
DNA PROFILING AND CRIMINAL JUSTICE IN INDIA: A STUDY OF ITS ROLE AS AN INVESTIGATIVE TOOL

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ABSTRACT

DNA profiling is considered one of the most secure scientific methodologies for forensic investigation in the modern era, which has transformed the detection of crimes and dispensation of justice. This is especially important in the Indian legal environment, where justice delayed is justice denied, and evidentiary challenges and trustworthiness in traditional forms of evidence are often heavily scrutinized. DNA evidence in the Indian context will allow for a higher level of accuracy and objectivity to the justice process.

The goal of this thesis is to dissect the efficacy of the DNA profiling process in Indian Justice Administration as an investigative instrument by using scientific, legal, jurisprudential and practical dimensions of the support of DNA evidence in criminal trials. DNA profiling advance the usefulness of forensic evidence in supporting forensic evidence in the courts in a reliable and objective manner in homicide cases, sexual assault cases, paternity disputes and missing persons cases. However, a thorough analysis should also address barriers to the use of DNA technology in India which includes privacy concerns, lack of comprehensive regulation framework, lack of infrastructure, and the possibility of contamination and abuse of the samples in cases.

The paper highlights the pressing need for a credible legal and institutional framework regulating the application of DNA technology through a consideration of the legislation, case law, and suggestions from law reform agencies. Ultimately, the study determines a conclusion that DNA profiling, if regulated and used reasonably, can enhance the investigatory process and impacts significantly, the search for truth and justice in the Indian legal system.

1. Introduction

The role of Scientific technologies in Criminal Investigation and law enforcement in modern criminal justice administration is very crucial. The police forces use many technical criminal investigation tools to detect real offenders and criminals. The purpose of the law is to ensure the protection of the innocent and to prevent the acquittal of the guilty, in doing so the law serves as a tool. When the legal system works in collaboration with science and technology, for the identification of criminals and penalizing the accused involved in the commission of a crime, the law becomes a powerful criminal justice mechanism to ensure public safety and order in society.

The term DNA stands for Deoxyribose Nucleic Acid. It's found in each cell of the human body in the form of unique features and structures. It would be right to say that DNA is the blueprint of the human body in other words DNA is the Genetic-Bare Code of the physical body of every individual¹. DNA covers the genetic information or genetic code that works or that genetic information is required to identify any person or individual. It's only difficult to identify identical twins through DNA profiling, and except the identical twins, every person can be identified by the analysis of his DNA profiling under forensic science. DNA is a concept relating to the hereditary study, that carries the characteristics of parents to children, be it physical or psychological.

DNA profiling (often referred to as DNA fingerprinting), is the process of identifying an individual's DNA characteristics. Distinct from DNA profiling, when the goal is to identify a species (as opposed to the individual), this is referred to as DNA barcoding. As a forensic technique, DNA profiling can help law enforcement investigate crimes by profiling criminal suspects and then comparing their respective profiles to DNA evidence gleaned from a crime scene to further ascertain the potential for their involvement in a criminal act.

Everyone has their own unique set of fingerprints. Similarly, just as we can distinguish one person from another through their fingerprints, we can distinguish one individual from another because of their genetic material. This genetic material represents the hereditary blueprint

¹ Subhash Chandra Singh, "DNA Profiling and the Forensic Use of DNA profiling in Criminal Proceedings" 53 *Journal of Indian Law Institute* (2011). Available at: <https://www.jstor.org/stable/43953503> (Last visited on 2nd November 2024)

bestowed upon us by our parents, and is contained in the molecule known as deoxyribonucleic acid (DNA), the chemical fundamental to all life.

A DNA molecule is a long twisting chain of two strands. While it might seem complicated, DNA is only made of four nucleotides:

1. Adenine
2. Cytosine
3. Guanine
4. Thymine

These nucleotides exist as base pairs that are attached together much in the way the rungs of a ladder are attached together. Always, adenine will bond with thymine as a pair, and cytosine will bond with guanine as a pair. While most of DNA does not vary from person to person, some 3 million base pairs of DNA (about 0.10 percent of your whole genome) vary from person to person.

In human cells, DNA is tightly packed into 23 pairs of chromosomes. One member of each pair of chromosomes come from your mother, and the other member comes from your father. In other words, your DNA is a combination of your mother's and your father's DNA. Unless you have an identical twin, yours is unique to you. This is how DNA evidence is so powerful in investigations - its very unlikely some one else has identical DNA to you².

Properties of DNA

Deoxyribonucleic acid (DNA) is a large, polymeric molecule that is found in virtually every cell in the body. Two significant exceptions are red blood cells and nerve cells. Red blood cells are produced in bone marrow and have no need to DNA for replication, and nerve cells do not generally regenerate. DNA can be found in two regions of a cell: the nucleus and mitochondria.

² Jaising P. Modi, *A Textbook of Medical Jurisprudence and Toxicology*, 112 (LexisNexis-Butterworths Wadhwa, Nagpur, 24th Ed., 2011)

Nuclear DNA is a unique type of molecule³.

Its shape is called “double Helix”, consider a very long ladder. This ladder has two complementary pieces that are joined together. Now, take ladder and twist it many times throughout its length until it resembles a spiral staircase. The DNA molecule has a similar shape. The poles of the DNA molecule (called the backbone) are not significant forensically. They are exactly the same in all the people. The rungs are special; however each rung is made up of two bases or nucleotides that are joined together in the middle as well as to the poles, so each rung is made up of a base pair.

DNA is a material that determines whether a person has blue, green, or brown eyes; blonde, brunette, or red hair; or whether they are tall or short, or among many other characteristics of humans and other animals. DNA is a long, but narrow string-like item. A typical one-foot-long string or strand of DNA is usually packed into an amount of space of approximately a cube one/millionth of an inch on a side. This is possible because of the thinness of the string.

Collecting DNA Evidence

For a long time, fingerprints were regarded as the gold standard for connecting suspects to a crime scene. Nowadays, because DNA can be collected from almost any surface, DNA evidence is the gold standard. The gloves that criminals wear when committing a crime may still transmit considerable amounts of biological material. This could be a hair, saliva, blood, semen, skin, sweat, mucus or even earwax! All we really need is a few cells to have enough DNA information to place a suspect, sometimes with nearly perfect precision. When biological material is collected from a sample, like blood or saliva, DNA is only part of what was in that sample.

Before DNA can be analyzed, it must first be extracted and purified from the cellular material. There are multiple ways to accomplish this, but they use essentially the same basic steps. It is necessary to disaggregate (break open) the cell and nuclear membrane in order to liberate DNA into solution. Once DNA can be removed from its cellular components, the DNA can be separated from the cellular material. Once DNA is in solution, then the excess cellular debris

³ B.R. Sharma, *Forensic Science in Criminal Investigation and Trials* 54 (Universal Law Publishing Co. Pvt., Ltd., New Delhi, 7th edn., 2014).

can be removed from the solution and discarded, resulting in only DNA remaining⁴.

The principal procedures for extracting DNA are organic extraction (also known as phenol chloroform extraction), Chelex extraction, and solid phase extraction. Differential extraction is a specialized method of extraction in which DNA from two different types of cells may be separated from each other prior to being purified away from the solution.

While any of these extraction methods will provide good extraction in a laboratory, officers and forensic technicians routinely evaluate their extraction method considering the cost, time, yield of DNA, and quality of DNA. Once the DNA is extracted from the biological sample, the DNA can be used for any analysis, such as RFLP analysis or quantification and PCR analysis.

For this reason, officers involved with crime scenes are extremely careful about avoiding contamination of evidence. The police officers and detectives typically work closely with laboratory personnel, or evidence collection technicians, to avoid contamination when collecting evidence. To avoid any contamination they wear gloves and use disposable instruments that can be discarded after collecting each sample. As the officer collects evidence, they take precaution to not touch areas of the crime scene where a DNA based criminal could reside. Additionally, the officer avoids talking over evidence, sneezing or coughing onto evidence, and touching their face, nose, or mouth.

When an evidentiary material is recovered by officers, it is placed in a paper bag or envelope, not a plastic bag. This is important as plastic bags retain moisture, and moisture can destroy DNA. In addition to moisture, direct sunlight and warmth can degrade DNA, thus officers try and keep biological material in a cooled room temperature area. In addition to bags, officers usually label the bags giving a description on the evidentiary item being collected, where it was discovered, and where it will ultimately be taken to. They are following chain-of-custody procedures, which ensure that the legal integrity of the sample is in place once it leaves collection, through various transportation until it reaches the laboratory for analysis.

In order for crime to exist there must be some type of human society. As time has progressed and society has become more technologically advanced, the methods and techniques used to commit a crime have change in a most unimaginable way. This paradigm shift renders the

⁴ B.S. Nabar, *Forensic Science in Crime Investigation* 193 (Asia Law House, Hyderabad, Reprint 2018).

traditional methods of interrogation incapable of suppressing or controlling the criminals and hence requires something more modern and scientific in crime detection and investigation.

The geneticist from the United Kingdom, Sir Alec Jeffreys created it in 1984, while Dr. Jeffrey Glassberg established it in 1983. Jeffreys used the RFLP study of mini satellite DNA as the basis for his novel research. DNA fingerprinting relies heavily on methods such as RFLP analysis. Somewhere between 25 and 500 base pairs of DNAs are required for the RFLP examination. Restrictive enzymes are also used in traditional DNA fingerprinting to cleave DNA into little fragments.

In addition to DNA fragments, oligonucleotides may be employed as probes, and they can straightly bind to DNA fragments on gels. A person's specific number of mini satellites influences the size of the constraint fragments, as does the size of the restriction fragments themselves. As a result, it is possible to identify a person based on their pieces. As a result of its utilization of PCR amplification of VNTRs from several alleles, AFLP is a quicker approach than RFLP⁵.

Molecular biology, particularly DNA fingerprinting and genetic fingerprinting, can be used to identify human beings based on their genetic makeup. Forensic DNA profiling, a vital forensic technique, may be used to identify individuals. Parentage identity testing may also be performed through this technology⁶.

1.1 Statement of Problem

The law enforcement agency usually uses DNA profiling to solve crime puzzles and identify the offender in any of the following way;

- By comparing evidence from the crime scene with the DNA profile of the suspect, where a suspect is identified.
- By analyzing biological evidence collected at a crime scene and comparing it to the

⁵ Dr Lalji Singh, "DNA Profiling and its Applications" 60 *Current Science* (1991). available at: <http://www.jstor.org/stable/24099013>. (Last visited on 2nd November 2024)

⁶ Dr Nirpat Patel, "The role of DNA in criminal investigation Admissibility in Indian legal system and Future Perspective", Available at: https://www.researchgate.net/publication/279299013_The_Role_of_DNA_in_Criminal_Investigation_Admissibility_in_Indian_Legal_System_and_Future_Perspectives/download (Last visited on 25th December 2024).

DNA profile of an offender found in the National DNA database bank, where no specific suspect is identified.

- By linking the evidence from the crime scene to another evidence collected at a crime scene with DNA profiling in DNA database.

Further, the technique of DNA profiling can be used to prevent possible future crimes. This is because of surveillance on habitual criminals whose DNA data will be stored in a data bank which is taken at the time of conviction. But there is no law providing practical application of the technique of DNA profiling effectively in India. We do not have the legal and scientific infrastructure to implement the technology in a wide range needed of time. Despite many burning issues and challenges are coming out as a consequence of the introduction of a new scientific technique of DNA profiling in a criminal investigation.

The conflict between DNA mechanisms and the fundamental rights of individuals poses a serious challenge to the state. Right to privacy, and the right against self-incrimination is the main challenge in consequence of this the court is generally hesitant in accepting and directing to have DNA profiling of the criminals to identify the real culprit. There is a need to establish a proper balance between technology and the conflicting rights and other interest of an individual in society.

1.2 Literature Review

The literature review intends to identify legal loopholes in India's justice system which is responsible for the failure of proper incorporation and implementation of DNA Profiling in the criminal justice administration.

- **Dr B. R. Sharma, Forensic Science and Criminal Investigation and Trials, Universal Law Publishing Co., 4th Edition, 2003.**

This book titled "forensic science and criminal investigation and trial cover almost every aspect of forensic DNA analysis and scientific investigation. of crimes and criminal. The author explains the manner, in which the modern technique of forensic science of criminal investigation has changed the nature and the role of a criminal investigation.

- **B. S. Nabar, Forensic Science in Crime Investigation, Asia Law House, Hyderabad, 3rd Edition, Reprint 2007.**

The book on forensic science in criminal investigation systematically describes the historical development of DNA profiling and the initiation of its use in the criminal investigation. This book explores every aspect of DNA fingerprinting in India. This book especially deals with the issue of paternity determination by the use of DNA profiling in India.

- **Jyothirmoy Adhikary, DNA Technology in the Administration of Justice, Lexis Nexis Butterworths, New Delhi, 2007.**

The author of this book exposed the innovative scientific technology of DNA profiling in criminal justice administration this book is being bifurcated into six chapters. The author describes the current development in the field of forensic science of DNA profiling and explains how the technology promises accuracy and infallibility. The author explained the possibility of the use of DNA profiling in criminal investigations and civil matters.

- **V. R. Dinkar, Justice in Genes Evidential Facets of Forensic DNA Fingerprinting, Asia Law House, Hyderabad, 1st Edition 2008.**

In this book, the author described the concepts methods and techniques of DNA profiling. The book is bifurcated into six parts. The matter of admissibility of DNA profiling in evidence for criminal identification has been elaborated in a simplified manner. The author has taken up the positive and negative aspects of the technique of DNA profiling. The book is focused on the concept and is influenced by the existing trend of DNA profiling in the United State of America. There is commentary in the book criticizing the capacity and role of the Indian judicial system which is incapable from in legal and physical infrastructure perspective.

- **Govind Singh, Role of Forensic Science in Crime Control 7 Cyber Tech Publications, New Delhi, 1st edition, 2013.**

This book covers various facets and suspects of DNA profiling as an advanced scientific technique in solving complicated questions of facts in legal cases and traces evidence

– small in quantity but beneficial quality-wise. Genetic profiling based on inherited genetic variation acts as a forensic tool to facilitate proper and complete investigation and resolve many civil and grave offences punishing the criminals. As per the author use of DNA profiling in a criminal investigation does not violate the right to privacy enshrined under Art.20 (3) of the Constitution of India.

- **Subhash Chandra Singh “DNA Profiling and The Forensic Use of DNA Evidence in Criminal Proceedings” Vol.53, Journal of Indian law institute (2011).**

The author emphasizes that DNA testing has become an established part of the criminal justice process, and the admissibility of the test results in the courtroom has become routine. This paper examines the current debate over the many roles that DNA can, and should, play in criminal justice.

- **Dr Durga Pada Das,” DNA Fingerprinting and its impact on the Administration of Criminal Justice” Vol. 4 MLJ Cri. L. J, (2005).**

The author of this book explained the impact and role of DNA fingerprinting on the administration of justice. The author also explains the importance of DNA fingerprinting in criminal justice investigations.

1.3 Objectives of Research

- To evaluate how far DNA profiling technique has an ability to aid forensic investigations.
- To understand the decisive value of DNA in the outcome of trials.
- To study the possibilities of infringement of privacy and other human rights of individuals.
- Lastly, to evaluate the fact whether the legal framework is sufficient for optimum utility of DNA.

1.4 Hypothesis

This research paper will be concentrating on testing the following prepositions:

1. The legal institutional framework to deal with the use and applicability of DNA profiling in criminal investigation in India isn't adequate to cope with the constitutional challenges.
2. The DNA profiling technique of investigation is not violating the human rights of the accused but it is a protective mechanism because it ensures a better investigation.

1.5 Research Questions

1. What are the laws concerning use of DNA profiling in Criminal Investigation?
2. What is the legal framework for DNA profiling in a few developed countries like the USA, UK, and Canada?
3. How much the DNA profiling infringes various human rights, especially the right to privacy of an individual?
4. What is the role of law in protecting the right and interests of affected persons?

1.6 Research Methodology

The methodology that is used in this study is Doctrinal which will involve an in-depth study of the source materials, Text books, articles, acts and case laws.

Primary as well as secondary sources like legal texts, books, articles, encyclopedias, research papers, newspapers, publications of special institutions of leading nations on dealing with forensic science and techniques of DNA profiling are referred to get the most pertinent information.

1.7 Limitation of Study

This study is limited to a limited number of papers, judgements and other literary sources due to lack of time and resources.

1.8 Mode of Citation

Citations of this paper will be in accordance of ILI Citation method.

2. Historical Perspective: Determination of DNA as an Evidence

In the early stages of criminal investigations and trials taken equal parts on oaths, verbal confessions, and witness testimony. In a context wherein there has yet not been a differentiation of religion, magic, and superstition from science, it's no wonder that some societies used practices like the trial by ordeal to infer guilt or innocence. Forensic science in the early middle ages began with the use of fingerprints to determine identity (first known record of this was in 600 AD). Arabic merchants would collect a debtor's fingerprint, affix it to a bill and back to the creditor.

The first forensic science manual named Xi Yuan Lu (Washing Away of Wrongs written in Song Dynasty China by Song Ci) was published in 1248. This was the first indication of medical knowledge applied for the purpose of solving a criminal case. Pathology reporting began in 1600 and physical evidence was used for a murder conviction in 1784.

In 1806, the German chemist Valentine Ross pioneered a method for detecting arsenic inside a victim's stomach, which was then used to investigate alleged poison related deaths. In 1854, San Francisco became the first country to use photography for criminal identification. So, it is evident from the above discussion that as the societies progressed, people became educated, and definite status was accorded to the medical jurisprudence that actually should have been accorded to it earlier, being a complete science in itself.⁷ This was done in 16th century and since then, there has been no looking back; and many discoveries have been made in many fields, namely, fingerprints, DNA, Anthropometry, hair for identification, use of trace evidence, ballistics, lie detection, voice recording, etc.⁸

For the scientists it was not an easy road before they realized through research that DNA, deoxyribonucleic acid, which is present in every nucleated cell in the body, would be useful and definitive in the identification of individual representation. At the onset of discovery, Scientists did not really know what was inside the nucleus. In fact, they did not know there was an organelle called nucleus. The only thing known was Cell. Coincidentally and miraculously,

⁷ Anjum Parvez, Scientific Aid in Evidence and Justice An Analytical Study with Special Reference to Police Investigation, (2020) (Unpublished Ph.D. thesis, Uttaranchal University).

⁸ Yashpal Singh and Mohd. H.Zaidi, *DNA Tests in Criminal investigation, Trial and paternity disputes (Justice through science)* 49, (Alia Law Agency, Allahabad, 2006).

nucleus, the home of the DNA, was the very first organelle discovered by Antoine Phillips Van Leeuwenhoek (1632-1723) while looking at red blood cells of salmon fish.⁹

Genetics is the basis for development of DNA evidence and the credit for discovery of genetic sciences goes to Gregor George Mendel, that's why he is called "Father of Genetics". He explained the way how certain characteristics are transferred from a parent to offspring and found that individual traits in any living being were determined by discrete "factors," now known as genes. These factors were inherited from the parents and that is why children resembled their parents.¹⁰

The use of DNA profiling for forensic investigation began in 1980s following the rape and murder of Lynda Mann and Dawn Ashworth, both happening in the same circumstances, in Leicester, England. After these murders, Police turned to Professor Alec Jeffrey's, who was doing research on mutations of diseases in DNA¹¹. He had a eureka moment in 1984, when he determined that the DNA in every human was unique with only limitation of mono zygotic twins, which made it infallible source for investigative purposes. His tests amazed the police, with respect to, that the evidence could strengthen their theory regarding that, there was one person responsible for both crime deterrent offences. The tests also established, without reasonable doubt that their prime suspect who has confessed to the second killing, was not capable of committing either killing. Following mass screening in the area surrounding the murders, turned up Colin Pitchfork, who was the murderer and tried to avoid detection, during the screening by persuading a friend to stand in his place. Once his trickery was found out, he sealed his fate, and forensic DNA profiling began an era of forensic DNA profiling.

Barbaric and torturous methods of crime detection have no place in a civilized society and where human rights are given the utmost important priority. In these present day and age, crime investigation agencies have no alternative but to develop a science, the forensics. Forensic science in its initial stages of development was not bifurcated into different branches, however, as the science advanced, new subdivisions have emerged, out of which, one branch is Forensic

⁹ B.R. Sharma, *Forensic Science in Criminal Investigation and Trials* 196 (Universal Law Publishing Co. Pvt., Ltd., New Delhi, 7th edn., 2014).

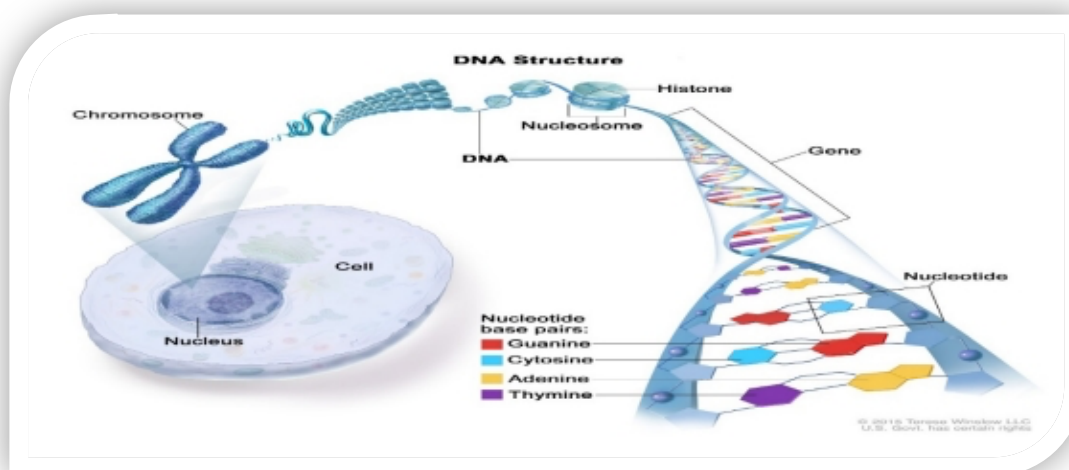
¹⁰ *Ibid.*

¹¹ Govind Singh, *Role of Forensic Science in Crime Control* 7 (Cyber Tech Publications, New Delhi, 1st edn., 2013).

Profiling that utilizes the trace evidence to answer various questions about the criminal or the crime¹².

3. Analysis of Structure Of “DNA”

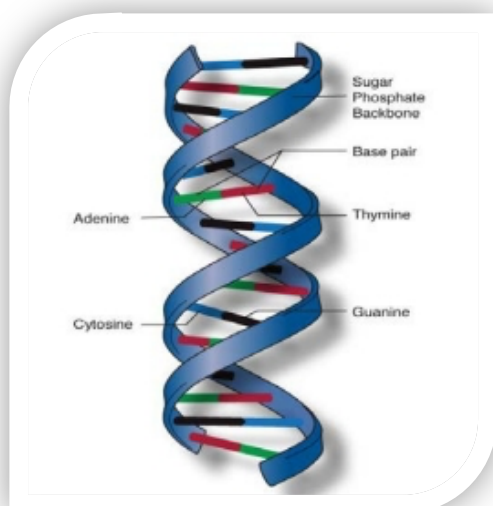
It can be inferred that DNA is the chemical structure that forms chromosomes. A segment of a chromosome that specifies a particular trait is called a gene, which is why DNA is also referred to as the genetic blueprint, it carries the information for the essential genetic components that from one generation to the next. This information for the genetic blueprint is encoded in four chemical building blocks of DNA, the A, T, G, and C bases, which are strung sequentially on a string, in pairs called base pairs¹³.



DNA is comprised of a nucleotide unit (sequences of bases) and each nucleotide unit is comprised of: a. Deoxyribose sugar b. phosphate group c. nucleon base (one of A, T, G, C). The sugar and phosphate represent the backbone of the DNA and the bases are attached to the sugar groups of the backbone, which allows for variation among the nucleotide units. The particular arrangements of these four bases allow for variations between living beings and living variations of humans. Which humans have been estimated to contain approximately one billion nucleotide positions among their total genomic DNA.

¹² Nivedita Grover, Isha Tyagi, “Development of Forensic Science and Criminal Prosecution-India.”, *International Journal of Scientific and Research Publications*, 4, 2nd Issue (2014).

¹³ *Ibid*.



However, Watson and Crick noted from the X-ray diffraction studies that the two single strands of the double helix are similar in overall structure but vary substantially in base sequence. DNA's structural features are striking and the individual nucleotides matches up with their complementary base via hydrogen bonds. The base-pairing rules dictate that A can only hybridize with T and C can only hybridize with G. The hydrogen bonds between the two strands of DNA chemically via base-pairing are broken either by increased temperature or a chemical treatment called denaturation. These two strands are attached by a process called hybridizations that is a fundamental property of DNA. The two strands of DNA are “anti-parallel” with one strand going in the 5' to 3' direction and the other strand going the opposite direction. The genomic DNA is composed of 'coding' and 'non-coding' regions; the 'coding' regions are called genes because their programming is to provide a cell with the information 'to make' protein. Genes consist of exons (the proteins- coding regions) and introns (the non- coding intervening sequence). Approximately five per cent of all human genomic DNA consists of genes. The remaining 95% was referred to as junk DNA because this part of the genome does not directly contain instructions to produce proteins and much of its functionality is not yet understood. Interestingly enough, these are the components of junk DNA that differ between individuals and the markers used in human identity testing are located in the non-coding portions.

4. DNA Profiling: Tools and Techniques

The measurement of DNA to locate shared patterns or shared DNA types between individuals

is identified as DNA profiling. In the forensic context, this identification testing is used, either as a confirmation of parentage in the case of alleged biological parents, or to include or exclude individuals from consideration as possible sources of biological evidence, blood, saliva, or semen or stains due to biological evidence from the body parts of those individuals, bones teeth, or hair. In the forensic casework perspective, DNA profiling involves the comparison of the biological evidence DNA results to the individual in question, either direct reference samples of that individual, or indirect reference samples of individuals in the close blood family of that individual. The choice of reference sample for analysis, which reflects overall integrity of the family in question, is essential to the success of the case; Success does not depend on just authenticity of the reference samples but also authenticity of each specimen donors biological relationship with the individual in question.¹⁴

There maybe cases when the social or legal relationship may be different from the biological one and more education needs to be done on the issues to investigating officers, forensic analysts, and the courts. According to Dictionary.com, Genetic Fingerprinting is “the examination of a small amount of genetic material from a blood or cellular sample that is as unique to an individual as a fingerprint to provide identification; also called genetic fingerprinting.”

“DNA profiling is a process used by forensic scientists to aid in the identification of individuals by DNA typing. DNA profiles are coded sets of numbers that represent an individual's DNA composition which can also be used to reference the individual. DNA profiling is not to be confused with whole genome sequencing. DNA profiling is used in for example parental testing and criminal investigations.”¹⁵

4.1 Source of DNA

Incriminating evidence is anything which can be tied to a crime scene and its offender. One type of physical evidence is DNA based biological evidence. But biological evidence may not always be obvious to the naked eye. Every piece of biological evidence collected at a crime scene can be evaluated for DNA. In each case, just a small number of cells can be utilized to identify the useable DNA. DNA sites that may be present on the evidence as well as biological

¹⁴ Subhash Chandra Singh, “DNA Profiling and the Forensic Use of DNA profiling in Criminal Proceedings” 56 *Journal of Indian Law Institute* (2011).

¹⁵ Yashpal Singh and Mohd. H.Zaidi , *DNA Tests in Criminal investigation, Trial and paternity disputes (Justice through science)* 54 , (Alia Law Agency ,Allahabad ,2006).

sources from which cells may be present are all included in the preceding list. If you can't see a stain, you don't have enough cells to do a DNA test. When a suspect denies being at the site of a crime, their DNA may be able to establish otherwise. The attention changes to the subject's consent after an alibi is abandoned. Any of the evidence sources described in the table may be used to obtain evidence for a DNA test. It's possible to get our genetic code from many different sources, some of which are listed below. All of our bodies and the things that make up our bodies have DNA. The following is a complete list: Blood and bloodstains, Semen and semen stains, Saliva, saliva stains, Urine, urine stains, Bone marrow, Canal root pulp, Facial matter, Fingernail pairings, Body tissues, and body organs, Fort material, Hair and hair roots, Bones marrow, Urine tooth canal root pulp and from other fluids and body material.

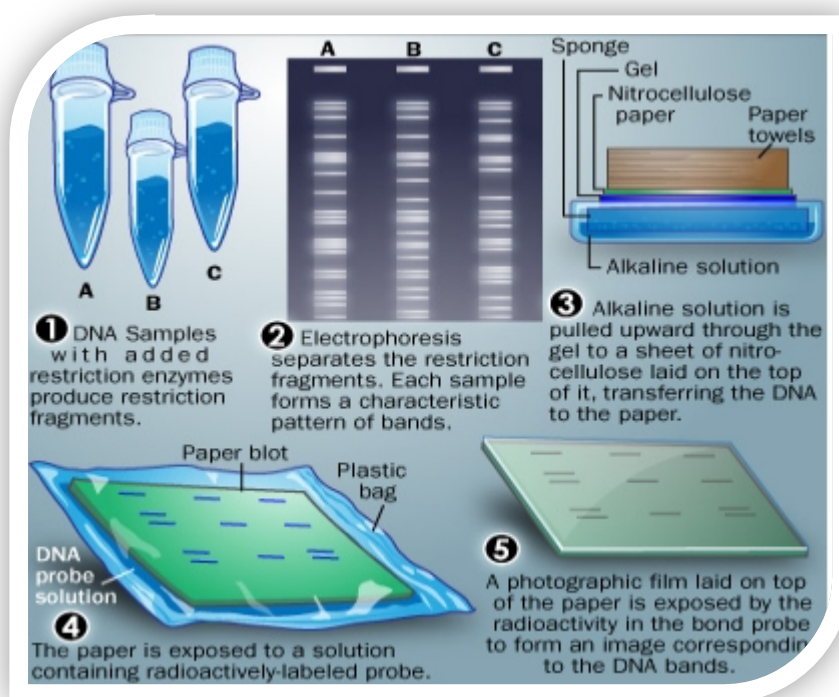
Serial No.	Evidence	Possible Location of DNA	Source of DNA
1	Cricket Bat, Hockey etc	Handle, end	Sweat, skin, blood tissue
2	Hat, Mask	Inside	Sweat, hair, dandruff
3	Eyeglasses	Nose or Earpieces, lens	Sweat, skin
4	Facial tissue, Cotton swab	Surface area	Blood, sweat semen, ear wax
5	Dirty Laundry	Surface area	Blood, sweat, semen
6	Toothpicks	Tips	Saliva
7	Used cigarette	Cigarette-butt	Saliva
8	Tape	Inside-outside surface	Skin, sweat
9	Bottle, Can, Glass	Sides, mouthpieces	Saliva, sweat
10	Used condom	Inside/outside surface	Semen, vaginal cells
11	Blanket, pillow, sheet	Surface area	Sweat, hair, semen, urine, saliva
12	Bullet	Outside surface	Blood tissue
13	Bite mark	Person's skin or clothing	Saliva
14	Finger nail	Person's skin or clothing scraping	Blood, sweat, tissue.

4.2 Techniques of DNA Profiling

4.2.1 Restriction Fragment Length Polymorphism

This analysis was the first DNA investigation method, and it is used to examine forensic DNA samples, evidential DNA, or biological material to identify persons. It is the basis for all

subsequent DNA investigation techniques. Dr Botstein was the first person to propose that we employ the RFLP technique to map the human genome, and he did it in 1982. Wyman and White made a breakthrough in the area of DNA technology when they uncovered the first hyper variable region in the human genome. It was introduced by a well-known criminalist and scientist, Prof. Alec Jeffery, in 1985 while solving the case of two teenage schoolgirls who were raped and murdered, and it was later used to track down a serial rapist in the United Kingdom, making it the most significant discovery of the twentieth century.⁵⁴ For the criminal justice system, this finding has been very beneficial since it has the power to identify crimes and offenders earlier on. The use of this technology has made criminal investigations considerably simpler than they were before. This approach may now be used to identify crime and criminals since biological samples, which serve as evidence, are often discovered at the scene of an incident.



RFLP analysis of DNA involves the following steps¹⁶:

1. Isolation of high molecular weight DNA from biological material

¹⁶ How DNA profiling works available at: <https://science.howstuffworks.com/dnaprofilng.htm#pt1> (Last visited on November 8th 2024).

2. Fragmentation of DNA molecule through Restriction Enzymes (RE)
3. Separation of the Restriction Fragment Lengths (RFLs) through electrophoresis
4. Transference of RFLs to Nylon Membrane (Southern Blotting)
5. Preparation of radioactive probes
6. Hybridization of the RFLs through radioactive probes
7. Visualization of RFLs bands on X-ray film through autoradiography and its development to give visible patterns of the Restriction Fragment Length Polymorphs (RFLPs).

4.2.2 Polymerase Chain Reaction (PCR)

The second method of DNA analysis is based on polymerase chain reaction (PCR). It has become more important in recent years, and most institutions are now using it in their day-to-day operations.

In 1983, Dr Kary Mullis, a biochemist, came up with a way to make copies of specific parts of a strand of DNA that were already there. When he came up with this method, he called it “Polymerase Chain Reaction.” In 1983, he was given the Nobel Prize for his work. Mullis came up with a way to make DNA grow in a lab by heating and cooling it over and over again with an enzyme called DNA polymerase. This enzyme makes DNA grow. DNA polymerase is a substance that is found in all living things. It helps with the replication of DNA as a cell splits. In the process of cell division, the double-stranded DNA unzips and turns into single-stranded DNA. DNA polymerase acts by attaching itself to every single strand of DNA and directing the formation of the complementary strand, which makes an exact copy of the DNA¹⁷.

The PCR-based testing technique increases the DNA analysis and with this technology, even extremely modest biological evidence may be analyzed. This approach duplicates precise copies of DNA found in the sample without harming the original one, for example, a million copies may be generated from a few skin cells.

¹⁷ B.R Sharma, *Forensic Science in Criminal Investigation and Trials*, 1137 (Universal Law Publication, Delhi, 2005).

When using PCR, contamination by foreign DNA may be detected with a high degree of accuracy. DNA extractions are always done in a location that is physically separated from the site where the following amplification will take place. To reduce the risk of extraneous material being brought into or out of the amplification environment, the scientist will often stay in the room until the extraction is complete¹⁸. It takes three stages to perform PCR. Everything happens in a thermal cycle, which is a device that can accurately reach and maintain certain temperatures. It is combined with different solvents and then placed into tiny vials of DNA samples.

4.2.3 Mitochondrial DNA (Mt DNA)

Cell nuclei do not contain all of the human genome's genetic material. The Mitochondria, which are structures within cells but outside the nucleus, contain a small amount (1%). Certain respiratory functions are performed by mitochondria, which are found in cells. The mitochondrial DNA provides the genetic code for the proteins needed to carry out these tasks. These samples, which cannot be examined using RFLP or STR, can be examined using mitochondrial DNA analysis. In comparison to nuclear DNA, mitochondrial DNA is smaller.

Nuclear DNA sequencing, a far more advanced technology, was offered to the area of forensic inquiry in 1998, just a few years after the mt DNA sequencing method was originally introduced in 1994. Both of these methods can be used to establish a biological connection spanning several generations. Testing for mitochondrial DNA enables the analysis of discrete samples that are unlikely to contain nuclear DNA, such as hair roots, hair shafts, bones, saliva, teeth, and old tissue.

Mitochondrial DNA is inherited solely from the mother and it does not carry the father's features. Because mt DNA is passed down through the mother's line, everyone in the mother's family will have the same mt DNA. Samples from other women's wombs may be compared to this one. The rate of mutation in mt DNA is 10 times greater than in nuclear DNA. When a kid inherits his or her mitochondrial DNA from their mother, the father has no role in its creation or maintenance whatsoever. Shortly after the fertilization mitochondria from sperm are removed by an unknown method. As haplotypes, mt DNA does not go through the recombination process. A haplotype is a group of genes that have a tight relationship and are

¹⁸ Yashpal Singh and Mohd. H.Zaidi , *DNA Tests in Criminal investigation, Trial and paternity disputes (Justice through science)* 141, (Alia Law Agency ,Allahabad ,2006).

passed down as a single unit from generation to generation. Mitochondrial DNA discovered in the form of double-stranded, closed circular molecule sequences of the two primary highly variable sections inside the regulated area are investigated

It is important to highlight that the sequencing of mitochondrial DNA is a time-consuming and arduous process. The number of specimens needing comprehensive processing may decrease as screening procedures improve¹⁹.

4.2.4 Y- Chromosome Analysis

There are male and female Y-chromosomes in a biological sample. Forensic use may be made of a genetic marker found on the y chromosome. All of a father's sons inherit this chromosome, making it possible to establish a man's paternal lineage. Semen and vaginal cells may be analyzed without having to be extracted or separated. It is possible to utilize this form of identification to determine the connection between two or more guys, or to examine biological evidence that has been produced by numerous males.

Y-chromosome single nucleotide polymorphism (SNP) analysis is the term for this kind of genetic testing (SNP). Replacement of a single Y chromosome base pair occurs throughout time. When a person's DNA is damaged, it leads to alterations in the nucleotide bases, such as damnation, depurination, or other changes. SNPs are created when the body's DNA repair machinery fails to fix the error. However, despite its modest mutation rate, long-term studies of population movement may benefit from SNP analysis. The Y-chromosome sequences are amplified using a fluorescently tagged primer in PCR. It is then permitted to hybridize with allele-specific oligonucleotide probes covalently linked to colour-coded beads (microspheres)²⁰.

The Y-chromosome contains STRs that may be used to identify those responsible for acts of sexual assault. A vaginal swab often contains both male and female components in the event of sexual assault. Differential lyses, a technique for locating and removing just the sperm and testes, are used to accomplish this goal.

¹⁹ Dr. Swati Parikh, *DNA Tests In Criminal Investigation And Paternity Disputes (A Modern Scientific Technique)* (Dwidevi And Company, Allahabad, 2nd Edition 2009).

²⁰ Jaising P. Modi, *A Textbook of Medical Jurisprudence and Toxicology*, 343 (LexisNexis-Butterworths Wadhwa, Nagpur, 24th Ed., 2011)

It is not possible to have Y chromosome genes in the DNA of females. The attacker must be the source of this. Only male components will be recognized after amplification. If the victim was attacked by more than one individual, the Y-STR method might be quite helpful in gathering information. Y-Chromosome STR loci are very useful in anthropology, ancestry identification, and the study of rape because of their heterogeneous pattern²¹.

5. National Legal Framework on DNA Evidence

The implementation of forensic evidence in criminal trials helps in resolving critical cases logically and rationally. However, the use of forensic evidence is limited in the Indian legal system owing to restriction related to the provision of Articles 20 (3) of the Indian Constitution²². The protection is available not just in respect of evidence given in Court trial but at an earlier stage as well.

The protection against self-incrimination envisaged in Article 20(3) is available only in cases where any interpretation of compulsion was involved and not against voluntary statement or disclosure or production of a document or other material. The purpose of the protection under Article 20(3) is to assure to every person that they cannot be compelled to answer a question or produce a document or thing if the document or thing would have the appropriate tendency to result in the person being convicted of crime. The applicability of forensic evidence in relation to violating Art. 20(3) of the Indian Constitution is not without question.

In *The State of Bombay v. Kathi Kalu Oghad & Others*²³, the Supreme Court held that the act of giving thumb impression, specimen signature, blood, hair, semen etc. by the accused does not amount to a witness in the meaning of the Article. The accused does not have any right to challenge DNA examination for the purpose of investigation and trial.

However, in a subsequent case of *Selvi & Ors v. State of Karnataka & Anr.*²⁴, the Supreme Court questioned the use of involuntary scientific techniques to enhance investigation in Criminal matters and held that the brain mapping and polygraph tests were inconclusive and that compulsory of such testing would be unconstitutional in a criminal trial.

²¹ Yashpal Singh and Mohd. H.Zaidi , *DNA Tests in Criminal investigation, Trial and paternity disputes (Justice through science)* 151 , (Alia Law Agency ,Allahabad ,2006).

²² The Constitution of India, 1950

²³ AIR 1961 SC 1808

²⁴ Smt. Selvi & Ors v. State of Karnataka, 2010 (7) SCC 263

Section 51 of the Bhartiya Nagrik Suraksha Sanhita (BNSS) allows for a medical examination of the accused upon their arrest, provided there are grounds to believe that the medical examination will provide evidence which relates to the commission of the crime.

Section 52 of BNSS specifically deals with examination of person accused of rape by Medical Practitioner. Section 53 of the BNSS provides for the examination of the arrested person upon the request of the arrested person, by a registered medical practitioner.

Section 184 of the BNSS makes provisions for the medical examination of a woman who is an alleged victim of rape and the examination is to be made within twenty four hours of the offence, which includes the DNA profiling of the woman. Section 328 of BNSS further deals with report of certain Government scientific experts provides including Forensic experts that his report may be used in evidence.

Under the Bhartiya Sakshya Adhiniyam 2023, forensic report is stated to be an opinion give by an expert. An expert can be defined as a person who becomes skilful or expert by practice and observation, in any science or trade. Section 39 of the Bhartiya Sakshya Adhiniyam 2023 (BSA) provides for opinion of experts. The opinion of experts is admissible and relevant. Where the court is to form an opinion as to science or identify of hand writing or finger impression, the opinion of an expert as to that point is a relevant fact. Section 72 of BSA authorises the court to require any person including the accused to submit to the taking their finger impressions.

The Indian parliament has enacted the Criminal Procedure (Identification) Act, 2022, to empower the police to take measurements of any person convicted for any offence or any other person for investigation and identification of the criminal. This act authorises keeping the record of such measurements for incidental purposes for 75 years. Sec. 3 of the Act a person shall allow their measurements to be taken by police or prison officer. Only the person arrested for an offence punishable with imprisonment of less than 7 years may not be obliged to allow to give his biological sample except when he is accused of a crime against women or children.

The NCRB shall have the power to collect, store or preserve and destroy, process and share and disseminate the record of measurement in a manner prescribed by the central government. Any such agency as may be notified by the Union or the state government shall have the power to collect and preserve and share such records.

The magistrate shall have the power to order the collection of measurements from any person to his satisfaction. The resistance by such person from taking measurement shall be an offence under sec. 186 of IPC. The central or the state government shall have the power to make rules for this Act. The police officer shall have the authority to collect the measurements means a police officer is not below the rank of “Head Constable”. The “measurement” which may be collected from a person includes biological samples, footprints, finger impressions, retina and iris-scan, and all the examinations as provided under sec. 51 or sec. 52 of the BNSS.

The Act further provides that in case the record of measurement is collected from a person who is neither previously convicted for any imprisonment and is acquitted, released or discharged by the court or pre-trial released. All records of measurement if collected from such person shall be destroyed immediately. Thus, the Act is authorised to collection of biological material from the person for DNA profiling and identification of criminals based on DNA comparison and storage of such profiles for 75 years.

The act grants the authority to the magistrate to order the collection of biological material if he is satisfied to do so. Here one more thing is noticeable, that the police officer up to the rank of head Constable shall have the power to collect biological material for DNA profiling without the authority of a magistrate.

This Act would empower the investigation authorities to exhaust the scientific mechanism, scientific evidence, tools and technologies for criminal investigation and identification of criminals be it biometric identification, forensic identification etc.

The purpose of the act is to utilize every scientific method to convict the real culprit, thus, delivery of justice to the victim of crime and maintenance of law and order in society with effectiveness. The provisions for collection of measurements for examination of DNA test will only be appropriate when the law would be made which will provide for DNA regulatory Board and DNA Data Bank, where the Board shall be required for regulation and standardization of collection, storage or preserve, destroy, process and share and disseminate the record of measurement.

Unfortunately, still, there is no specific legislation to regulate the concern for individual privacy. Thus, there must be a comprehensive Act to strengthen forensic DNA technology and secure privacy to make the justice delivery system more efficient and technically stronger.

6. Judicial Approach

With the introduction of every new technology there are always clashes between old system and new system. The same thing applies to DNA evidence because with the introduction of DNA technology in the courtroom in recent years, we have seen the clashes between legal and scientific approaches. Sometimes the evidences are discarded because of some special reasons like forensic samples are old or they are too old to accept because they loose there evidential value.

Considering the importance of DNA profiling, it was critical in Nirbhaya Rape and Murder Case²⁵, forensic DNA profiling played a decisive role in determining the guilt of all four accused. DNA of semen found in the body of the prosecutrix was compared with the DNA found at the crime scene and from all accused which established their identities beyond a reasonable doubt and convicted all the accused.

In *Dharma Deo Yadav v. State of U.P.*²⁶, Court has given its opinion that, The person performing DNA test is a reliable witness. His/her report and opinion is presumed to be 99.9% accurate, correct, authentic and reliable. For achieving his status the DNA expert must be expert and eligible not only in forensic science but in status too. In this case, the expert opinion about DNA testing of human skeleton was accepted by the Court.

In the famous case of *Rohit Shekhar Tiwari v. Narayan Dutt Tiwari*²⁷, The Supreme Court upheld the Delhi High court's judgement requesting veteran congress leader, N.D. Tiwari, to take the DNA test comes through a prominent point of view - the acceptability of such evidence. In this case, Rohit Shekhar had claimed to be the biological son of N.D. Tiwari, but N.D. Tiwari showed unwillingness to submit the DNA test indicating that it would be a violation of his Right to privacy and an embarrassment to him. Here, the Supreme Court dismissed this argument by stating when the result of the test would not be disclosed to anyone and would be under a sealed envelope.

In the famous case, *State of U.P. v. Amarmani Tripathi*²⁸, where the accused was convicted of the charge of murder on the basis of evidence of DNA test of fetus conducted by the order of

²⁵ Mukesh & Anr vs State For Nct Of Delhi & Ors, AIR 2017 SC 2161

²⁶ 2005 (2) DNR (HC) 675.

²⁷ 2010 RCR (Delhi) 289.

²⁸ (2005) 8 SCC 21

the court.

In *Santosh Kumar Singh v. State*²⁹ (Priyadarshini Mattoo Murder Case), The appellant/accused Santosh Kumar Singh, committed rape and murder of a hapless junior college student for having refused his amorous overtures after causing severe harassment and stalking her. The trial court acquitted him. Death sentence was awarded by High Court for the offences under sections 302 and 376 of IPC.

In *Surendra Koli v. State of Uttar Pradesh & Others*³⁰, The facts of the case are dreadful and terrible. The Appellant Surendra Koli Indisputably was Accused 1 Maninder Singh's servant from whom the children were missing, House No. D-5, Sector 31, Nithari Vilage, Gautam Budh Nagar, Noida in period case for the previous two years from 2005. Surendra Koli was alleged to have killed chopped then Murder and also consumed some body parts after cooking. In his confession, Surendra Koli claimed he choked the girls luring them in House No. D-5, Sector 31, Nithari Vilage, Gautam Budh Nagar, Noida, admitted to strangling them, and chopping/cooking/eating parts of their bodies. The remnants were being recovered which included body parts, slippers and clothes were disposed off and thrown in the enclosed latched gallery behind the house, under the confession given to the Magistrate.

Surendra Koli agreed without hesitation to lead the police, as he confessed, to the exact location of the articles/body parts hidden. Then, 15 skulls and others bones, and a knife recovered from the water tank of the bathroom.

The court held that in the present case the identity of Rimpa Halder was established by matching DNA extracted from pieces of her body with the DNA extracted from her parents and brother. Such kind of matching can establish identity to a certain degree of probability but not absolute identity of deceased person. There is absolutely no discussion in any of the Supreme Court Judgements or High Court Judgments regarding what degree of probability was found in the case of Rimpa when her DNA was matched with DNA of her parents and her brother, and whether the degree of probability found in the case is judicially acceptable.

In *Mohammad Amir Ajmal Kasab v. State of Maharashtra*³¹, This was the largest terrorist attack

²⁹ (2010) 9 SCC 747

³⁰ (2011) 4 SCC 80

³¹ (2012) 9 SCC 1

case in Mumbai which started on 26.11.2008 and killed 166 persons, injured 238 people and destroyed property estimated at Rs. 150 crores. The sole surviving terrorist Ajmal Kasab was captured among ten terrorist. He made bold confession under section 164 of CrPC which was corroborated with ocular evidence of eyewitnesses who had life and death encounters with the terrorists and it was further corroborated with forensic evidences like DNA etc.

In *Bhabani Prasad Jena etc. v. Convexer. Sec. Arissay Orissa State Commission for women*³², In this case, the question was whether the High Court of Orissa was correct in giving direction for DNA of the child and the appellant. The answer was that the High Court was incorrect in allowing the application for grant of DNA test of the child on the base of whether there will be possibility of reunion of the parties if such DNA can be conducted and therefore if it is found arises from the outcome of the DNA that the son was born out the wedlock of the parties.

In *Anil Kumar v. Turaka Kondala Rao*³³, The petitioner, who was illegitimate son of the respondent, filed the petition claiming the maintenance. The dispute regarding parenthood arose. The petitioner and respondent were referred for DNA diagnostics. The DNA test so conducted, confirmed that respondent was biological father of petitioner. Hence, it was held that respondent was putative father of petitioner and there was an obligation upon him to maintain the petitioner through he was illegitimate son of the respondent. Rupees 300/- per month maintenance was allowed to the petitioner considering the facts of the case.

Again in the case of, *Mr. X. v. Mr. Z*³⁴, The Delhi High Court ordered that at the expense of husband, DNA testing should be conducted by the pathology department of the All India Institute of Medical Science. The DNA test was to be conducted of a fetes. A fortiori, where the welfare of child is in question, a similar test should be directed. The Court held that, If husband and wife were living together at the time of conception but DNA test proved that child was not born to husband, the conclusiveness of law would remain uncontradicted.

In the case of *Thangavelu v. S. Kannammal*³⁵, marriage was not consummated with the wife and the respondent and child was not conceived by him. He also stated that he was willing to take DNA test in order to prove his case. The wife denied allegations. The learned Subordinate Judge dismissed the petition. It was held, That Court has ample power to direct for DNA test if

³² SLP (c) Nos. 22905-22906 of 2009.

³³ 1998 (CrLJ) 4279.

³⁴ AIR 2002 Del. 217.

³⁵ AIR 2005 Mad. 106.

a strong prima facie case is made out but in the facts and circumstance of the case the petitioner could not make out such a case.

In *Nirmaljeet Kaur v. State of Punjab*³⁶ DNA test was preformed in a case to establish maternity and it was proved after DNA test that the petitioner was not biological mother of child.

In the case of *Salom v. Ayisha*³⁷, woman was raped and a child was born. Than in such circumstances the dispute regarding paternity was raised and parties got the DNA test conducted. The DNA test established the relation between them.

In the case of *Heera Singh v. State of U.P.*³⁸, The Court held that when there is no direct and positive evidence to rebut the presumption of legitimacy the order of DNA test cannot be allowed because law requires very strict and direct proof.

In a case *Vandana Kumari v. P. Parveen Kumar*³⁹, husband alleged that his wife having illicit intimacy with her own brother in law and at the marriage she was pregnant. While establishing the legitimacy of born child, than it was held that it was deserving case where the DNA test could be conducted. Court held that in paternity dispute DNA test is permissible, when it is in the interest of child.

The Court decided in the case of *Thograni v. State of Orissa*⁴⁰, The biological evidence is also a very powerful and important tool used to settle paternity disputes. Each person has its own unique DNA. The only exception is monozygotic twins where both the twins may have the same DNA sequence. The biological evidence includes blood, urine, saliva, skin-cells, hair, hair roots, tissues, tooth, semen, vaginal swab, bone-marrow, fetal, materials, post-mortem samples and blood samples of relations. All these and other such a material contain nucleated cells. Once a sample is collected from the place of occurrence or in the case of paternity dispute from the child and if it is compared with DNA of the suspect at present, it will reveal the truth.

In the case of *Chandra Devi v. State of Tamilnadu*⁴¹, The court accepted the DNA evidence presented by the expert witness from the CCMB, Hyderabad. The court remarked that the

³⁶ (2005) 8 SLT 755

³⁷ (2007) 1 DMC 289.

³⁸ (2006) 1 DMC 48

³⁹ (2007) 1 DMC 246.

⁴⁰ 2004 Cr. LJ 4003 Ori.

⁴¹ Manupatra TN/ 335/ 2002.

expert witness from CCMB had himself participated in the experiment and had exhibited his evidence with proof to the Court by way of reliable and valid procedure.

The courts have an extra ordinary responsibility in deciding on the admissibility of scientific evidence and in accepting an expert's evidence. Advancements in science and technology have made it hard for the Judges also to keep up with the latest developments. In India because of lack of technical and scientific knowledge, judges face the problem to appreciate the complex scientific domain.

7. Conclusion

At this age of advanced science and technology, the law should not lag behind in adopting scientific methods in lawful manner by legal means. So we can come to conclusion that taking DNA evidence doesn't constitute a contravention of person's dignity. The limitation should be drawn to protect the person's constitutional right to dignity which is necessary & reasonable in democratic society in respect of DNA evidence taking for purpose criminal and civil proceeding.

The need of the hour is not only to invent and develop more scientific tools and techniques but also to strive for achieving perfection in their application. It is hoped that our legal system would improve substantially and thereby restore people's faith in the state and create favourable condition for rule of the law.

At this time, DNA testing has gained acceptance in the Indian legal realm as the Courts in India are passing orders for DNA tests in complex cases. Now is the time for the government to fulfill its role in creating legislation for DNA evidence and vital amendments to other pieces of legislation, and binding the parties to the agreed-upon DNA testing before a trial under the codes such as in Bhartiya Sakshya Adhiniyam, The Constitution of India, Bhartiya Nagrik Suraksha Sanhita, Hindu Marriage Act, Civil Procedure Code, etc. in order to make effective use of DNA evidence. Now the time to deny legislation is over. It is the need of present day to accept, adopt and include the latest scientific developments by enacting a new legislation.

The Indian justice system needs to embrace the advances in the science of genetic profiling and devise procedural frameworks to address the changing judicial issues. The important standards for DNA fingerprints cannot be left to the courts to decide upon temporary bespoke

arrangements. If the courts are to be able to utilize the new advances in DNA profiling, then there is an urgent need for a specific statute to be enacted which provides the framework governing the DNA Testing in India.

Some of the recommendations arising out of this research are that:

- 1) Reformers must endeavor to enact a uniform statute that can be adopted by all jurisdictions regarding the way a DNA test is conducted and the admissibility of DNA test results in the court. Because without statutory recognition, a position of ambiguity and uncertainty will exist for the judiciary.
- 2) There must be a special police wing with at least two police personnel in each police station having expertise or proficiency in collecting and storing forensic biological samples from the crime scene.
- 3) The police should be accommodated with “live streaming body cameras” while deployed for investigation so that a fair record of evidence collected from the crime scene would be ensured.
- 4) There should be a district-wise FSL facility made available in every state of India to ensure a prompt and speedy scientific investigation of any crime.
- 5) There should be a compulsory periodical interactive session between judicial officials and forensic experts on the current trend of forensic DNA evidence. Judicial officers should be made aware of the method of Forensic DNA profiling and the positive or negative aspect which can lead to a just decision.

Thus, it can be concluded that criminal investigation has undergone a vast change with the use of the most advanced scientific technique of DNA profiling. This technique has been universally applied in most countries of the world and has got a great berth in the detection of suspects of any crime and other complicated issues.

It has been developed as a very prominent tool of the criminal justice system DNA profiling not only helps in crime detection but also comes to rescue many prisoners who have wrongly been convicted due to inaccurate eyewitnesses, dishonest confession, humanoid mistakes,

incorrectly executed methodical investigations including misinterpretations of examinations outcome, etc. Hence, helping in securing the justice and leading to safe and crime free society.