SCIENCE & TECHNOLOGY

Genetic 'fingerprinting' helps identify criminals, but critics raise concerns about its reliability and misuse

The Jury Is Out on DNA

By Simson L. Garfinkel
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MORE than a dozen police laboratories around the United States use DNA, the genetic code in every human cell, to perform identity tests. This relatively new forensic technique is rapidly gaining in popularity.

"The FBI has trained over 240 crime laboratory technicians from 80 different agencies around the country," says John Hicks, assistant director of the Federal Bureau of Investigation Laboratory in Washington, D.C. "Within the next year, I would expect that you would see a tremendous increase in the number of laboratories that are on-line."

The FBI is also laying the groundwork for a national databank of DNA information collected from crime scenes and convicted felons. Such a databank would help in the investigation of crimes and in catching repeat offenders, Mr. Hicks says.

DNA – deoxyribonucleic acid – is the molecular basis for heredity. Scientists say that each individual, except for identical twins, has a unique sequence of DNA.

But DNA identity tests are increasingly coming under attack. Last month in Massachusetts, the state's Supreme Judicial Court ordered a new trial for a man convicted of raping a 14-year-old disabled girl, saying that the scientific community does not have widely accepted uniform methods for testing and interpreting DNA evidence. In Arizona, a superior court judge ruled that the results of a DNA test could not be introduced in a trial because the apparent scientific accuracy of the test might convince a jury of the defendant's guilt, even though the scientific community itself has questions about the underlying test.

"They've rushed to the courts with this, instead of doing the real hard groundwork that they need to make a good system," says Richard Lewontin, a professor of population biology at Harvard University, who is an outspoken critic of DNA identification systems.

Proponents of the technology disagree. "Having testified as an expert in over 50 cases, I would say that the introduction and the acceptance of this technology has been very good in the courts," says Michael Baird, director of research at Lifecodes, a New York company that pioneered the identification technique. Dr. Baird says DNA evidence has been used in more than 400 cases.

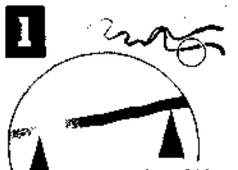
Using DNA identity testing, sometimes called "DNA fingerprinting," scientists say they can determine if two samples of human tissue or bodily fluids came from the same person. The test needs only tiny amounts of genetic information for success: a drop of blood, saliva, or semen, a few hair roots, or a piece of skin.

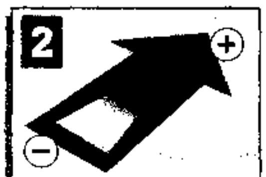
THE tests were pioneered between 1982 and 1986 by Cellmark (Rockville, Md.) and Lifecodes (Valhalla, N.Y.). In 1986, the FBI developed its own system, Hicks says.

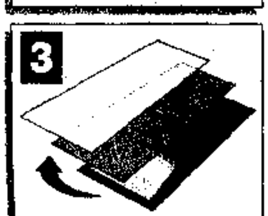
DNA testing is likely to have the biggest impact in rape cases, says Bruce Budowle, an FBI re-

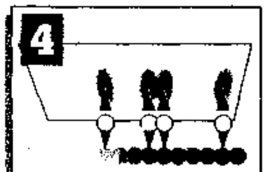
JOHN VAN PELT – STAFF

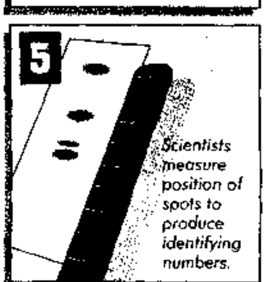
Fingerless 'Fingerprinting'


Long-chain DNA molecules are chemically 'cut' at specific points.


Molecule fragments are put in an electric field that sorts them by size — 'gel electrophoresis.'


Fragments are transferred (blotted) to a nylon membrane covered by X-ray film.


Fragments are treated with radio-active probes; where the probes stick, spots are produced on the film.


Scientists measure position of spots to produce identifying numbers.

Every cell of the human body contains a complete copy of that individual's DNA — deoxyribonucleic acid, the genetic blueprint of organic life.

Surprisingly, most of DNA that all humans share is identical. Only 1 percent of the genetic code between any two individuals has any difference at all, says Dr. Paul R. Billings, chief of genetic medicine at the Pacific Presbyterian Medical Center in San Francisco. DNA identification testing finds those differences and makes them plainly visible.

In the test, DNA is chemically extracted from a small number of cells — from a drop of blood, a semen smear, a drop of saliva, or a few hair roots. The long chains of the DNA molecule are treated with special enzymes that cut the molecule at specific points, wherever particular patterns of DNA occur **(1)**. These patterns occur at different places on each individual's DNA.

Next, the DNA fragments are put in an electric field that sorts them by size **(2)**, a technique called gel electrophoresis, and then are transferred onto a nylon membrane **(3)**.

Finally, the DNA fragments are treated with radioactive probes **(4)**. The probes stick to some DNA fragments but not to others. A piece of X-ray film is put on top of the membrane; wherever the probes stick, a spot is produced on the film.

Typically, each probe produces two spots: one for the genetic contribution from each parent. Using a ruler, scientists measure the position of the spots on the film and produce a set of numbers **(5)**.

Actual DNA tests use at least four probes. Experts claim that the pattern of numbers is unique, and the odds of two individuals having the exact same match are millions to one.

— S. L. G.

Archaeo-Chemists Track Ancient DNA

ROBERT C. COWEN

THE molecule that carries the genetic blueprints of plants, animals, and humans – DNA – has opened a new window into the past.

Its ability to reflect both differences and linkages between individuals and families, as well as between larger groups, is the key to a fast-growing science of biomolecular archaeology that would have seemed a science fiction dream even a decade ago.

In one of the latest developments, Peter Parham and David A. Lawlor at Stanford University in Palo Alto, Calif., and William W. Hauswirth and Cynthia D. Dickel at the University of Florida at Gainsville have studied DNA from the nuclei of cells in human brain tissue. It is preserved at what is known as the Windover site – a swampy pond in central Florida. Remains of 165 individuals in the pond are 6,990 to 8,130 years old.

As the archaeo-chemists explain in describing their research recently in Science, they have just begun to study distinctive features in such DNA. They say that further work "may determine familial relationships between Windover individuals and further define the relationship between this ancient population and modern Amerindian populations."

That would supplement a 1989 study by Swedish biochemist Svante Pääbo. While doing postdoctoral work at the University of California, Berkeley, Dr. Pääbo extracted DNA from a 7,000-year-old human brain preserved in another Florida bog called Little Salt Spring. This raised a question about the first migrations of Amerindians from Asia. Modern Amerindians show only three distinct DNA lineages. Pääbo found indications of a fourth lineage. Such studies may eventually show approximately where in Asia the original migrating groups came from and how many people were in each group.

This is different from the DNA "fingerprinting" used to link criminals with their crimes. Ancient DNA is hard to work with. It's scarce and generally is damaged. The technical breakthrough that makes the new molecular archaeology possible was developed six years ago at Cetus Corporation in San Francisco. Called by a name that only a chemist would love – polymerase chain reaction – it enables a researcher to pick out a desired DNA segment even when the sample is small and damaged. It then makes hundreds of thousands of copies of that segment to produce enough material for standard analyses.

Until now, researchers such as Pääbo have worked with DNA from mitochondria. These units, which are employed in energy production within a living cell, lie outside the cell nucleus. They have limited genetic information and are inherited only from mothers. DNA in the nucleus has much more genetic information and is inherited from both parents. But it is very scarce. Now Parham and his colleagues have learned to work with nuclear DNA, opening up a potentially rich research field.

This kind of work has implications beyond archaeology. The hundreds of millions of dead and dried specimens in museums potentially are a rich store of DNA that biologists could use to trace evolution of both extinct and living species.

Thus a technical breakthrough in one field – in this case DNA chemistry – can open new research avenues in other fields. As Pääbo has noted, the new techniques "have enabled us to ... catch evolution red-handed."