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MATRIC NO: 17/MHS01/248

DEPARTMENT: PHARMACOLOGY

COURSE: PHA210

EXPLAIN THE APPLICATIONS OF DNA FINGERPRINTING IN MEDICAL BIOTECHNOLOGY

**DNA fingerprinting**, also called **DNA typing, DNA profiling, genetic fingerprinting, genotyping,**or **identity testing**, in [genetics](https://www.britannica.com/science/genetics), method of isolating and identifying variable elements within the base-pair sequence of [DNA](https://www.britannica.com/science/DNA) (deoxyribonucleic acid). The technique was developed in 1984 by British geneticist Alec Jeffreys, after he noticed that certain sequences of highly variable DNA (known as [minisatellites](https://www.britannica.com/science/minisatellite-DNA)), which do not contribute to the functions of [genes](https://www.britannica.com/science/gene), are repeated within genes. Jeffreys recognized that each individual has a unique pattern of minisatellites (the only exceptions being multiple individuals from a single [zygote](https://www.britannica.com/science/zygote), such as identical twins).

The procedure for creating a DNA [fingerprint](https://www.britannica.com/topic/fingerprint) consists of first obtaining a sample of [cells](https://www.britannica.com/science/cell-biology), such as skin, hair, or [blood](https://www.britannica.com/science/blood-biochemistry) cells, which contain DNA. The DNA is extracted from the cells and purified. In Jeffreys’s original approach, which was based on [restriction fragment length polymorphism](https://www.britannica.com/science/restriction-fragment-length-polymorphism) (RFLP) technology, the DNA was then cut at specific points along the strand with [proteins](https://www.britannica.com/science/protein) known as [restriction enzymes](https://www.britannica.com/science/restriction-enzyme). The enzymes produced fragments of varying lengths that were sorted by placing them on a gel and then subjecting the gel to an [electric current](https://www.britannica.com/science/electric-current) ([electrophoresis](https://www.britannica.com/science/electrophoresis)): the shorter the fragment, the more quickly it moved toward the positive pole (anode). The sorted double-stranded DNA fragments were then subjected to a blotting technique in which they were split into single strands and transferred to a nylon sheet. The fragments underwent autoradiography in which they were exposed to DNA probes—pieces of [synthetic](https://www.merriam-webster.com/dictionary/synthetic) DNA that were made radioactive and that bound to the minisatellites. A piece of [X-ray](https://www.britannica.com/science/X-ray) film was then exposed to the fragments, and a dark mark was produced at any point where a radioactive probe had become attached. The resultant pattern of marks could then be analyzed.

The assay developed by Jeffreys has been supplanted by approaches that are based on the use of the [polymerase chain reaction](https://www.britannica.com/science/polymerase-chain-reaction) (PCR) and so-called microsatellites (or short tandem repeats, STRs), which have shorter repeat units (typically 2 to 4 base pairs in length) than minisatellites (10 to more than 100 base pairs in length). PCR amplifies the desired fragment of DNA (e.g., a specific STR) many times over, creating thousands of copies of the fragment. It is an automated procedure that requires only small amounts of DNA as starting material and works even with partially degraded DNA. Once an adequate amount of DNA has been produced with PCR, the exact sequence of nucleotide pairs in a segment of DNA can be determined by using one of several biomolecular sequencing methods. Automated equipment has greatly increased the speed of [DNA sequencing](https://www.britannica.com/science/DNA-sequencing) and has made available many new practical applications, including pinpointing segments of genes that cause [genetic diseases](https://www.britannica.com/science/human-genetic-disease), mapping the [human genome](https://www.britannica.com/science/human-genome), engineering drought-resistant [plants](https://www.britannica.com/plant/plant), and producing biological [drugs](https://www.britannica.com/science/drug-chemical-agent) from genetically altered [bacteria](https://www.britannica.com/science/bacteria).

An early use of DNA fingerprinting was in [legal disputes](https://www.britannica.com/topic/criminal-investigation), notably to help solve crimes and to determine [paternity](https://www.britannica.com/topic/father-kinship). Since its development, DNA fingerprinting has led to the [conviction](https://www.merriam-webster.com/dictionary/conviction) of numerous criminals and to the freeing from prison of many individuals who were wrongly convicted. However, making scientific identification coincide exactly with legal proof is often problematic. Even a single suggestion of the possibility of error is sometimes enough to persuade a jury not to convict a suspect. Sample contamination, faulty preparation procedures, and mistakes in interpretation of results are major sources of error. In addition, RFLP requires large amounts of high-quality DNA, which limits its application in [forensics](https://www.merriam-webster.com/dictionary/forensics). [Forensic](https://www.merriam-webster.com/dictionary/Forensic) DNA samples frequently are degraded or are collected [postmortem](https://www.britannica.com/topic/autopsy), which means that they are lower-quality and subject to producing less-reliable results than samples that are obtained from a living individual. Some of the concerns with DNA fingerprinting, and specifically the use of RFLP, subsided with the development of PCR- and STR-based approaches.

## Genetic Research

In 1984, Alec Jeffreys, a British geneticist, identified the presence of minisatellites within the boundaries of genes. These minisatellites do not contribute to the functioning of genes and are distributed throughout the cellular DNA of an organism in a unique and inheritable pattern. The DNA fingerprint can be revealed by processing cells collected from individuals through one of several different techniques. These different techniques for genetic fingerprinting have been applied to identify and isolate disease genes, develop cures for diseased genes, and diagnose genetic diseases.

## Paternity Testing

Testing paternity samples requires the collection of cells and comparison of DNA fingerprints from and between children and potential parents. Children will have a mix of DNA fingerprints inherited from each parent. When a child is conceived, each parent provides half of the genetic information. Most often the test is performed when the mother of the child is known but the father is in question. Since it is highly unlikely that any two people will have the same genetic fingerprint, paternity testing using DNA fingerprints is a reliable way to determine the parentage of a child.

## Genetic Forensics

A crime scene can contain biological samples, including blood, semen, saliva, skin, urine and hair, from perpetrators, victims and bystanders that can be processed to provide DNA fingerprints. The DNA fingerprints obtained are used to search existing databases for matches and to identify victims or suspects. The biological evidence and the DNA fingerprints can be used in trials to help prove guilt or innocence. The United States military has been storing DNA fingerprints of all military personnel for identification of casualties and those missing in action. The military has found the technology to be superior to identification methods used previously.

## Plants and Animals

DNA fingerprinting of plants and animals is performed for food security, food safety, identification and parentage. In food animals, DNA fingerprinting can be used to trace meat to the source animal. The technique can be used to identify endangered and non-endangered fish species, while the sources of plants can be verified to prevent counterfeiting of seeds and stock. Pathogenic food organisms can be quickly identified by their DNA fingerprints, allowing doctors to provide timely, targeted treatment.

# **The Significance of Penta E**

Penta E is known as an identifier in genetic testing. Over the past decade, genetic scientists have distinguished a core of short tandem repeat (STR) loci that are widely used for DNA typing applications. They are characterized by physical location in the human genome. The Penta loci were discovered by Promega Corporation scientists in an effort to ﬁnd loci with a high variability yield and little residual information.

## Identity Testing

Penta E has become part of the common sequence of data variables for human identity testing. Promega's current system, the PowerPlex kit, is preferred in genetic testing laboratories for paternity testing. These commercial STR kits identify sixteen core loci through a color detection system. Penta E is easily identifiable because it is labeled with flourescein.

## DNA Genetic Ancestry

STR testing is widely used in anthropological research of populations, civilizations, ethiciotes and geography. Individuals can trace their ancestry through DNA Tribes Genetic Ancestry Analysis. This service uses genetic material from paternal and maternal ancestors to measure connections to ethnic groups and world regions. The individual's results are compared to locations matching his or her blend of ancestry.

## Forensic Application

STR testing has important applications in forensic casework and criminal activity. Forensic science makes use of Penta loci's uniquely distinguishable nature. The Red Cross depends on human identity testing during a mass disaster. The loci are made use of for victim identification as well as missing persons investigations.

## Genetic Diseases

Scientists investigate the potential relationship of STR loci to genetic disease-causing genes. In 2004, a team of scientists investigated genetic mutations in Indian populations. They discovered the Penta E locus is found in certain disease-carrying alleles. From there, scientists came up with methods that trace Penta loci in populations as well as transmission rates within ethnic groups. Disease-causing genes can be introduced as a result of migration or mutation.

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