DNA Fingerprinting

DNA fingerprinting is a test to identify and evaluate the genetic information-called DNA (deoxyribonucleic acid) in a person's cells. It is called a "fingerprint" because it is very unlikely that any 2 people would have exactly the same DNA information, in the same way that it is very unlikely that any 2 people would have exactly the same physical fingerprint. The test is used to determine whether a family relationship exists between two people, to identify organisms causing a disease, and to solve crimes.

Only a small sample of cells is needed for DNA fingerprinting. A drop of blood or the root of a hair contains enough DNA for testing. Saliva, hair, or skin scrapings are often used in criminal investigations. (http://www.webmd.com/a-to-z-guides/dna-fingerprinting)

To identify individuals, forensic scientists scan 13 DNA regions, or loci, that vary from person to person and use the data to create a DNA profile of that individual (sometimes called a DNA fingerprint). There is an extremely small chance that another person has the same DNA profile for a particular set of 13 regions. (http://www.ornl.gov/sci/techresources/Human_Genome/elsi/forensics.shtml)

A common technique used to fingerprint DNA is based upon the variability between individuals of several noncoding regions of DNA in the genome, called VNTRs (variable number of tandem repeats). These regions are composed of a fixed nucleotide sequence that is repeated 2 to 10,000 times. The exact number of repeats is highly variable among individuals. Thus, most individuals are heterozygous because they have inherited a different number of repeats from each parent. Also, it is unlikely that any two unrelated individuals will have the same two VNTR alleles. In fact, if enough VNTR loci are used, even related individuals can be distinguished. (http://www.ansci.cornell.edu/usdagen/dnafingerprint.html)
Uses of DNA Fingerprints

Diagnosis of inherited disorders: DNA fingerprinting is used to diagnose inherited disorders in both prenatal and newborn babies in hospitals around the world. These disorders may include cystic fibrosis, hemophilia, Huntington's disease, familial Alzheimer's, sickle cell anemia, thalassemia, and many others. Early detection of such disorders enables the medical staff to prepare themselves and the parents for proper treatment of the child. In some programs, genetic counselors use DNA fingerprint information to help prospective parents understand the risk of having an affected child. In other programs, prospective parents use DNA fingerprint information in their decisions concerning affected pregnancies.

Developing cures for inherited disorders: Research programs to locate inherited disorders on the chromosomes depend on the information contained in DNA fingerprints. By studying the DNA fingerprints of relatives who have a history of some particular disorder, or by comparing large groups of people with and without the disorder, it is possible to identify DNA patterns associated with the disease in question. This work is a necessary first step in designing an eventual genetic cure for these disorders.

Forensic or criminal: FBI and police labs around the U.S. have begun to use DNA fingerprints to link suspects to biological evidence-blood or semen stains, hair, or items of clothing-found at the scene of a crime. Since 1987, more than 150 cases have been decided with the assistance of DNA fingerprint evidence.

Paternity: Another important use of DNA fingerprints in the court system is to establish paternity in custody and child support litigation. In these applications, DNA fingerprints bring an unprecedented, nearly perfect accuracy to the determination.

Personal identification: Because every organ or tissue of an individual contains the same DNA fingerprint, the U.S. armed services have just begun a program to collect DNA fingerprints from all personnel for use later, in case they are needed to identify casualties or persons missing in action. The DNA method will be far superior to the dog tags, dental records, and blood typing strategies currently in use.

(http://www.biotech.iastate.edu/biotech_info_series/bio6.html)

Some Interesting Uses of DNA Forensic Identification

Identifying September 11th Victims
Identifying the victims of the September 11, 2001, World Trade Center attack presented a unique forensic challenge because the number and identity of the victims were unknown and many victims were represented only by bone and tissue fragments. At the time of the attack, no systems were in place for rapidly identifying victims in disasters with more than 500 fatalities. The National Institutes of Justice assembled a panel of experts from the National Institutes of Health and other institutions to develop processes to identify victims using DNA collected at the site. Panel members produced forms and kits needed to enable the medical examiner’s office to collect reference DNA from victims’ previously stored medical specimens. These specimens were collected and entered into a database. The medical examiner's office also received about 20,000 pieces of human remains from the World Trade Center site, and a database of the victims’ DNA profiles was created. New information technology infrastructure was developed for data transfer between the state police and medical examiner’s office and to interconnect the databases and analytical tools used by panel members. In 2005 the search was declared at an end because many of the unidentified remains were too small or too damaged to be identified by the DNA extraction methods available at that time. Remains of only 1585, of the 2792 people known to have died had been identified. In 2007, the medical examiner's office reopened the search after the Bode Technology Group developed a new methodology of DNA extraction that required much less sample material than previously necessary. The victim DNA database and the new methods have allowed more victims to be identified, and further identifications will be possible as forensic DNA technology improves.

The DNA Shoah Project
The DNA Shoah Project is a genetic database of people who lost family during the Holocaust. The database will serve to reunite families separated during wartime and aid in identifying victims who remain buried anonymously throughout Europe.
Disappeared Children in Argentina
Numerous people (known as "the Disappeared") were kidnapped and murdered in Argentina in the 1970s. Many were pregnant. Their children were taken at birth and, along with other kidnapped children, were raised by their kidnappers. The grandparents of these children have been looking for them for many years. Read an article about a DNA researcher who has been helping them.

Tomb of the Unknowns

The Murdered Nicholas Romanov, the Last Czar of Russia, and His Family

Peruvian Ice Maiden
The Ice Maiden was a 12-14-year-old girl sacrificed by Inca priests 500 years ago to satisfy the mountain gods of the Inca people. She was discovered in 1995 by climbers on Mt. Ampato in the Peruvian Andes. She is perhaps the best preserved mummy found in the Andes because she was in a frozen state. Analysis of the Ice Maiden's DNA offers a wonderful opportunity for understanding her genetic origin. If we could extract mitochondrial DNA from the Ice Maiden's tissue and successfully amplify and sequence it, then we could begin to trace her maternal line of descent and possibly locate past and current relatives.

African Lemba Tribesmen
In southern Africa, a people known as the Lemba heed the call of the shofar. They have believed for generations that they are Jews, direct descendants of the biblical patriarchs Abraham, Isaac, and Jacob. However unlikely the Lemba's claims may seem, modern science is finding ways to test them. The ever-growing understanding of human genetics is revealing connections between peoples that have never been seen before.

Super Bowl XXXIV Footballs and 2000 Summer Olympic Souvenirs
The NFL used DNA technology to tag all the Super Bowl XXXIV balls, ensuring their authenticity for years to come and helping to combat the growing epidemic of sports memorabilia fraud. The footballs were marked with an invisible, yet permanent, strand of synthetic DNA. The DNA strand is unique and is verifiable any time in the future using a specially calibrated laser. A section of human genetic code taken from several unnamed Australian athletes was added to ink used to mark all official goods—everything from caps to socks—from the 2000 Summer Olympic Games. The technology is used as a way to mark artwork or one-of-a-kind sports souvenirs.

Migration Patterns
Evolutionarily stable mitochondrial DNA and Y chromosomes have allowed bioanthropologists to begin to trace human migration patterns around the world and identify family lineage.

Wine Heritage
Using DNA fingerprinting techniques akin to those used to solve crimes and settle paternity suits, scientists at the University of California, Davis, have discovered that 18 of the world's most renowned grapevine varieties, or cultivars are close relatives. These include varieties long grown in northeastern France such as Chardonnay, the "king of whites," and reds such as Pinot and Gamay noir, are close relatives.

DNA Banks for Endangered Animal Species

Poached Animals

Declining Grizzly Bear Population

Snowball the Cat
A woman was murdered in Prince Edward Island, Canada. Her estranged husband was implicated because a snowy white cat hair was found in a jacket near the scene of the crime, and DNA fragments from the hair matched DNA fragments from Snowball, the cat belonging to the husband's parents. See M. Menotti-Raymond et al., "Pet cat hair implicates murder suspect," Nature, 386, 774, 1997. Also see Holmes, Judy, Feline Forensics, Syracuse University Magazine, Summer 2001.

Angiosperm Witness for the Prosecution
The first case in which a murderer was convicted on plant DNA evidence was described in the PBS TV series, "Scientific
American Frontiers." A young woman was murdered in Phoenix, Arizona, and a pager found at the scene of the crime led the police to a prime suspect. He admitted picking up the victim but claimed she had robbed him of his wallet and pager. The forensic squad examined the suspect's pickup truck and collected pods later identified as the fruits of the palo verde tree (*Cercidium spp.*). One detective went back to the murder scene and found several Palo Verde trees, one of which showed damage that could have been caused by a vehicle. The detective's superior officer innocently suggested the possibility of linking the fruits and the tree by using DNA comparison, not realizing that this had never been done before. Several researchers were contacted before a geneticist at the University of Arizona in Tucson agreed to take on the case. Of course, it was crucial to establish evidence that would stand up in court on whether individual plants (especially Palo Verde trees) have unique patterns of DNA. A preliminary study on samples from different trees at the murder scene and elsewhere quickly established that each Palo Verde tree is unique in its DNA pattern. It was then a simple matter to link the pods from the suspect's truck to the damaged tree at the murder scene and obtain a conviction. [WNED-TV (PBS - Buffalo, N.Y.)]

(http://www.ornl.gov/sci/techresources/Human_Genome/elsi/forensics.shtml#4)