Basics of DNA Fingerprinting

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There has always been a need felt for identification of individuals in a unique way. There are many situation in which such identification is needed. The concept developed more in the field of criminal law where it was imperative to identify the criminal in an undisputed manner. Fingerprints were found to serve this purpose to a great extent. However, criminal soon discovered ways and means of hoodwinking fingerprints. More recently computer simulated facial reconstruction and eye imaging have been developed as additional methods for individual identity.

The individual features do refer between any two individuals. Let us try to understand what gives individuality to this feature. Dioxiribose Nucleic Acid (DNA) is the genetic material in most organisms. By genetic material we mean a substance that is able to store, maintain and transmit genetic information & is essential for smooth functioning of life processes. It is this genetic information that is passed on from parents to offspring.

However, an individual is a sum of genetic information inherited from parents and environmental influences. That is to say that the same information may express differently in changed environmental conditions. Therefore, it is said that both nature and nurture are important for development of a good human being.

I higher organisms, the process of sexual reproduction has evolved. The purpose of this was to give a change to genes to mix and match. This gives rise to new gene combinations. Nature selects the best gene combinations from among the ones available to it. Thus the genes of mother and father reach the offspring and are able to recombine to produce novel combination. This ensures and continues availability of variability among individuals of a population. Since there are thousands of genes in each organism, the number of possible combinations becomes mind boggling. The unique gene combination coupled with environmental factor determines individualized traits like fingerprints. Genes express under the influence of environment to produce certain proteins. The actions of these proteins give us our characteristics appearance. However, some of these characteristics changes over a period a time. Therefore, a more fixed individual identity system is needed.

Each individual tends to have a unique combination of genes. If we develop some way of differentiating among individuals based on their genetic makeup, we would be able to develop a system of perfect identity. Since prior to DNA based system of individual identity, fingerprints

were developed for identifying individuals, the DNA based method was called DNA fingerprinting. We shall try to understand how we develop DNA based identity. WE must first learn about the tools required for developing DNA fingerprints.

Basic tools for developing DNA fingerprints

1. **Restriction Digestion**
2. **Hybridization**
3. **Polymerase Chain Reaction**

Bacteria employ a two step process as a defiance mechanism for digesting invading alien DNA. This involves imprinting resident DNA by specific methylation of restriction sites and degrading DNA that lacks the methylation of these sites. This system is called as Restriction-Modification system. The invading DNA is selectively targeted and degraded by the endogenous enzymes. These enzymes have been designated as restriction enzymes and are very precise with respect to their action. It is this precision which is exploited to develop very precise molecular scissors to cut DNA at very precise locations. These locations are called as restriction sites.

Restriction Digestion

Total DNA is first isolated and then digested using appropriate restriction enzyme. The digestion prod

Hybridization

There are two strands of DNA that are held together the help of very weak hydrogen bonds.

When these hydrogen bonds break, the two strands separate out. This is called as denaturation. Restoration of hydrogen bonds can renaturate the DNA. The ability of DNA to denaturate and renaturate is used in several tools of modern molecular biology. Hybridization is one such technique first developed by Southern. Total DNA is first denatured and then immobilized on a membrane to prevent renaturation. A suitable probe is then used to hybridize to the complementary sequence(s) on the probed DNA. The probe is generally radio-labeled for easy detection. Non-radioactive labels too are now available.

Polymerase Chain Reaction

In this technique the property of denaturation coupled with the inability of most DNA polymerases to initiate DNA replication is exploited.

Dispersed Repetitive DNAs-drDNA

Most eukaryotic genomes contain repeats of short sequences (2-15 bps), dispersed throughout the genome(also called as Variable Number of Tandem Repeats-VNTRs).

They can be detected either by using simple hybridization protocols or PCR.

Every strand of DNA has pieces that contain genetic information which informs an organism's development (unique sequences)

and pieces that, apparently, supply no relevant genetic information at all (repetitive DNA sequences). These sequences, called variable Number Tandem Repeats (VNTRs), can contain anywhere from twenty to one hundred base pairs.

Every human being has some VNTRs. TO determine if person has a particular VNTR, a Southern Blot is performed , and then the southern Biot is probed, through a hybridization reaction, with a radioactive version of the VNTR in question. The pattern which results from this process is what is often referred to as a DNA fingerprint. A given person's VNTRs come from the genetic information donated by his or her parents; he or she could have VNTRs inherited from his or her mother or father, or a combination, but never a VNTR either of his or her parents do not have. Shown below are the VNTR patterns for Mrs. Nguyen [blue], Mr. Nguyen [yellow], and there four children: D1 (the Nguyen's biological daughter), D2 (Mr. Nguyen's step-daughter, child of Mrs. Nguyen and her former husband [red]), S1 (the Nguyen's biological son), and S2 (the Nguyen's adopted son, not biologically related [his parents are light and dark green]).

DNA fingerprinting is used to determine paternity; in forensic crime analysis; in population genetics to analysis variation within populations or ethnic groups; in conservation biology to study the genetic variability of endangered species; to test for the presence of specific pathogens in food sources; to detect genetically modified organism either within plants or food products; in evolutionary biology to compare DNA extracts from fossils to modern day counterparts; and in the identification of victims of a disaster.