INDIAN JOURNAL OF LEGAL REVIEW

VOLUME 6 AND ISSUE 7 OF 2026

INSTITUTE OF LEGAL EDUCATION

INDIAN JOURNAL OF LEGAL REVIEW

APIS – 3920 – 0001 | ISSN - 2583-2344

(Open Access Journal)

Journal's Home Page – https://ijlr.iledu.in/

Journal's Editorial Page - https://ijlr.iledu.in/editorial-board/

Volume 6 and Issue 7 of 2026 (Access Full Issue on - https://ijlr.iledu.in/volume-6-and-issue-7-of-2026/)

Publisher

Prasanna S,

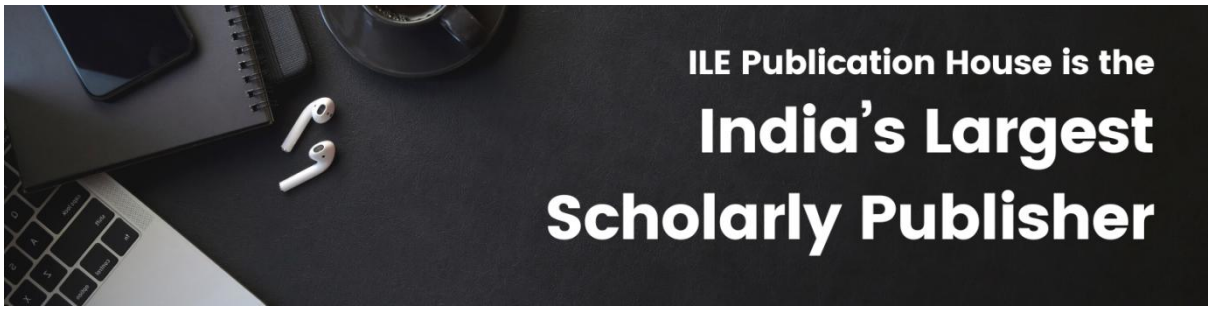
Chairman of Institute of Legal Education

No. 08, Arul Nagar, Seera Thoppu,

Maudhanda Kurichi, Srirangam,

Tiruchirappalli – 620102

Phone : +91 73059 14348 - info@iledu.in / Chairman@iledu.in



INDIAN JOURNAL OF LEGAL REVIEW [IJLR – IF SCORE – 7.58]

VOLUME 6 AND ISSUE 7 OF 2026

APIS – 3920 - 0001 *(and)* ISSN - 2583-2344

Published by

Institute of Legal Education

https://iledu.in

"SCIENTIFIC EVIDENCE AND CRIMINAL JUSTICE: EVALUATING THE ROLE AND ADMISSIBILITY OF DNA PROFILING IN INDIAN COURTS"

AUTHOR – YUKTA PARLIYA, STUDENT AT UNITEDWORLD SCHOOL OF LAW, KARNAVATI UNIVERSITY

BEST CITATION – YUKTA PARLIYA**,** "SCIENTIFIC EVIDENCE AND CRIMINAL JUSTICE: EVALUATING THE ROLE AND ADMISSIBILITY OF DNA PROFILING IN INDIAN COURTS", *INDIAN JOURNAL OF LEGAL REVIEW (IJLR),* 6 (7) OF 2026, PG. 365-375, APIS – 3920 – 0001 & ISSN - 2583-2344.

CHAPTER-1 - INTRODUCTION

The scientific evidence has now become an essential part of the new criminal justice system, as it has introduced objectivity and accuracy to the criminal investigations and trials.[682] As a result of the development of forensic science, courts no longer prefer using the traditional evidence but rather using scientific methods that give more dependability in ascertaining guilt or innocence.[683] Of these, DNA profiling has been one of the most potent tools that can be used to establish the identity of a person with a tremendous accuracy.[684] This paper aims to review how DNA profiling can be used in Indian courts and whether it should be admissible against scientific advancement, fairness, and due process.

[682] Ian Freckelton and Hugh Selby, *Expert Evidence* (5th edn, Thomson Reuters 2013).
[683] Andrew Roberts and Paul Roberts, 'The Evolution of Forensic Science and Its Impact on Criminal Justice' (2015) 19 *International Journal of Evidence & Proof* 123.
[684] Forensic DNA Evidence Interpretation John M Butler, *Forensic DNA Evidence: Interpretation* (2nd edn, Academic Press 2015).

INDIAN JOURNAL OF LEGAL REVIEW [IJLR – IF SCORE – 7.58]

VOLUME 6 AND ISSUE 7 OF 2026

APIS – 3920 - 0001 *(and)* ISSN - 2583-2344

Published by

Institute of Legal Education

https://iledu.in

Concept and Importance of Scientific Evidence in Criminal Justice System

In modern day criminal justice system, science has become a very necessary partner with law in trying to find truth.[685] In the past, the courts primarily relied on eyewitnesses, confessions and circumstantial evidence that, though important, were prone to human error, fear, memory failure or prejudice.[686] Criminal investigations have shifted toward an objective and dependable mode due to the evolution of forensic science.[687] The introduction of scientific evidence into the justice process also brings accuracy and neutrality to the justice process because such a method and empirical evidence are based on tests and are not based on personal perceptions.

Fingerprint analysis, ballistics, forensic toxicology and DNA profiling are some of the techniques that have allowed linking of crimes to people in a more specific way. Among which, DNA profiling is one of the most effective tools due to being unique and having a high level of reliability.[688] It assists in the detection of the offenders as well as in the protection of the innocent individuals who would otherwise be mistakenly charged. Through this, scientific evidence acts in a twofold way; it boosts the conviction of the guilty as well as protecting rights of the innocent.[689]

The increasing tendency to resort to scientific proof is an evidence of the attempt of the justice system to be fairer, more precise, and transparent. Thanks to the decreased reliance on unreliable human opinions and the introduction of facts that could be verified with science, the courts will feel more confident in delivering the verdict that will be based on the truth and not on the likelihood. Therefore, scientific evidence is crucial towards increasing the integrity of the criminal justice system and strengthening the belief of the people in the rule of law.[690]

DNA Profiling as Revolutionary Forensic Tool

One of the greatest contributions made by science in the context of forensic science is the DNA profiling that has transformed the nature of criminal investigations in a completely different manner. Genetic information contained in DNA, which is found in nearly every cell within the human organism, is unique to a particular individual except when it comes to identical twins. DNA profiling is the scientific process related to the study of select areas of DNA in order to establish a genetic profile which can be applied in identification. DNA is regarded as one of the most stable and dependable types of scientific evidence ever to be used in the modern world due to its uniqueness.

As opposed to the conventional ways of identification like fingerprints or eyewitnesses, DNA profiling is in a position to associate an individual to a crime scene even using small biological elements like blood, saliva, hair, or even skin cells. This has brought about precision and evidence-based investigations. DNA profiling helps in identifying accused individuals, determining identity of victims in case of unknown bodies or mass disasters and settling paternity and lineage disputes. It has also been very crucial in solving cold cases which previous processes had not been able to yield a definite result.

Above all, DNA profiling has enhanced the impartiality of the criminal justice system since it has allowed to prove both guilt and innocence. Although it allows the prosecution to introduce solid and scientific evidence on the offenders, it is also instrumental in acquitting persons who have been wrongly charged or sentenced. It is in this regard that DNA profiling is not just a device to achieve a conviction but a potent weapon to achieve a sense of justice. It is revolutionary because of the fact that it

[685] Mike Redmayne, *Expert Evidence and Criminal Justice* (OUP 2001).
[686] R v Turnbull *R v Turnbull* [1977] QB 224 (CA).
[687] Paul C Giannelli and Edward J Imwinkelried, *Scientific Evidence* (5th edn, LexisNexis 2012).
[688] State of Bombay v Kathi Kalu Oghad *State of Bombay v Kathi Kalu Oghad* AIR 1961 SC 1808 (India SC).
[689] Forensic DNA Evidence Interpretation John M Butler, *Forensic DNA Evidence: Interpretation* (2nd edn, Academic Press 2015).
[690] Selvi v State of Karnataka *Selvi v State of Karnataka* (2010) 7 SCC 263 (India SC); Mike Redmayne, *Expert Evidence and Criminal Justice* (OUP 2001).

realizes the ability to merge scientific accuracy to legal procedures hence rendering criminal adjudication to be more accurate, reliable, and just.[691]

Judicial Acceptance and Challenges in Indian Courts

The Indian courts have over time realized the evidentiary power of DNA profiling and have embraced it as a credible kind of scientific evidence provided it is gathered and analyzed[692] in an appropriate way. In the years, the judiciary has admitted that DNA evidence may have a powerful corroborative support in criminal cases, especially in sexual offence and homicide

cases, victim identification cases, and cases of paternity[693]. As frequently noticed by the courts, DNA profiling when performed by a certified laboratory and accompanied with an appropriate chain of custody has a high probative value and can significantly help reach the truth.[694]

This acceptance has however been conditional and cautious than being absolute. The lack of a detailed and standardized law that governs DNA profiling solely in India[695] is one of the greatest barriers. In the past, the courts used to use the general provisions of the Indian Evidence Act, 1872, according to which DNA evidence was regarded as expert evidence. Since the introduction of the BSA, 2023, which so far has substituted the Evidence Act, the legal basis of admissibility of scientific and electronic evidence has been updated, and DNA profiling has remained to gain its evidentiary value as expert scientific evidence.[696] However, so far as there are no specific and detailed statutory provisions that would regulate DNA profiling exclusively, the courts continue to rely much on judicial precedents, which in some instances have led to inconsistencies on the issue of admissibility and weight of evidence. The method used by different courts in determining the reliability of DNA reports has been varying thus resulting in uncertainty and non-uniformity in their use.

Breach of procedures also makes the use of DNA evidence complicated. The handling of samples in improper ways, contamination, time delays in delivery of samples to forensic laboratories and the lack of a proper documentation can have serious implications on the credibility of DNA results.[697] The chain of custody, which is meant to guarantee that the evidence has not been tampered with between the scene of the crime and court, is usually not upheld well thus casting a dream of doubts regarding the authenticity and integrity of the samples.[698]

The issue of the danger of abuse or over-reliance on DNA evidence is also emerging as a concern. Although DNA profiling is very robust, it is not flawless and is prone to human error, laboratory errors and systemic errors.[699] The principles of the fair trial and the due process may be compromised by the blind application of DNA without due questioning. As such, it is a fine balancing act that Indian courts have to achieve by striking the right balance between the scientific weight of the DNA evidence, and legal protection, under the BSA, 2023, so that DNA profiling is applied as the potent means of distributing justice, but not as the ultimate evidence.

Previously, the admissibility of the DNA evidence was controlled by the Indian Evidence Act, 1872, however, gathering and the process of the DNA were controlled by the Code of Criminal Procedure, 1973. The CRPC did not stipulate the

[691] Forensic DNA Typing John M Butler, *Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers* (2nd edn, Academic Press 2005); Daubert v Merrell Dow Pharmaceuticals Inc *Daubert v Merrell Dow Pharmaceuticals Inc* 509 US 579 (1993).
[692] State of Bombay v Kathi Kalu Oghad *State of Bombay v Kathi Kalu Oghad* AIR 1961 SC 1808 (SC).
[693] Krishna Kumar Malik v State of Haryana *Krishna Kumar Malik v State of Haryana* (2011) 7 SCC 130.
[694] Mukesh v State (NCT of Delhi) *Mukesh v State (NCT of Delhi)* (2017) 6 SCC 1.
[695] Law Commission of India, *Human DNA Profiling – A Draft Bill for the Use and Regulation of DNA-Based Technology* (Report No 271, 2017).
[696] Bharatiya Sakshya Adhiniyam 2023, S 39–45 (expert evidence provisions)
[697] Barry A J Fisher, *Techniques of Crime Scene Investigation* (7th edn, CRC Press 2004)
[698] Paul C Giannelli and Edward J Imwinkelried, *Scientific Evidence* (5th edn, LexisNexis 2012
[699] Forensic DNA Typing John M Butler, *Forensic DNA Typing* (2nd edn, Academic Press 2005).

admissibility or evidentiary value of DNA profiling, but merely gave the framework of the medical examination, and collection of biological samples. The legal framework Evidence Act has been changed with the BSA, 2023, and the CRPC has been replaced with the BNSS, 2023. Nevertheless, DNA profiling still receives admissibility under the law of evidence, even under the new laws, procedural considerations are still under the criminal procedure and because of the lack of legislation that is specific and comprehensive, regulating DNA profiling alone still causes uncertainty and uneven judicial practice.[700]

Need and Purpose of the Present Study

The increased application of DNA profiling in crime cases has necessitated the need to look critically at its application and admissibility under the Indian law. Although DNA evidence is like no other, in terms of accuracy and scientific reliability, this method cannot be reliably used to deliver justice unless the ruling courts collect, analyze and evaluate the evidence in the most effective way possible. Without a comprehensive statutory framework and standardized procedural guidelines, there is a threat that these potent scientific instruments will not be used in a consistent manner which could result in either mistaken convictions or a tendency to dismiss useful evidence.

This research is required to evaluate the suitability of the current litigation in India in terms of its ability to balance scientific progression and constitutional protection including the right to life and the right to personal liberty, the right to privacy and the right to a just trial. These rights are directly involved in the use of DNA profiling since the practice deals with sensitive personal and genetic data that is collected and stored. The possibility of abuse, coercion, or infringement of human dignity cannot be disregarded without a rigid legal regulation and judicial control.

The objective of the current research is, thus, to assess the current legal context of the DNA evidence, examine the judicial tendencies regarding its admissibility and value as evidence, and find out the loopholes between legal protection and scientific practice. In this way, the study aims at bringing the development of clearer standards on the application of DNA profiling that

both guarantee the proper criminal adjudication and safeguard the basic human rights. Finally, the research will facilitate change in the criminal justice system whereby scientific advancement will reinforce, but not weaken, the principles of fairness, justice and due process of law.

Research Problem

Regardless of the increased use of DNA profiling as a scientific instrument in case investigations, major ambiguities in the admissibility, reliability, and interpretation of DNA profiling are still evident in Indian courts. The lack of a legal framework, a range of legal frameworks, and the little judicial knowledge of scientific practices, as well as the issues of privacy and consent and the possibility of misappropriation, makes it doubtful that DNA evidence is effective in bringing fair and accurate criminal justice. This paper will attempt to critically analyze the importance of DNA profiling in the Indian criminal justice system and discuss whether the application of DNA profiling by the courts is scientific and compliant with the constitutional standards.

Research Objective

To examine the role of scientific evidence in strengthening the accuracy and reliability of criminal justice outcomes in India.

To evaluate the admissibility standards and judicial approach toward DNA profiling in Indian courts.

To identify key legal, procedural, and ethical challenges affecting the effective use of DNA evidence in criminal trials.

[700] Bharatiya Nagarik Suraksha Sanhita 2023; Law Commission of India.

INDIAN JOURNAL OF LEGAL REVIEW [IJLR – IF SCORE – 7.58]

VOLUME 6 AND ISSUE 7 OF 2026

APIS – 3920 - 0001 *(and)* ISSN - 2583-2344

Published by

Institute of Legal Education

https://iledu.in

Research Question

A. How scientifically reliable and legally admissible is DNA profiling in Indian criminal courts?

b. To what extent is DNA profiling recognized and accepted as legally admissible evidence in India?

c. Do Indian courts consider DNA evidence to be a significant and relevant form of proof in criminal cases?

d. How effectively do Indian criminal courts evaluate and apply DNA evidence in the administration of justice?

Hypothesis

Despite the known effectiveness of the DNA profiling technique as a valuable scientific tool in the successful identification of the criminals, the lack of standardized legal provisions, mentioned inefficient legal safeguards, insufficient forensic facilities, and diverse judicial interpretations usually undermine its admissibility and weight of evidence in the Indian courts. The combination of all these factors affects the determination of the DNA evidence and can impact the legitimacy and adequacy of the outcomes of the criminal justice in India.

Research Methodology

The study is based on a doctrinal research approach that entails the logical study and analysis of the legal materials in existence. The analysis of the primary sources used in the study is the provision of the constitution, statutory legislation, rules of evidence, and decisions of the Supreme Court and the High Courts on DNA profiling. Secondary sources such as legal textbooks, academic articles, law commissions report and literature in forensic science are also read to back up and put into perspective the legal analysis. This methodology allows obtaining a clear picture of the legal framework that regulates the admissibility and the role of the DNA evidence in Indian criminal justice system.

CHAPTER-2

UNDERSTANDING DNA PROFILING AND ITS GLOBAL SUSTAINIBILITY

2.1 INTRODUCTION

The integration of science in the criminal justice system has had a fundamental change in the way the criminal justice system will conduct its investigations, evidence gathering and adjudication.[701] DNA profiling is one of the most revolutionary inventions in forensic science of the modern world. It has also provided a new degree of precision, dependability and objectivity in the criminal investigations and has made the pursuit of justice more robust[702]. The DNA evidence in contrast to the traditional evidence like eyewitness testimony which can be subjected to human error, bias and manipulation is based on scientific principles which provide reproducible and verifiable results.[703]

The increasing use of DNA profiling in the jurisdictions is indicative of the international movement of moving to evidence-based systems of justice.[704] This has become especially important in the handling of wrongful conviction matters whereby DNA evidence has been very instrumental in clearing cases that had been earlier convicted due to inadequate or faulty evidence. The dual character of the DNA profiling to incriminate and exonerate underscores its significance as a crime-solving tool of ensuring fairness and accuracy in the process of delivering justice.

The adoption of DNA profiling in the Indian context has been accelerated in the past few years owing to improvement in forensic technology, and a growing awareness of the evidentiary worth of DNA profiling among courts. Nonetheless, introduction of the DNA profiling into the legal system is not free of challenges. Admissibility, procedural

[701] Mike Redmayne, *Expert Evidence and Criminal Justice* (OUP 2001).
[702]Forensic DNA Typing John M Butler, *Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers* (2nd edn, Academic Press 2005).
[703] R v Turnbull *R v Turnbull* [1977] QB 224 (CA).
[704] Paul Roberts and Adrian Zuckerman, *Criminal Evidence* (2nd edn, OUP 2010).

protections, privacy, ethical, and infrastructural constraints remain challenges that define its use. Moreover, the fact that there is no detailed legislative framework regulating DNA profiling is also a cause of concern regarding whether it can be sustained in the long run. This chapter seeks to offer a comprehensive insight into DNA profiling through the scientific basis of DNA profiling, the working mechanism, worldwide evolution, ethical consideration, and the future outlook of DNA profiling.

2.2 MEANING AND CONCEPT OF DNA PROFILING

DNA profiling also known as DNA fingerprinting is a scientific technique, which is used to identify individuals by their distinct patterns in the genetic material.[705] Deoxyribonucleic Acid (DNA) is the genetic material that is contained in the cell of all living organisms and it contains genetic information that defines the physical traits and biological processes of an individual. DNA has a structure that consists of two strands, which form a double helix, and each of the strands is a sequence of nucleotides.[706]

Human DNA is strikingly similar in all individuals but this does not mean that there is no variation that is just enough to make one individual different than the other. These differences are in certain areas of the genome called polymorphic regions, which do not encode proteins, but have varying lengths or compositions. DNA profiling is the examination of these areas to produce a genetic profile which is unique to a person.[707]

DNA profiling is a highly effective method of identification since DNA is unique, except in identical twin cases. It has turned out to be a necessity in many areas such as criminal investigation, civil litigation, paternity testing, and identification of victims of disasters. This power to create identity with a high level of confidence has made DNA profiling to be a fully accepted aspect of forensic science.[708]

2.3 Scientific Basis of DNA Profiling

DNA profiling is based on the scientific principle of genetic variation in the human genome. DNA consists of four nitrogenous bases-adenine, thymine, cytosine, and guanine-arranged in certain sequences to create genetic information. Although most of these sequences are the same in all individuals, some of them are variable and can be used to identify individuals.[709]

One of the most important features used in DNA profiling is Short Tandem Repeats (STRs), which are repetitive sequences of DNA found at specific locations in the genome. These regions have different number of repeats in different people and thus are very useful in differentiating between different DNA samples. Through a series of analyses of various STR loci, forensic scientists are able to construct a DNA profile which is statistically distinct.[710]

DNA profiling also entails the use of Polymerase Chain Reaction (PCR), which increases small amounts of DNA to yield enough material when it comes to analysis. This is especially handy in the context of forensic investigations where samples can be scarce or of poor quality. The amplified DNA is further examined through methods like electrophoresis which separates DNA fragments according to their size, and thus the identification of STR patterns is possible.[711]

Statistical analysis provides reliability of DNA profiling by determining the likelihood of a random match. Such probabilities are usually very low and this adds to the value of DNA that it has. But DNA profiling relies on correct collection, handling and analysis of samples

[705] Forensic DNA Typing John M Butler, *Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers* (2nd edn, Academic Press 2005).
[706] Molecular Biology of the Gene James D Watson and others, *Molecular Biology of the Gene* (7th edn, Pearson 2014).
[707] Introduction to Forensic Genetics William Goodwin, Adrian Linacre and Sibte Hadi, *An Introduction to Forensic Genetics* (2nd edn, Wiley-Blackwell 2011).
[708] DNA Technology in Forensic Science National Research Council, *DNA Technology in Forensic Science* (National Academies Press 1992).
[709] Molecular Biology of the Gene James D Watson and others, *Molecular Biology of the Gene* (7th edn, Pearson 2014)
[710] Forensic DNA Typing John M Butler, *Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers* (2nd edn, Academic Press 2005).
[711] Introduction to Forensic Genetics William Goodwin, Adrian Linacre and Sibte Hadi, *An Introduction to Forensic Genetics* (2nd edn, Wiley-Blackwell 2011).

and also on the observed laboratory standards.[712]

2.4 Historical Development and Evolution of DNA Profiling

Innovation of DNA profiling is one of the greatest advancements in the history of forensic science. Sir Alec Jeffreys initially presented the technique in 1985 and his work showed that some parts of the DNA are variably unique to individuals.[713] This finding resulted in the initial application of DNA evidence in a criminal case in the United Kingdom, where it was applied to convict a suspect in a murder and murder case.

DNA profiling was first based on Restriction Fragment Length Polymorphism (RFLP) analysis, which needed quite large amounts of high-quality DNA and was time-intensive. With the improvement of technology, more efficient methods like PCR-based analysis have been developed and therefore, it is possible to examine smaller and degraded samples. This was further enhanced by the introduction of STR analysis that increased accuracy and efficiency of DNA profiling and has become the standard procedure applied in the forensic lab today.

Gradually, DNA profiling was widely accepted throughout the world and national DNA databases were created and forensic science became part of criminal justice systems. The history of DNA profiling indicates a more general tendency towards the utilization of.

legal procedures that make use of scientific practices, and this improves the accuracy and efficiency of investigations.[714]

2.5 Sources and Types of DNA Evidence

The work of DNA profiling is based on the gathering of biological material, on which the forensic examination is based. In criminal investigations there are a variety of sources of evidence and it is important to know the sources of evidence to ensure reliability, admissibility and probative value.[715] Generally, DNA evidence is obtained using biological samples and it is categorized according to the material type, how it was collected and the purpose of its usage in criminal or civil cases.

2.6 SOURCES OF DNA

DNA evidence can be found in the most usual places such as:

Blood: Blood is a highly rich source of DNA which has white blood cells that contain the nuclear genome. Fresh and dried blood may be collected on the crime scenes. Violent crimes, including homicides or assaults, in which physical injury is involved, often involve the use of blood. Stains of blood on a piece of clothing, weaponry, or a surface could be powerful evidence to implicate a criminal with the crime scene.[716]

Saliva: The other frequent source is the saliva, which is frequently gathered on cigarette butts, drinking glasses, envelopes or bite marks. Buccal cells are found in saliva, and provide high-quality DNA to be used in profiling. Saliva is often discovered on victims during sexual assault on their clothing or skin and can be a crucial piece of evidence between the criminal and the crime.[717]

Semen: Semen is a primary source of DNA in sexual assault cases. Both the nuclear DNA which are found in sperm cells and the mitochondrial DNA which are found in epithelial cells are obtained in semen samples taken off the victim or off the crime scene. Semen identification does not just identify sexual contact, but also allows the identification of the rapist with DNA matching.[718]

Hair: Hair may serve as a source of DNA in case the root or follicle remains. When the hair shaft

[712] Scientific Evidence Paul C Giannelli and Edward J Imwinkelried, *Scientific Evidence* (5th edn, LexisNexis 2012).
[713] Individual-specific 'fingerprints' of human DNA Alec Jeffreys, 'Individual-Specific "Fingerprints" of Human DNA' (1985) 316 *Nature* 76.
[714] DNA Technology in Forensic Science National Research Council, *DNA Technology in Forensic Science* (National Academies Press 1992).
[715] Scientific Evidence Paul C Giannelli and Edward J Imwinkelried, *Scientific Evidence* (5th edn, LexisNexis 2012).
[716] Forensic DNA Typing John M Butler, *Forensic DNA Typing* (2nd edn, Academic Press 2005).
[717] Introduction to Forensic Genetics William Goodwin, Adrian Linacre and Sibte Hadi, *An Introduction to Forensic Genetics* (2nd edn, Wiley-Blackwell 2011).
[718] John M Butler (n 2).

INDIAN JOURNAL OF LEGAL REVIEW [IJLR – IF SCORE – 7.58]
VOLUME 6 AND ISSUE 7 OF 2026
APIS – 3920 - 0001 *(and)* ISSN - 2583-2344
Published by
Institute of Legal Education
https://iledu.in

has mitochondrial DNA (maternally inherited and less specific), the hair root has nuclear DNA that is an individual. Hair is usually gathered at crime scenes, garments or bodily confrontations.[719]

Skin Cells / Epithelial Cells: These cells are shed naturally off the body and can be gathered on touched objects which include weapons, door handles, mobile phones or clothing. Touch DNA, as it is commonly referred to, can be used especially in crimes where a criminal did not leave behind any biological fluids.[720]

Other Biological Fluids: DNA can be found in urine, sweat and tears, but in lower concentrations and occasionally more degraded. Such fluids may still hold valuable forensic evidence, especially when they are supplemented with other evidence.[721]

Bone and Teeth: Bones and teeth are important sources of DNA in instances of decomposing, burned, or skeletonized remains. Bone marrow can be used to take nuclear DNA and teeth are used to yield both nuclear and mitochondrial DNA. These are particularly vital sources in post mortem identification.[722]

2.7 TYPES OF DNA

There are two types of DNA evidence, depending upon how

it is used in the forensic process and its origin:

Nuclear DNA (nDNA): Nuclear DNA is present in the cell nucleus and is specific to each individual, unless in the case of identical twins. It is the main form of DNA that is utilized in identification due to high discriminating ability. nDNA finds applications in criminal cases to provide a linkage between suspects and crime, paternity testing, and identification of remains.[723]

Mitochondrial DNA (mtDNA): Mitochondrial DNA is found in the cell cytoplasm and is maternally inherited. It is not as specific as nuclear DNA but can be used in situations when nuclear DNA is not available or destroyed, e.g., in hair shafts or old bones. mtDNA is commonly utilized in determining maternal lineage and determining remains in mass disasters or historical research.[724]

Y-Chromosome DNA: This is a kind of DNA that is sperm to son and can be used to trace the fatherline. Y-DNA will be specifically useful in sexual assault cases that contain mixed DNA profiles, as it will allow isolating male DNA even in the presence of female DNA.[725]

Trace DNA / Touch DNA: Trace DNA is small traces of DNA that are deposited when an individual touches an object. With current forensic methods these small samples can be amplified so that suspects may be connected to items that they may have touched. Although it is very important, trace DNA can easily be contaminated and should be taken with strict procedural precautions.[726]

Degraded or Ancient DNA: When the body is decomposed, or historical remains, the DNA can be degraded or broken. These samples are reconstructed and analyzed to identify them by means of specialized techniques, such as PCR amplification and next-generation sequencing.[727]

2.8 Evidentiary Importance of Different Types

All forms of DNA evidence have certain forensic uses:

Blood and Semen: This is mainly used in connecting suspects with violent or sexual offenses.

Saliva and Touch DNA: Can be used to identify a criminal in case of theft, assault, or any form of contact crime.

[719] William Goodwin and others (n 3).
[720] Forensic Biology Richard Li, *Forensic Biology* (CRC Press 2015).
[721] John M Butler (n 2).
[722] Forensic Taphonomy William D Haglund and Marcella H Sorg (eds), *Forensic Taphonomy: The Postmortem Fate of Human Remains* (CRC Press 1997).
[723] Forensic DNA Typing John M Butler, *Forensic DNA Typing* (2nd edn, Academic Press 2005).
[724] William Goodwin, Adrian Linacre and Sibte Hadi, *An Introduction to Forensic Genetics* (2nd edn, Wiley-Blackwell 2011).
[725] John M Butler (n 1).
[726] Forensic Biology Richard Li, *Forensic Biology* (CRC Press 2015).
[727] Ancient DNA Beth Shapiro and Michael Hofreiter, *Ancient DNA: Methods and Protocols* (Humana Press 2012).

INDIAN JOURNAL OF LEGAL REVIEW [IJLR – IF SCORE – 7.58]

VOLUME 6 AND ISSUE 7 OF 2026

APIS – 3920 - 0001 *(and)* ISSN - 2583-2344

Published by

Institute of Legal Education

https://iledu.in

Hair and Bones: This is used to solve missing persons, mass disasters, and skeletal identification.

Mitochondrial and Y-Chromosome DNA: Additional analysis when the nuclear DNA is not available or mixed.[728]

The probative value of DNA is not only dependent on the type but also on the quality of the sample, method of collection and lab analysis. Statutory recognition and procedural guidance The collection and handling of all these forms of DNA evidence have statutory recognition and procedural guidance in the Bharatiya Sakshya Adhiniyam (BSA), 2023, and the Criminal Procedure (Identification) Act, 2022, and scientific accuracy is accompanied by legal protection in Indian courts.[729]

2.9 Procedural Integration

Depending on the type of crime committed, the forensic investigator must determine the source of DNA to use. The protocols vary: blood should be collected using sterile swabs and preserved properly, semen should be collected carefully not to be degraded, and touch DNA should be collected with the utmost care regarding contamination. All stages have to be documented in laboratories and there should be a chain of custody to be admissible. When determining the weight of the evidentiary value of DNA in a court of law, the type and source of DNA are given more weight, and the nuclear DNA of high-quality samples and corroboration with other evidence are taken into account to avoid false convictions.[730]

2.10 Process and Methodology of DNA Profiling

DNA profiling process can be described as a multi-step process where each step is critical in the assurance of the accuracy and reliability of the results. The initial step is the collection of biological samples, which should be done in a sterile manner to avoid contamination. The samples are then correctly labeled, stored and transported to forensic laboratories to be analyzed.[731]

The second step entails DNA extraction of the samples collected. In this process the genetic material is separated out of the rest of the cell components so that it can be further analyzed. The amplification of the extracted DNA is followed by PCR which helps in analyzing even small quantities of DNA.[732]

The third step entails analysis of the STR regions in which the amplified DNA is divided into fragments and then analyzed to determine patterns that are individual to that person. These patterns are then used to create a DNA profile. The last process is the interpretation of results whereby the DNA profile is matched against known samples to find a match.[733]

DNA profiling accuracy is based on the quality of laboratory operations, forensic analysts, and the standard operating procedures. Any deviation from these standards can affect the reliability of the results.[734]

2.11 Role of DNA Profiling in Criminal Justice Systems

DNA profiling has brought about a revolution in the criminal justice system of the world and its importance in India has increased significantly in the past 20 years. Fundamentally, DNA profiling offers a scientifically proven mode of identification of individuals with respect to their distinctive genetic composition.[735] The implications of this capability to criminal investigations, prosecutions and the overall justice objectives, such as accuracy, efficiency, and fairness, are far reaching.

DNA profiling plays a major role in the criminal justice system through identification and

[728] National Research Council, *DNA Technology in Forensic Science* (National Academies Press 1992).
[729] Bharatiya Sakshya Adhiniyam 2023; Criminal Procedure (Identification) Act 2022.
[730] Mukesh v State (NCT of Delhi) *Mukesh v State (NCT of Delhi)* (2017) 6 SCC 1; Paul C Giannelli and Edward J Imwinkelried, *Scientific Evidence* (5th edn, LexisNexis 2012).
[731] Forensic DNA Typing John M Butler, *Forensic DNA Typing* (2nd edn, Academic Press 2005).
[732] An Introduction to Forensic Genetics William Goodwin, Adrian Linacre and Sibte Hadi, *An Introduction to Forensic Genetics* (2nd edn, Wiley-Blackwell 2011).
[733] Forensic DNA Typing (n 1).
[734] Scientific Evidence Paul C Giannelli and Edward J Imwinkelried, *Scientific Evidence* (5th edn, LexisNexis 2012).
[735] Mike Redmayne, *Expert Evidence and Criminal Justice* (OUP 2001).

correlation of the suspects with a crime. Crime scene biological evidence may be gathered and analyzed, and compared with samples taken of suspects, including blood, hair, semen, or skin cells. When the match is positive, it is a strong evidence about the presence of the suspect at the location or being involved in the criminal activity. DNA evidence is based on objective science as opposed to circumstantial evidence or eyewitness testimony which is prone to human error and prejudice, giving it a high level of confidence. This role has been more recognized by Indian courts especially in cases of serious crimes like murder, rape and human trafficking, where traditional evidence might be inadequate.[736]

Besides identifying the suspects, DNA profiling is also very important in exoneration of the innocent. Incriminating wrong persons is a major issue in criminal justice systems and DNA evidence seems to provide a way of averting miscarriages of justice. Convictions that are quashed and the release of innocent persons may result when DNA results do not match a suspect or convict. In cases related to paternity and sexual assault, the Supreme Court has pointed out that DNA evidence plays a crucial role in ensuring fairness and eliminating unjust punishment.[737]

DNA profiling also makes the criminal investigation more efficient. DNA analysis may help reduce the number of possible perpetrators in instances where there are several suspects, or when there are few leads to the case through conventional investigative methods. In India, law enforcement agencies have the powers to collect and analyse DNA of convicted individuals and individuals under investigation under the framework of the Criminal Procedure (Identification) Act, 2022. [738]The establishment of the DNA database of forensic data would also contribute to the cold case breakage, the detection of serial offenders, and the connecting of seemingly unrelated crimes. This organized application of DNA technology enhances investigative powers and guarantees justice in time.

The other important factor is the application of DNA profiling in determining paternity and family relationships that are not just implicated in the criminal law but also in civil proceedings such as inheritance and maintenance. DNA evidence has been regarded by courts over the years as a credible evidence of biological relationships, which in most cases, defeats the opposing oral evidence or circumstantial evidence. The ground-breaking case of Nandlal Wasudeo Badwaik v. Lata Nandlal Badwaik (2008) reported that DNA evidence is much more probative than traditional evidence in determining the paternity.

Another role of DNA profiling is in deterring and preventing crime. The awareness that biological evidence can decisively pin down criminals is a deterrent to would-be offenders because they would not want to commit any violent or sexual crime. DNA profiling increases the effectiveness and believability of the criminal justice system by increasing the chances of apprehending and convicting the offender.[739]

Moreover, DNA profiling plays a crucial role in enhancing confidence of the judiciary in verdicts. DNA evidence is important to courts since it is less likely to be manipulated or prone to human error as opposed to testimonial or circumstantial evidence. Indian courts however also emphasize that DNA evidence should be considered together with other evidence with the conviction being made based on a holistic view of the case. This prudent manner of balancing the probative power of DNA evidence with procedural and constitutional protections like the right to privacy in Article 21 and the right to avoid self-incrimination in Article 20(3).[740]

The role of DNA in criminal justice has become formalized and regulated with the introduction

[736] Mukesh v State (NCT of Delhi) *Mukesh v State (NCT of Delhi)* (2017) 6 SCC 1
[737] Nandlal Wasudeo Badwaik v Lata Nandlal Badwaik *Nandlal Wasudeo Badwaik v Lata Nandlal Badwaik* (2014) 2 SCC 576.
[738] Criminal Procedure (Identification) Act 2022.
[739] Gautam Kundu v State of West Bengal *Gautam Kundu v State of West Bengal* (1993) 3 SCC 418.
[740] Selvi v State of Karnataka *Selvi v State of Karnataka* (2010) 7 SCC 263.

of modern legislations like the Bharatiya Sakshya Adhiniyam (BSA), Bharatiya Nyaya Sanhita (BNS), Bharatiya Nagarik Suraksha Sanhita (BNSS),[741] and Criminal Procedure (Identification) Act, 2022. These laws formalize the process of collecting, storing and analyzing DNA, which guarantees a level of scientific integrity, as well as the rights of individuals. The legal system has now offered a well-defined legal foundation on which DNA evidence can be used to aid law enforcement, improve judicial procedures, and promote the principles of fairness and precision.

Lastly, DNA profiling facilitates the larger goals of contemporary, science-oriented criminal justice, such as transparency, accountability, and adjudication that is evidence-based. It enables the system to go past relying on human observation which may not be reliable and instead makes judgments based on facts which can be empirically, scientifically tested. The introduction of DNA technology in the investigative and judicial practices is a paradigm shift as it will enable the Indian criminal justice system to comply with the global best practices and resolve its domestic issues like wrongful convictions, intricate crimes, and quick and precise resolution of cases.

To sum up, it can be concluded that DNA profiling plays a complex role in the criminal justice system: it helps to identify offenders, exonerate innocent, make paternity and family determinations, increase the efficiency of investigations, and build more confidence in the judiciary regarding the verdicts. The fact that it is now incorporated into the legal system by recent legislation acts as a guarantee that DNA evidence is not only a means of scientific accuracy, but also a guarantee of constitutional rights, which are a changing priority within the Indian criminal justice system.

2.11 DNA Databases and International Practices

A key element of the contemporary forensic system is DNA databases, in which genetic profiles can be stored and compared. The United States and the United Kingdom are some of the countries that have developed large DNA databases that have greatly enhanced detection and prevention of crimes.

The databases allow law enforcement agencies to easily identify the suspects by comparing DNA profiles at the crime scenes to those in the database. Nevertheless, application of DNA databases poses significant issues in terms of privacy, data security and possible abuse of genetic data.

Various nations have taken different strategies to control the DNA databases. Some believe in efficiency in enforcing the law whereas others put more emphasis on safeguarding individual rights. India is currently working on a model of DNA databases, which points to the necessity of a compromise that would consider both security and privacy issues.

2.12 Ethical, Legal, and Social Implications

DNA profiling has a number of ethical, legal, and social concerns that need to be closely addressed. The protection of privacy is one of the main issues that concern it because DNA holds more sensitive information than just identification.[742] Consent, confidentiality, and data security are put into question due to the potential misuse of genetic data.

There are also ethical aspects, such as the threat of genetic information discrimination, the consequences of DNA profile storage in databases.[743]Without an extensive legal protection, people might lose trust, and the use of DNA profiling may become undermined.

The solution to these concerns has to do with the creation of strong legal provisions and codes of ethics that guarantee the responsible DNA evidence utilization.[744]

[741] Bharatiya Sakshya Adhiniyam 2023; Bharatiya Nagarik Suraksha Sanhita 2023; Criminal Procedure (Identification) Act, 2022.

[742] K S Puttaswamy v Union of India *K S Puttaswamy v Union of India* (2017) 10 SCC 1 (Right to Privacy).

[743] United Nations Educational Scientific and Cultural Organization, *Report on Human Genetic Data and Ethics* (UNESCO 2003).

[744] Law Commission of India, *Human DNA Profiling – A Draft Bill for the Use and Regulation of DNA-Based Technology* (Report No 271, 2017).

2.13 Sustainability and Future Developments

The future of DNA profiling lies in its capacity to embrace the changes that come with the technological changes and deal with legal and ethical issues. It requires constant investment in forensic infrastructure, training, and research in order to implement it successfully.

The recent technological advances of rapid DNA testing, next-generation sequencing, and artificial intelligence are likely to increase the efficiency and accuracy of DNA analysis. Such developments can revolutionize forensic science even further, as DNA profiling becomes more available, and more accurate.[745]

The implementation of these technologies, however, needs to be supported by robust regulation structures that will guarantee responsible use of the technology. The other concerns that sustainability needs to entail involve the cost, accessibility, and awareness by the population.

2.14 Conclusion

DNA profiling has become one of the greatest breakthroughs in the field of forensic science with no other way of being more accurate and reliable in identifying individuals. Its implementation with the criminal justice systems has improved performance of investigations, and helped to guard human rights by eliminating wrong convictions.[746]

Although it has significant benefits, DNA profiling has raised significant legal, ethical, and social issues which need to be addressed so that there can be sustainability in its use. Such a solution is a moderate position on involving scientific innovation with legal protection and ethical administration that is necessary to possess an effective use of DNA profiling in the future.[747]

[745] Forensic DNA Typing John M Butler, *Forensic DNA Typing* (2nd edn, Academic Press 2005).
[746] Nandlal Wasudeo Badwaik v Lata Nandlal Badwaik *Nandlal Wasudeo Badwaik v Lata Nandlal Badwaik* (2014) 2 SCC 576.
[747] Selvi v State of Karnataka *Selvi v State of Karnataka* (2010) 7 SCC 263; Law Commission of India (n 3).

INSTITUTE OF LEGAL EDUCATION

(Managed by L TO J LAW ASSOCIATES)

NO. 08, ARUL NAGAR, SEERA THOPPU,
MARUDHAANDA KURICHI, SRIRANGAM - 620102,
TAMILNADU, INDIA.

ISSN 2583-2344