

The Science of DNA Fingerprinting: Present, Past and Future

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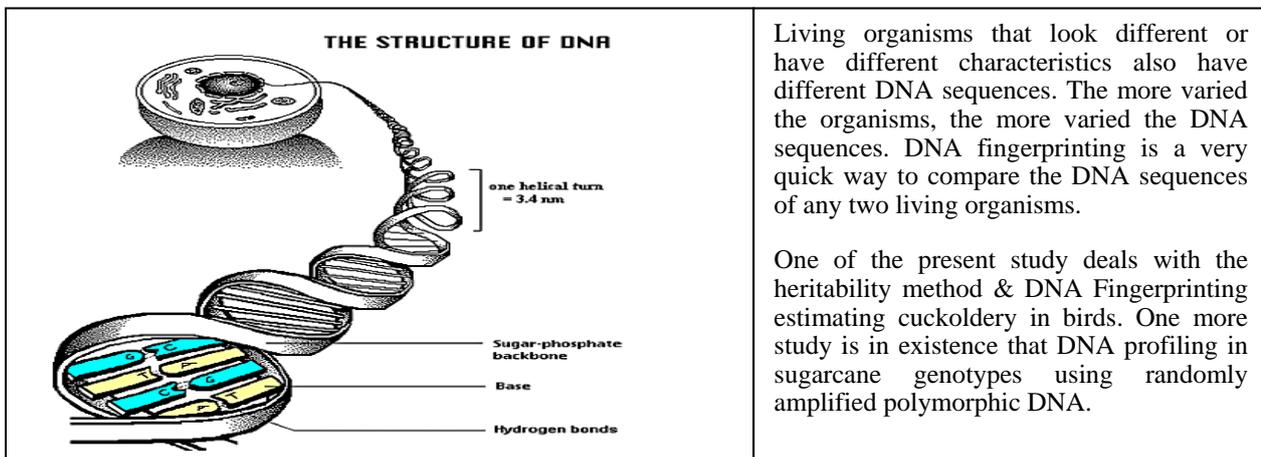
Abstract:

DNA fingerprinting also called DNA Typing in genetics is the method of isolating and making images of sequences of DNA (deoxyribonucleic acid). The technique was developed in 1984 by the British geneticist Alec Jeffrey's, after he noticed the existence of certain sequences of DNA (called mini satellites) that do not contribute to the function of a gene but are repeated within the gene and in other genes of a DNA sample. Jeffrey's also determined that each organism has a unique pattern of these mini satellites, the only exception being multiple individuals from a single zygote (e.g., identical twins). The chemical structure of everyone's DNA is the same. The only difference between people (or any animal) is the order of the base pairs. There are so many millions of base pairs in each person's DNA that every person has a different sequence. Using these sequences, every person could be identified solely by the sequence of their base pairs. However, because there are so many millions of base pairs, the task would be very time-consuming. Instead, scientists are able to use a shorter method, because of repeating patterns in DNA. These patterns do not, however, give an individual "fingerprint," but they are able to

determine whether two DNA samples are from the same person, related people, or non-related people. Scientists use a small number of sequences of DNA that are known to vary among individuals a great deal, and analyze those to get a certain probability of a match.

The Structure of DNA:

The characteristics of all living organisms, including humans, are essentially determined by information contained within DNA that they inherit from their parents. The molecular structure of DNA can be imagined as a zipper with each tooth represented by one of four letters (A, C, G, or T), and with opposite teeth forming one of two pairs, either A-T or G-C. The letters A, C, G, and T stand for adenine, cytosine, guanine, and thymine, the basic building blocks of DNA. The information contained in DNA is determined primarily by the sequence of letters along the zipper. For example, the sequence ACGCT represents different information than the sequence AGTCC in the same way that the word "POST" has a different meaning from "STOP" or "POTS," even though they use the same letters. The traits of a human being are the result of information contained in the DNA code.



Living organisms that look different or have different characteristics also have different DNA sequences. The more varied the organisms, the more varied the DNA sequences. DNA fingerprinting is a very quick way to compare the DNA sequences of any two living organisms.

One of the present study deals with the heritability method & DNA Fingerprinting estimating cuckoldery in birds. One more study is in existence that DNA profiling in sugarcane genotypes using randomly amplified polymorphic DNA.

Methodology of DNA Fingerprinting:

The procedure for creating a DNA fingerprint consists of first obtaining a sample of cells containing DNA (e.g., from skin, blood, or hair), extracting the DNA, and purifying it. The DNA is then cut at specific points along the strand with substances called restriction enzymes. This

produces fragments of varying lengths that are sorted by placing them on a gel and then subjecting the gel to an electric current (electrophoresis): the shorter the fragment the more quickly it will move toward the positive pole (anode). The sorted, double-stranded DNA fragments,

are then subjected to a blotting technique in which they are split into single strands and transferred to a nylon sheet. The fragments undergo autoradiography in which they are exposed to DNA probes—pieces of synthetic DNA that have been made radioactive and that bind to the mini satellites. A piece of X-ray film is then exposed to the fragments, and a dark mark is produced at any point where a radioactive probe has become attached. The resultant pattern of these marks can then be analyzed. It has been recognized that DNA fingerprinting, similar to other DNA-analysis techniques, is limited by the quality of the sample obtained. DNA samples that are degraded or collected postmortem typically produce less-reliable results than do samples that are obtained from a living individual.

Performing a southern blot:

The Southern Blot is one way to analyze the genetic patterns which appear in a person's DNA. Performing a Southern Blot involves:

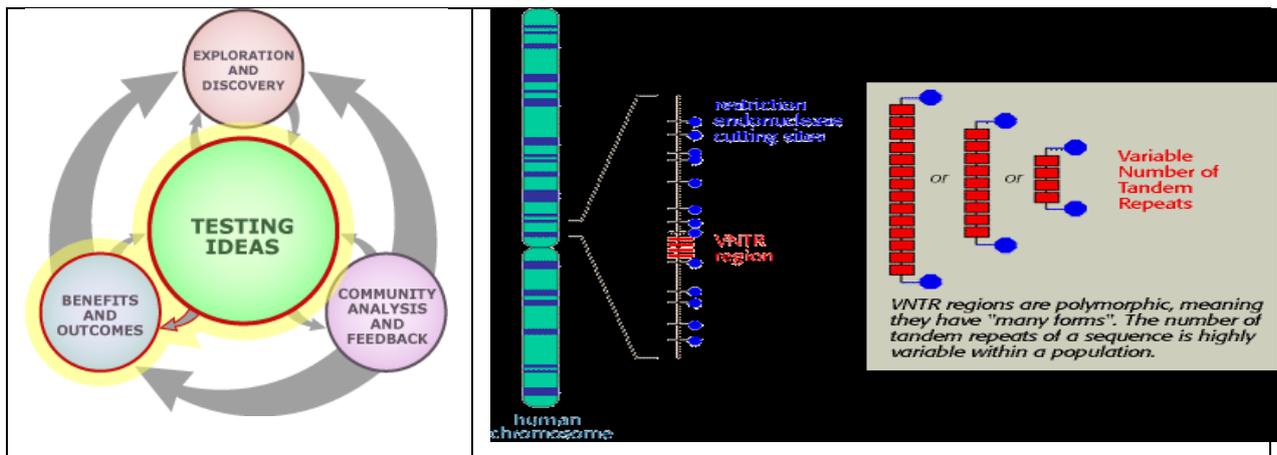
1. Isolating the DNA in question from the rest of the cellular material in the nucleus.
2. Cutting the DNA into several pieces of different

sizes. This is done using one or more restriction enzymes.

3. Sorting the DNA pieces by size. The process by which the size separation, "size fractionation," is done is called gel electrophoresis.
4. Denaturing the DNA, so that the entire DNA is rendered single-stranded. This can be done either by heating or chemically treating the DNA in the gel.
5. Blotting the DNA.

In order to analyze a Southern Blot, a radioactive genetic probe is used in a hybridization reaction with the DNA in question. If an X-ray is taken of the Southern Blot after a radioactive probe has been allowed to bind with the denatured DNA on the paper, only the areas where the radioactive probe binds will show up on the film. This allows researchers to identify, in a particular person's DNA, the occurrence and frequency of the particular genetic pattern contained in the probe. The final DNA fingerprint is built by using several probes (5-10 or more) simultaneously. It resembles the bar codes used by grocery store scanners.

Practical Applications of DNA Fingerprinting:



1. Paternity and Maternity:

Because a person inherits his or her VNTRs from his or her parents, VNTR patterns can be used to establish paternity and maternity. The patterns are so specific that a parental VNTR pattern can be reconstructed even if only the children's VNTR patterns are known (the more children produced, the more reliable the reconstruction). Parent-child VNTR pattern analysis has been used to solve standard father-identification cases as well as more complicated cases of confirming legal nationality and, in instances of adoption, biological parenthood.

2. Criminal Identification and Forensics:

DNA isolated from blood, hair, skin cells, or other biological evidence left at the scene of a crime can be compared, through VNTR patterns, with the DNA of a criminal suspect to determine guilt or innocence. VNTR patterns are also useful in establishing the identity of a homicide victim, either from DNA found as evidence or from the body itself.

3. Personal Identification:

The notion of using DNA fingerprints as a sort of genetic bar code to identify individuals has been

discussed, but this is not likely to happen anytime in the foreseeable future. The technology required to isolate, keep on file, and then analyze millions of much specified VNTR patterns is both expensive and impractical. Social security numbers, picture ID, and other more mundane methods are much more likely to remain the prevalent ways to establish personal identification.

DNA Fingerprinting In Human Health and Society:

Like the fingerprints that came into use by detectives and police labs during the 1930s, each person has a unique DNA fingerprint. Unlike a conventional fingerprint that occurs only on the fingertips and can be altered by surgery, a DNA fingerprint is the same for every cell, tissue, and organ of a person. It cannot be altered by any known treatment. Consequently, DNA fingerprinting is rapidly becoming the primary method for identifying and distinguishing among individual human beings.

An additional application of DNA fingerprint technology is the diagnosis of inherited disorders in adults, children, and unborn babies. The technology is so powerful that, for example, even the blood-stained clothing of Abraham Lincoln could be analyzed for evidence of a genetic disorder called Marfan's Syndrome.

Problems with DNA Fingerprinting:

Like nearly everything else in the scientific world, nothing about DNA fingerprinting is 100% assured. The term DNA fingerprint is, in one sense, a misnomer: it implies that, like a fingerprint, the VNTR pattern for a given person is utterly and completely unique to that person.

1. Generating a high probability
2. Problems with Determining Probability
 - A. Generating a high probability
 - B. Technical Difficulties

Defined keywords:

➤ **Base pairs:**

A set of two bonded nucleotides on opposite strands of DNA. There are two possible base pairs: C-G and A-T.

➤ **Chromosome:**

A rod-like structure of tightly coiled DNA found in the cell nucleus of plants and animals. Chromosomes are normally found in pairs; human beings typically have 23 pairs of chromosomes.

➤ **DNA polymerase:**

An enzyme which repairs DNA by facilitating the formation of hydrogen bond between a nucleotide on a broken piece of DNA, such as a nicked or single-stranded piece of DNA as created in the laboratory, and the individual

nucleotide it needs to form a complete and stable base pair.

➤ **Gene:**

A section of a chromosome, made up of DNA. A given gene provides the information a cell needs to create a specific protein. Collectively, the genes of an organism inform, to some extent, nearly every aspect of the development and formation of that organism. Genes do not, however, dictate behaviors or traits, and neither are genetically informed behaviors and traits incapable of being modified or supplanted; environmental factors also play a very important part in influencing the organism's development and formation.

➤ **Homology:**

The degree to which two pieces of DNA match, or complement each other (two pieces of DNA are complementary if their respective nucleotides, in their current order, match C to G and A to T). If one piece of DNA is 100% complementary to another piece of DNA, they demonstrate very high homology; if the pieces are only able to form a handful of base pairs between their corresponding nucleotides, they demonstrate very low homology.

➤ **Hybridization reaction:**

A process in which a probe binds to a Southern Blot if the probe's DNA sequence and the DNA on the Southern Blot match.

➤ **Nucleus:**

The center of a cell, where the entire DNA, packaged in chromosomes, is contained.

➤ **Probe:**

A radioactive strand of DNA often used to find particular sequences in a Southern Blot.

➤ **Restriction Enzyme:**

An enzyme normally found in bacteria which cuts DNA at specific sites (i.e. each time a specific nucleotide pattern occurs). Because a restriction enzyme always acts upon DNA in the same manner, a map can be made of restriction enzymes actions on a known set of nucleotides.

➤ **Trait:**

The physical manifestation of the information on a gene. If a gene contains the information needed by the organism to create purple eyes, for example, the fact that the organism did indeed have purple eyes is considered a trait of that organism.

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[7] <http://protist.biology.washington.edu>

[8] en.wikipedia.org/wiki/DNA_profiling

[9] www.supremainc.com

[10] www.accessexcellence.org/AB/BA/DNA_Fingerprinting_Basics.php

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[12] "DNA fingerprints witness for the prosecution." *Discover*. June 1988, p. 44.

Conclusion:

From the above facts which are based on secondary data, it was known that the DNA Fingerprinting is very crucial and important factor in criminology. It has also an important role in Human society and health. A problem is only with the feasibility in terms of 100% assurance. It leaves many doubts in its result as the result can not be assured. Its future prospects are very bright because it can control over the illegal offences. Presently it is playing a role of dynamism.

An early use of DNA fingerprinting was in legal disputes, notably to help solve crimes and determine paternity. The technique was challenged, however, over concerns about sample contamination, faulty preparation procedures, and erroneous interpretation of the results. Efforts were made to improve its reliability, and today the technique has been refined through the use of more-specific and more-sensitive probes and better blotting membranes.

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