory attempts are the quarks (out of which neutrons, protons and a host of others are built) and the leptons (building blocks of electrons, muons and neutrinos). It has been customary to represent them as geometrical points, dimensionless objects without any spatial extension. That simplifies the mathematical operations. The superstring theories, however, represent them as strings, geometrical objects that extend in one dimension.

Such a change is necessary to provide a theory that will include gravity and subatomic phenomena and be consistent with the quantum mechanics that govern the subatomic domain, according to Michael B. Green of Queen Mary College of the University of London (now temporarily at California Institute of Technology). Such a union of gravity and subatomic phenomena has been the sticking point of other approaches.

Superstrings are no longer than 10^{-35} of a meter, as Green pointed out at last week's meeting in Crystal City, Va., of the American Physical Society. But that is enough to give theorists "the hope...that this will provide a realistic unified theory that will explain observations with few or no free parameters," he writes in the April 4 NATURE. Free parameters are mathematical terms that can be adjusted more or less at will to make predictions of experimental values come out correctly. Theorists don't like free parameters. A good theory should predict correct experimental values without any such fiddling.

Superstrings are so short that they almost look like points. But choosing them yields a mathematical derivation that determines almost uniquely the mathematical group that can be used to represent the symmetries of physics. Superstrings also specify uniquely the number of dimensions in which to calculate. These two features get rid of a lot of free parameters.

Symmetry is a basic principle on which physical explanations or theories are built. Physicists notice symmetries in the properties of subatomic particles and in the processes and interactions they engage in. They try to represent symmetries with mathematical groups. Mathematically, a group is a collection of related objects with a rule that allows one member to be generated out of other members. For instance, the real numbers are a group, with the ordinary rules of arithmetic. Other groups come from geometric operations, such as the possible rotations of an equilateral triangle or those of a regular hexagon (with appropriate combining rules).

These geometrically derived groups are particularly useful for representing physical symmetries. In general, the larger the group, the more physical symmetries can be included in a given formulation. Theorists have tried quite a variety of them. Superstring theory limits the choices to two, thereby chucking a lot of free parameters.

The two allowed groups, Green says, have the advantage of being huge. They start out with the ability to contain very many symmetries, so, as the theory is broken to subtheories of different classes of phenomena, the smaller groups into which these two can be broken have more than enough symmetries to accommodate any needs. They also contain nature's one notorious asymmetry, known as chirality (from the Greek word for hand). In some phenomena, nature distinguishes between left-handed and right-handed things. Other approaches to unified field theory do not successfully explain chirality, Green says.

Superstring also determines that 10 dimensions should be used. Frustrated in attempts to derive a consistent theory in the four dimensions we experience (three of space and one of time), theorists have gone into more dimensions, hoping that when they were finished they could return the theory to our experienced four dimensions by "compacting" the extra dimensions. That is, the extra dimensions are so tightly curved that an object moving along them comes back to its starting point after no more than 10^{-35} meter; we are not able to notice such tightly curled dimensions. In other approaches, various numbers of dimensions from five to 26 have been tried. By specifying 10, superstring gets rid of many important free parameters.

Superstring theories have a long way to go, however, before they reveal the mass of a top quark or of a tau neutrino or other similar things they are supposed to tell us, but NATURE's editor, John Maddox, writing in the April 4 issue, calls them "...the best hope yet that theories of particle physics will be united with gravitation...." —*D. E. Thomsen*