

## DNA Fingerprinting: 7 Critical Applications

### Introduction:

DNA fingerprinting, a revolutionary technique in genetics, has transformed forensic science, paternity testing, and various other fields. It involves analysing unique DNA sequences to establish individual genetic identity. This technique, rooted in biostatistics, research methodology, and genetics, has been extensively studied and discussed.

**DNA Fingerprinting:**

- Discovery
- Principle
- Applications
- Short Tandem Repeats (STRs)
- Summary

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### Discovery of DNA Fingerprinting:

DNA fingerprinting was discovered by Dr. Alec Jeffreys in 1984 at the University of Leicester, UK. He found that certain regions of DNA, known as short tandem repeats (STRs),

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exhibit high variability between individuals. This discovery formed the basis for the principle of DNA fingerprinting.

## Principle of DNA Fingerprinting: In-Depth Explanation

The principle of DNA fingerprinting is a fundamental concept that underlies the entire process of identifying individuals based on their unique DNA sequences. This principle revolves around the variability of certain DNA regions, specifically the Short Tandem Repeats (STRs), which are integral to creating distinctive DNA profiles for each individual.

**1. Short Tandem Repeats (STRs) and Genetic Variation:** The starting point of the principle is the existence of regions within an individual's DNA that exhibit a pattern of repeating sequences of nucleotides. These regions are known as Short Tandem Repeats or STRs. Imagine these STRs as sequences of genetic "words" that are repeated multiple times in a row. The length of these repeated sequences can vary between individuals. This variation creates the diversity observed among people, as each person might have a different number of repeats in these specific DNA regions.

**2. Creating Unique DNA Profiles:** The variable nature of STRs is what gives rise to the uniqueness of DNA profiles. When analyzing an individual's DNA, scientists look at specific STR locations in the genome. By counting the number of repeats at each STR location, a characteristic pattern is established for that individual. No two individuals (except identical twins) will have the exact same pattern at every STR location due to the random variation in the number of repeats.

**3. Polymerase Chain Reaction (PCR) Amplification:** To work with these STR regions effectively, a technique called Polymerase Chain Reaction (PCR) is employed. PCR is a method that enables the selective amplification of specific DNA sequences. In the context of DNA fingerprinting, it's used to make many copies of the STR regions under investigation. This amplification is necessary because the amount of DNA from a sample might be limited, and PCR ensures there's enough DNA to study.

**4. Comparing STR Loci for Identification:** Once the STR regions have been amplified, scientists analyse them to determine the number of repeats at different loci (positions) along the genome. This data is then compiled into a unique DNA profile for the individual. The profile consists of the number of repeats at each STR location. By analyzing multiple STR loci, the resulting DNA profile becomes highly distinctive, making it exceedingly improbable for two unrelated individuals to have identical profiles.

## Applications of DNA Fingerprinting:

DNA fingerprinting finds applications in diverse areas:

- 1. Forensic Science:** DNA profiling is crucial in criminal investigations. DNA left at crime scenes, such as blood or hair, can be compared with suspect DNA to identify potential perpetrators. It has revolutionized criminal justice by providing strong evidence for conviction or exoneration.

2. **Paternity Testing:** DNA fingerprinting is used to determine biological relationships, such as parentage. By comparing the DNA profiles of an alleged parent and child, it can be established whether they share a biological relationship.
3. **Missing Persons and Disaster Victim Identification:** In cases of natural disasters or accidents, where bodies are unidentifiable, DNA fingerprinting helps match remains with missing individuals, bringing closure to families.
4. **Historical and Anthropological Studies:** DNA fingerprinting aids in tracing genetic lineages and migrations of human populations over time. It provides insights into human evolution, genetic diversity, and historical relationships between populations.
5. **Conservation Biology:** DNA fingerprinting is employed to study biodiversity, track endangered species, and combat illegal wildlife trade. It helps in identifying and prosecuting poachers and traffickers.
6. **Medical Diagnosis and Genetic Disorders:** DNA profiling is used for diagnosing genetic diseases and identifying carriers of genetic disorders. It enables personalized medicine approaches and guides treatment decisions.
7. **Biological and Archaeological Research:** DNA fingerprinting aids in identifying ancient DNA, studying ancient populations, and analyzing historical remains, contributing to fields like archaeology and palaeontology.

**Summary:** DNA fingerprinting's discovery, principle, and applications have revolutionized the way we understand genetics, solve crimes, establish relationships, and explore human history. This multidisciplinary technique showcases the powerful synergy between genetics, biostatistics, and research methodology, shaping diverse scientific and practical domains.

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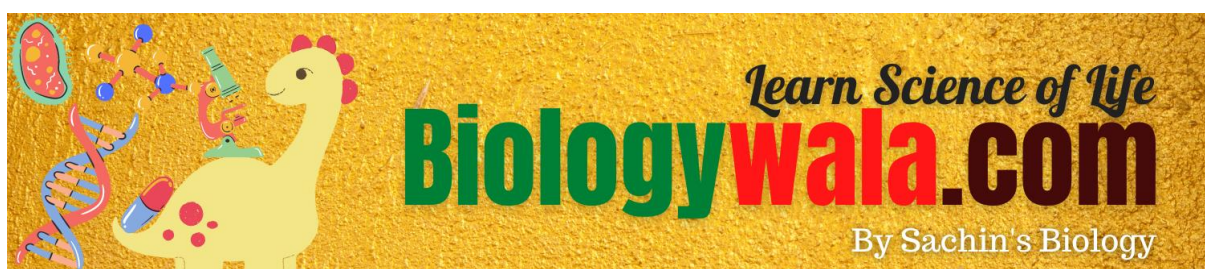
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