How dna and dna profiling works

DNA Testing

Provided its uniqueness in each individual, DNA has found many uses in the medical and criminal investigation fields. In the medical field, scientists use DNA analysis to determine paternity. In the criminal investigation field, scientists use DNA analysis to identify suspects in criminal investigations. Nonetheless, identification of people using DNA analysis is not foolproof.

DNA is an acronym for deoxyribonucleic acid. It occurs in the nucleus of a cell. DNA is the basic building blocks of any organism. To be able to understand the functioning and role that DNA plays in organisms, an insight into the cell is vital.

The cell is the basic living unit of an organism. The human body, for example, is made up of trillions of cells, each performing a distinct function. Each of these cells contains hereditary material, which makes it possible for it to make copies of itself when necessary. After a definite life span, the old cell dies.

The cell contains parts called organelles. The table below illustrates the parts of a human cell:

Part of Cell	Function
Nucleus	It is the central part of the cell. It controls all the activities

	of the cell which include telling the cell when to reproduce, when to grow and when to die. It houses deoxyribonucleic acid (DNA).
Cytoplasm	This is a fluid in which cell organelles float.
Mitochondria	These organelles produce energy for the cell, which are required in the numerous activities of

	the cell like growth, movement, and reproduction.
Lysosomes and Peroxisomes	These organelles function to destroy foreign bacteria and toxic substances that invade the cell.
Endoplasmic reticulum	It processes the molecules produced by the cell
Ribosomes	They manufacture proteins and produce genetic

	instructions within the DNA. Ribosomes may be located either on the surface of the endoplasmic reticulum or in the cytoplasm as free-floating bodies
Cell membrane	This is the outer wall of the cell.

Chromosomes are DNA strands that occur in the nucleus. However, chromosomes are only visible during cell division. Chromosomes have constriction points call centromeres from which two arms protrude. The short arm is the “ p arm” whereas the long arm is the “ q arm”. Each pair of chromosomes is distinct based on the size of its arms and the position of the centromere.

A human being normally has 23 pairs of chromosomes with 22 of these being the same in both men and women. Autosomes are the twenty-two pairs that are the same in both men and women. The 23 rd pair of chromosomes is the sex chromosomes. This pair differs between men and women. Men have one X chromosome and one Y chromosome, whereas women have two X chromosomes (Easteal, McLeod, and Reed 59).

Genes are the hereditary material that occurs in the cell nucleus. DNA constitutes genes. Genes are instructions for ribosomes to manufacture proteins. The Human Genome Project (qtd. in Mandal) gave the approximate number of human genes as lying between 20, 000 and 25, 000. The human being has two copies of each of these genes; each inherited from either parent. All these genes are similar in everyone save for less than 1 percent of genes which differ slightly between people, which form the basis of DNA analysis and paternity tests.

Though most of DNA occurs within the nucleus, some portion of DNA occurs within the mitochondria. DNA that occurs within the nucleus is nuclear DNA, whereas DNA that occurs in mitochondria is mitochondrial DNA. DNA contains four chemical bases: Adenine (A), Guanine (G), Cytosine (C), and Thymine (T). These chemical bases pair with each other. Adenine pairs with Thymine and Cytosine pairs with Guanine. After pairing, the units formed are base pairs. Phosphate and sugar molecules attach themselves to each base. In human beings, DNA contains about 3 million bases. Ninety-nine percent of these bases are similar for all human beings. These bases occur in different arrangements and these arrangements transmit different information.

A nucleotide is a combination of sugar, phosphate and a base. Nucleotides occur as two long spiral strands forming a double helix. The double helix resembles a twisted ladder. The base pair act as the rungs with the phosphate and sugar molecules acting as the sides of the ladder (Mandal).

DNA replicates itself. Where DNA replicates depends on whether the cell is a eukaryote or a prokaryote. For prokaryotes, replication takes place in the cytoplasm. For eukaryotes, replication takes place in the nucleus. Regardless of where replication takes place, the process is the same. Each DNA strand runs in anti-parallel directions. This structure unzips down the middle, and each strand in the pair serves as a template for replication. Each strand makes a copy of itself.

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DNA testing, also known as DNA profiling, came as a result of two separate breakthroughs in molecular biology. Kary Mullis invented the Polymerase Chain Reaction in the USA while Professor Sir Alec Jeffreys discovered DNA fingerprinting at the University of Leicester in the UK (Kilpatrick). Professor Sir Alec Jeffreys was the first to employ DNA analysis in a criminal investigation in 1986. He used DNA fingerprinting techniques in two rape and murder cases that took place in 1983 and 1986 in Leicestershire, UK. The probability of such a match occurring was $5.8 \times 10^{-8,}$ and this provided

credibility to his conclusions. His findings led to the conviction of the culprit Colin Pitchfork, and the exoneration of an innocent man who was previously the main suspect in the crimes. Professor Jeffreys' findings resulted in the first ever screening project that was carried out for DNA profiling. Though Professor Jeffreys' method was accurate and reproducible, it required large quantities of high quality DNA, which forensic scientists did not always recover during forensic investigations. Further research on DNA analysis led to two major breakthroughs in the 1980s and 1990s. These breakthroughs formed the basis for modern DNA analysis techniques that are in use today.

DNA profiling has both advantages and disadvantages which are represented in the table below:

Advantages	Disadvantages
It is ideal for confirming the identity of a person with certainty	For conclusive results, the scientist should carry out tests on multiple samples, and at least twice.
It is easy to obtain a	Privacy concerns may

	result from
specimen	misuse of
	DNA results
A thorough	Poor testing
DNA test	methods can
can take a	and have led
maximum	to wrongful
of 48	convictions in
hours	the past
DNA	
testing is	Access and
reliable	use of DNA
and	data is still
affordable	controversial

The concept behind DNA testing is finding the differences in the DNA sequences of two or more samples of DNA. Thus, scientists use two or more sets of DNA in the analysis. In forensics, these samples are samples of DNA from the crime scene compared with DNA samples from suspects. The initial step in testing varies depending on the testing techniques. However, the first step is normally the isolation of a small part of a DNA sequence. Forensic scientists then isolate the DNA fragments and sort them based on size by gel electrophoresis (Whiting). The forensic scientists then make a blot of gel, and they release a probe onto the sample, which finds and binds onto a DNA

sequence that is similar with that which is associated with the probe (Jones 527).

The common techniques used in DNA analysis include Restriction Fragment Length Polymorphism (RFLP), Polymerase Chain Reaction (PCR), Short Tandem Repeats (STR), and Amplified Fragment Length Polymorphism (AmpFLP).

Restriction Fragment Length Polymorphism (RFLP) is a widely used method of isolating DNA. It requires large quantities of undegraded DNA. Because of this, this method is ideal for fresh crime scenes that have a lot of DNA evidence. Once adequate samples are obtained, restriction enzymes are introduced to isolate the AATT sequence. Scientists carry out gel electrophoresis on the fragments, make a blot, and probe the sample as mentioned earlier. The scientists analyze the sizes of the DNA fragments that the probe has found. They then compare the results of each DNA sample. Forensic scientists declare a match if the sizes of the two bands (bands of DNA from the crime scene and suspect’s DNA) are within five percent of each other.

Polymerase Chain Reaction (PCR) is a method of DNA amplification, which has the ability to use information from minute and degraded DNA samples. This method amplifies specific parts of DNA. The method makes use of two short DNA pieces known as thermostable DNA polymerase and oligonucleotide primers to isolate the part of DNA, which scientists copy. The scientists carry out gel electrophoresis as with Restriction Fragment Length Polymorphism (RFLP). In Polymerase Chain Reaction, contaminated DNA

samples may bring about false results. Therefore, scientists only use uncontaminated samples.

Short Tandem Repeats refer to tiny regions of short repeated sequences. In these regions, DNA varies immensely between people who are not related. In this method, scientists seek to identify these regions in both samples and compare the two regions from the two samples. Scientists can achieve higher accuracy by isolating and testing many short tandem repeats. The amplifying effects of Polymerase Chain Reaction make it the ideal method for isolating short tandem repeats.

The Amplified fragment length polymorphism makes use of the variable number tandem repeats to differentiate alleles. Unlike in other tests where the criterion of separation of DNA sequences is size, scientists use polyacrylamide gel to separate alleles. This method is cheaper than the other methods and is highly automated.

Many people usually misunderstand the science behind DNA testing. Knowledge of how DNA tests are carried out is important to people. It makes people understand and appreciate such technology as well as accept the results that DNA testing gives.

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