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Applications of DNA fingerprinting in Medical Biotechnology

- paternity/maternity disputes
- Hereditary diseases
- Forensics
- Individuality
- Detection of somatic mutations or cancer
- Pathogen identification
- Detection of loci controlling quantitative traits or disease resistance
- Sex determination
- Food testing

- **Paternity/maternity disputes**

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.

By comparing the DNA profile of a mother and a child it is possible to identify DNA fragments in the child which are absent from the mother and must therefore have been inherited from the biological father.

- **Hereditary diseases**

Genetic fingerprinting can also include characterization of the genetic basis of human diseases, especially the inherited disorders. Some of the variants or haplotypes identified may run in families and thereby also have pathological or phenotypic connotations. The DNA sequencing technologies have evolved over the years, and nowadays, high-throughput techniques and applications are available with increased automation. Thus, genetic fingerprinting can have various connotations in relation to human diseases. The genetic testing done would depend on the clinical situation or phenotype, and what we are looking for in a specific patient or individual. Pretest and posttest counseling are important to facilitate decision-making.

Diagnosis of inherited disorders

* Help diagnose disorders in both prenatal and new born babies

* Disorders may include cystic fibrosis, hemophilia, Huntington's disease, sickle cell anaemia, thalassemia and familial Alzheimer's disease.

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.

• Forensics

Forensics science is the use of scientific knowledge in legal situations or matters. The DNA profile of each individual is highly specific. The chances of two people having exactly the same DNA profile is 300,000 million to 1(except identical twins).

The pattern of DNA profile is then compared with those of the victim and the suspect. If the profile matches the suspect it provides strong evidence that the suspect was present at the crime scene. If the profile does not match the suspect may be eliminated from the enquiry.

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

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.

• Individuality

The U.S armed services are just beginning a program where they collect DNA fingerprints from all personnel for later use, Incase they need to identify casualties or missing people.

• Detection of somatic mutations or cancer

The success of utilizing DNA fingerprint probes to detect somatic mutations in cancer raised the possibility that a similar approach might be successful in an investigation of two patients with the Proteus syndrome.

• Pathogen identification

DNA fingerprinting technology has enormous potential in clinical diagnostic microbiology. It offers the possibility of faster and cheaper identification of fastidious pathogens, including the detection of strains bearing known virulence factors and genes conferring resistance to antibiotics, and allows the direct detection of infectious agents in clinical specimens and in contaminated foods.

BRENDA provides a sensitive means of directly detecting minor genomic differences between micro-organisms. Restriction endonuclease specifically cleave DNA into different lengths, depending on the number and position of the individual recognition sequences, provided that they have not been modified in any way. A DNA polymorphism refers to the change in the size of a restriction fragment. If a change occurs in the sequence of the genome DNA-even a single nucleotide-base mutation-this can delete a site or create a new recognition site and result in the

generation of a restriction fragment-length polymorphism (RFLP). Sequence changes may also arise as a result of insertions, deletions or inversions of DNA between sites.RFLPs are most specific and reliable when the relevant gene has been located, its sequence has been defined and a probe has been made that is complementary to the sequence. Even if a change does not specifically involve restriction-site sequences, it may still be detected if the relevant fragments contain a suitable target sequence. The significance of DNA polymorphisms is that they most often represent neutral mutations and do not cause any phenotype change.
The restriction enzyme-recognition sites consist, in most cases, of four or six nucleotides arranged in a specific order with diad symmetry.

Detection of loci controlling quantitative traits or disease resistance

*** Sex determination**

In forensic casework there is often a need to determine the sex of an individual based on DNA evidence in instances such as identification of victims of mass disaster, missing persons investigations, and sexual assault cases. Analysis of Y-specific target sequences on the Y chromosome is a largely effective method for determining the chromosomal sex of an individual and estimating the ratio of male and female DNA in a mixed forensic sample.

The sex typing marker amelogenin is incorporated in most commercially available multiplex short tandem repeat (STR) kits and is currently the most common sex typing marker used in forensic casework. For a DNA profile to be accepted into the US National DNA Index System (NDIS), which is the national level of the Combined DNA Index System (CODIS), inclusion of the amelogenin marker is required for relatives of missing persons, along with the 13 CODIS Core Loci. The amelogenin test must be attempted for DNA profiles of missing persons and unidentified human remains, and is accepted but not required for offender and forensic profile. In addition to amelogenin, alternative Y-specific markers are being explored, which, when used in place of or in conjunction with the standard amelogenin test may provide more consistently reliable sex typing information for forensic casework.

It is worth noting that while the ultimate goal of sex typing in forensic investigations is often to discover the legal or perceived gender of an individual, there will always exist cases in which an individual's chromosomal sex, as discovered by DNA sex typing, does not match legal gender or gender presentation.However, because legal gender and chromosomal sex do correspond in the majority of cases, methods for accurate determination of chromosomal sex do and will continue to have widespread use in forensic investigations.

• Food testing

Controlling the authenticity of certain premium foods and traceability systems for meat requires analytical systems that can differentiate specific crop varieties, livestock breeds, or individual animals. This can be achieved by DNA fingerprinting based on simple sequence repeat or single nucleotide polymorphism markers, which have become routine procedures in forensics and now also in food analysis. This chapter will discuss DNA fingerprinting for authenticity testing of premium rice varieties like basmati and jasmine and how to control and verify labeling of meat origin by providing the link between the final product and the individual animal.

Famous cases include:

* Illinois Governor George Ryan famously placed a moratorium on executions in 2000 after a review of DNA evidence placed into question the cases against several death row inmates in the state. Illinois completely eliminated the death penalty in 2011.

* In Texas, DNA evidence further validated the case against Ricky McGinn, convicted of raping and murdering his stepdaughter. According to Forensic Outreach, DNA evidence reviewed as part of one of McGinn's appeals confirmed that a hair found on the victim's body belonged to McGinn. McGinn was executed in 2000.