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DNA Evidence In Criminal Justice System: Admissibility, Reliability, And Accuracy

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Abstract
DNA's significance extends to forensic science, where DNA profiling, introduced in 1986, has revolutionized criminal investigations and judicial processes. DNA profiling differentiates individuals based on unique genetic sequences, aiding in identifying suspects, establishing biological relationships, and solving crimes, even from minimal or degraded samples. Judicial scrutiny of DNA evidence ensures its credibility, as seen in notable cases.
Significance- The study explores the pivotal role of forensic DNA profiling in modern criminal justice. Landmark cases, such as the conviction of Colin Pitchfork and the resolution of paternity disputes, underscore DNA profiling's transformative role. Despite the lack of specific legislation in some regions, DNA evidence is increasingly recognized for its reliability and accuracy.
Objectives- This research examines the impact of DNA profiling in forensic science, focusing on its reliability, legal admissibility, and methodological advancements. It also highlights the stringent protocols essential for maintaining DNA evidence's integrity and the legal frameworks guiding its admissibility. It also analyses the reliability and accuracy of DNA evidence.
Methodology- The research is completed by using Doctrinal method while analysing the secondary data obtained from journal articles, books, landmark cases.
Findings- The findings emphasize DNA profiling's pivotal role in enhancing the accuracy of criminal investigations and reinforcing public confidence in the justice system, advocating for continuous advancements and adherence to rigorous standards in forensic science.

Keywords: DNA, DNA Profiling, DNA Evidence, Admissibility, Reliability

1. Introduction

Deoxyribonucleic acid, commonly known as DNA, is the molecule responsible for the storage and transmission of all genetic facts that help in the determination of the growth and operation of an organism. A DNA molecule consists of two strands that are intertwined and also coiling around each other, creating a framework that looks like a twisted ladder, which is called a double helix. The nucleotides that make up the backbone of each strand alternate between phosphate groups and deoxyribose sugar. Each sugar is bound to one of four bases: thymine (T), adenine (A), cytosine (C), or guanine (G). Chemical linkages between the bases bind the

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two strands together; cytosine binds to guanine and adenine to thymine. The bases form complementary pairs (A with T and G with C) and create chemical bonds that function as rungs on a ladder. This structure serves to maintain the cohesion of the two DNA strands. The DNA molecule's blueprint for building proteins and RNA molecules is contained in the sequence of nucleotide bases on the molecule's structural DNA.[3]

The genetic material present in practically every living thing is DNA, which is also called deoxyribonucleic acid. Almost all of a person's cells have the same genetic code. The nucleus of a cell contains the vast majority of its DNA, which is called nuclear DNA. On the other hand, mitochondria also contain a small amount of DNA, which is called mitochondrial DNA (mtDNA).

There exist three distinct forms of DNA:

i. A-DNA: Its shape is quite similar to B-DNA and is a right-handed double helix. In order to protect itself from extreme dryness and other challenging conditions, DNA takes on an A form when it becomes dehydrated. The DNA takes on an A shape when proteins bind to it, which removes solvent.
ii. B-DNA: It features a right-handed helical helix and is the most common form of DNA. The majority of DNA takes on a B-type structure under typical physiological conditions.
iii. Z-DNA: It is a kind of DNA that exhibits a left-handed helical structure characterized by a zigzag pattern in which the double helix coils to the left. Andres Wang and Alexander Rich made this discovery. It is located upstream of the gene's start site and is therefore thought to have a role in gene regulation.
iv. The discovery and identification of DNA was initially made by the Swiss researcher Johannes Friedrich Miescher in 1869 while studying white blood cells.

James Watson and Francis Crick later determined the double helix structure of a DNA molecule based on experimental evidence. Ultimately, it has been demonstrated that DNA is accountable in order to preserve the genetic code of organisms.

While the vast majority of human DNA sequences, around 99.9%, are identical across all individuals, there exist sufficient variations to enable the differentiation of one person from another. Scientists utilize a technique known as DNA testing, or DNA profiling, to examine a lengthy sequence of DNA and determine specific 'loci'. When comparing the loci of two closely related individuals, the similarities are significant. However, when comparing individuals who have no genetic relation, the contrasts are considerably more pronounced.

Genomic fingerprinting, often known as DNA profiling, is a forensic technique for positively identifying people. To rephrase, DNA profiling is a method that uses a person's specific DNA nucleotide sequence in certain parts of their molecule to establish their identity.

Because each person's DNA is structured differently, it is a highly effective and trustworthy tool in scientific investigations. DNA profiling is a component of contemporary forensic science that not only aids in civil and criminal investigations but also gives the courts precise data regarding all the relevant aspects of criminal identification. Forensic science goes from being an observer to a significant actor in the judicial system with the advent of DNA sample testing in the modern scientific period.

[3]https://www.genome.gov/genetics-glossary/Deoxyribonucleic-Acid#:~:text=Deoxyribonucleic%20acid%20 (abbreviated%20DNA) %20is, known%20as%20a%20double%20helix., (Last visited on 30.07.2024)

Medico-legal identification is primarily built upon the incorporation of scientific methodologies derived from several sectors, particularly biomedicine. The significance of their role is evident in cases pertaining to civil, family, and criminal law, as well as those involving multiple victims of accidents, natural calamities, terrorist acts, and conflicts (Raluca Dumache, Veronica Ciocan, et al., 2016). [1]

Fingerprints, footprints, blood, and other evidence that a criminal can leave behind after a crime were the mainstays of identification processes until DNA was utilized. Authorities in both the criminal justice system and law enforcement now have a better chance of positively identifying perpetrators because of DNA matching procedures that include samples taken from crime scenes. DNA can continue to be used indefinitely. Even after a body has deteriorated, DNA testing can be performed to identify the victims positively.

Therefore, DNA evidence is frequently utilized in criminal cases to establish a connection between an individual and the crime site, as well as to substantiate the accusation that they committed the crime. Alternatively, a defendant can utilize it to establish their factual innocence.

Professor Dr. Alec Jeffreys of the University of Leicester's Department of Genetics in the United Kingdom developed this forensic technique (Ankit Srivastava, Abhimanyu Harshey, et al., 2022). [2]

In order to achieve complete justice, an impartial investigation is required. Criminal investigations and the pursuit of fair justice are both aided by scientific methods. A sea change has occurred in the world of justice with the advent of DNA technology used in criminal justice. DNA is an essential piece of scientific evidence that helps solve many legal mysteries, including those involving sexual assault, child abuse, murder, and civil matters like disputes over paternity or maternity.

A significant paradigm change in Investigative strategies has been brought about as a direct consequence of the advent of DNA profiling as a means for application in an investigation of Criminal conduct. The amount of conviction it carries is higher than that of other scientific methods of investigation.

DNA Profiling Evidence can provide more information than other forms of Forensic Evidence. A person’s gender, hair, eye, skin colour, ethnicity, chronological age, and even susceptibility to certain diseases can all be subject to opinion from a DNA Sample. DNA testing is unique in its ability to provide detailed information about a person not available from any other source. The correct execution of all laboratory procedures and the provision of a trustworthy interpretation of DNA data will unquestionably result in an enhancement in its utility.

The Criminal Justice system has had vast experience with complicated Scientific and Expert testimony over the last two decades. DNA evidence is adopted as a legal tool by the Judicial system of every country. There is no doubt that the use of DNA identification has perplexed the judicial system far more than other types of Scientific and Technological Evidence.

The precedents reveal that DNA evidence is a reliable method to unveil the truth; it indirectly indicates the guilt of an accused. As a consequence of this, the Judicial system is now in a better position to evaluate the significance of DNA Profiling.

2. Evolution

DNA Profiling was first ever used as evidence to identify criminals in the year 1986. It was the well-known United Kingdom criminal case named R v. Pitchfork[4]. On November 21, 1983, and July 31, 1986, Colin Pitchfork murdered and raped two girls in Narborough, Leicestershire. Lynda Mann, a 15-year-old, departed from her residence one evening to visit her friend's abode but failed to return. The following morning, she was discovered on an uninhabited sidewalk, commonly referred to as the black pad, having been subjected to sexual assault and homicide. The semen collected from the crime site was subsequently analyzed and determined to contain type A blood. Dawn Ashworth, a 15-year-old girl, deviated from her usual route home on July 31, 1986, opting for a shortcut. Her corpse was found in a wooded location next to a trail called Ten-pound Lane two days after she was reported missing. She had been subjected to sexual assault and murder. A semen sample was extracted from Dawn and analyzed, just like in the case of Lynda Mann. The modus operandi exhibited by the perpetrator was identical to that of the initial assault, and analysis of the semen samples indicated a matching blood type. With the use of DNA profiling, Colin Pitchfork became the first person ever to be found guilty of rape and murder for the murders of two girls (Grette Sara Titus, 2023). [3]

In the 1991 case of Kunhiraman vs. Manoj [4], through relevancy and admissibility of expert opinion, a paternity dispute in India was resolved using DNA testing, marking the first instance of its use in the Indian judiciary.

3. Objectives of Research

i. To assess the National legal frameworks and judicial interpretations concerning the validity of DNA testing in Criminal proceedings
ii. To analyze the reliability of DNA evidence and the factors on which it depends

4. Research Methodology

This research involves a doctrinal method of study, which involves in-depth analysis of the secondary data available through the legislations, certain landmark judgments, and the research works of other authors in different journals.

5. Scope Of Research

This study will be helpful to legal researchers, the judiciary, advocates, students, academicians, and Policymakers to understand the present procedure followed by the authority for DNA profiling tests during the investigation, the grounds on which the admissibility of DNA evidence is dependent upon and the possible factors which examines the reliability and accuracy standard of such DNA evidence.

6. Legal Provisions on Admissibility of Human DNA Profiling Technique

In the criminal investigation process, the statements of the eyewitnesses have the highest value as primary evidence. Even in certain stages, hearsay evidence and other circumstantial evidence have got some importance in the court proceedings to establish the culpability of the defendant. However, due to the emergence of new crime techniques and also the way how

[4] ([2009 EWCA Crim 963), https://www.casemine.com/judgement/uk/5b46f2042c94e0775e7f062f (Last visited on 25.07.2024)

crimes are getting committed these days, it is getting challenging to ensure the culpability of the defendant only on the basis of the eyewitnesses or on the basis of circumstantial evidence. There comes the necessity of certain scientific evidence, such as Forensic DNA profiling. Suppose the procedures are adequately followed and the result of such Forensic technique can solve the criminal case beyond all the reasonable doubts of the court. In that case, such scientific evidence shall be admissible. There is no specific legislation regarding the admissibility and reliability of such Forensic DNA profiling techniques, and also, there is no mandatory law for the admissibility of such techniques. Still the Indian Judicial system has still made them count in many cases from time immemorial.

For DNA evidence to be admissible in court, it must meet legal standards that typically include relevance, reliability, and adherence to proper procedures. Courts evaluate the degree to which the DNA testing procedures employed are widely acknowledged within the scientific community if the methodologies have been scrutinized by other experts in the field, and whether there is a documented rate of mistakes. The admissibility of DNA evidence is further bolstered by precedents set in previous cases, which affirm the reliability and accuracy of DNA testing methodologies.

Indian legal framework regarding the utilization and acceptability of the forensic DNA profiling method was previously there in the criminal justice delivery system. But by the emergence of new criminal laws in the year 2023, followed by its coming into force on July 1st of 2024, there seems to be some ignition towards the implementation of such provisions. Also, it has been modified to some extent, which are provided as follows.

Sec. 51 of the BNSS (Bharatiya Nagarik Suraksha Sanhita, 2023) [5] is about the examination of an accused person when a police officer requests for such medical examination when there exists a reasonable ground of belief that such examination is necessary to proceed with the investigation in the proper direction. Such medical examination includes scientific techniques such as DNA profiling, etc.

Sec. 52 of the BNSS (Bharatiya Nagarik Suraksha Sanhita, 2023) [6] speaks about the medical examination by the registered medical practitioner of a person accused of rape. When there is a reasonable belief that such medical examination of the rape accused can lift the veil off the commission of the offence, then on the request of any police officer search medical examination of the accused can be made. On the successful completion of such examination, the registered medical practitioner shall prepare a report in this regard, which shall be submitted to the investigating police officer without any unnecessary delay. Search examination reports can make the job of the presiding officer of the judicial proceeding relatively easy; however, this report does not get mandatory support when its admissibility is in question.

Sec. 53 of the BNSS (Bharatiya Nagarik Suraksha Sanhita, 2023) [7] says that the accused must have a compulsory medical examination conducted by a medical officer appointed by either the central or respective state government or a registered medical practitioner, depending on the circumstances. During the aforementioned examination, the designated medical officer or qualified medical practitioner, as the case may be, shall record the outcome of such examination, mentioning any injury on the body of the arrested person and also the approximate time of the infliction of such injury. The medical examination under section 53 may include any type of forensic examination, such as DNA profiling.

Sec 176 (3) of the BNSS (Bharatiya Nagarik Suraksha Sanhita, 2023) [8] is a new provision that has been inserted to the procedure of investigation of cognizable cases. It says about the visit of a forensic expert to the crime scene and collection of evidence for forensic examinations in case an offence punishable with seven years or more has been committed. Such forensic examination may also include DNA profiling.

Sec 184 of the BNSS (Bharatiya Nagarik Suraksha Sanhita, 2023) [9] incorporates the provision for the forensic examination of a rape victim. A rape survivor must get a medical examination, with her consent, within 24 hours of the police being informed about the occurrence of the rape. Under Clause (3) of Sub Sec. (2) specifically, it has been given that necessary materials can be taken from such rape victims for DNA profiling.

Previously, there was no provision for storage of any data that has been collected by the forensic examinations. The DNA evidence was stored by the State Forensic Laboratories for a certain time period, i.e., at most up to 50 years. But, the enforcement of the (Criminal Procedure (Identification) Act, 2022) [10] permits the storage of such data for extended periods, potentially up to 75 years.

Sec 39 (1) of the BSA (Bharatiya Sakshya Adhiniyam, 2023) [11] speaks about the evidence given by an expert, which is otherwise known as expert opinion. If an expert gives a report and pronounces the grounds on which such report has been formulated, and if such report is related to any scientific examination technique such as DNA profiling, then such expert opinion may be accepted by the court in the criminal proceedings. It means the report given by a scientific expert may be admissible as a piece of evidence in the new era of the criminal justice delivery system. The court quite often depends on search scientific methods during the trial process, but still, the legislation of India feels it is merely advisory in nature.

7. Judicial Analysis in relation to Admissibility of DNA Evidence

With the passage of time, our justice delivery system became more advanced and inclined more toward such scientific and technological procedures. Many landmark cases have been adjudicated with the help of the DNA profiling technique. Some of them are the Tandoor case [12] (also known as the Naina Sahni case), Priyadarshini Matoo case [13], Shradhhananda case [14], Nirbhaya case [15] including the assassinations of Rajiv Gandhi [16] and Punjab Chief Minister Beant Singh, Swami Premananda scandal case.

Kishan Lal @ Champa Yadav vs State of Chhattisgarh (2023) [17] primarily revolves around charges of rape and the subsequent birth of a child. The accused, Kishan Lal (also known as Champa Yadav), the individual was found guilty under Section 376(3) of the Indian Penal Code (IPC) for sexually assaulting a juvenile, which led to the birth of a female child. The victim was a minor, aged 16 to 17, at the time of the offense. The prosecution's argument was primarily based on the DNA report (Exhibit P/23), which conclusively established the appellant and the victim as the biological parents of the child. However, both the victim and her father turned hostile during the trial. The victim denied the occurrence of any incident, and the father refuted the collection of blood samples in his presence. The court had to determine whether the conviction could be sustained solely based on the DNA evidence, given the lack of support from the victim and her father. The court referred to Sections 53A and 164A of the Criminal Procedure Code (CrPC), which outline procedures for the Forensic examination of both the perpetrator and the survivor in instances of sexual assault. The High Court upheld the trial court's conviction, emphasizing that the appellant's guilt was conclusively established

beyond a reasonable doubt by the use of DNA evidence, despite the uncooperative nature of the witnesses.

(Selvi v. State of Karnataka, 2010) [18] is a significant ruling by the highest judicial body in India, i.e., the Apex Court. It addresses the constitutionality and ethical implications of various forensic techniques, including DNA profiling, narco-analysis, and polygraph tests. The key concern in this case revolved around whether the forced implementation of these methods infringed upon the fundamental rights of the accused as guaranteed by the Indian Constitution. Regarding DNA profiling, the Court took a nuanced approach. It recognized that DNA evidence is largely objective and does not involve the use of the accused's mental faculties to extract information. Consequently, it does not infringe upon the right to remain silent and avoid self-incrimination. However, the Court emphasized the need for stringent safeguards to protect the privacy and personal liberty of individuals, suggesting that DNA profiling should be conducted with the consent of the individual and in accordance with legal procedures.

(Lilu Ahmed v. State of Assam, 2013) [19] revolves around the application and the acceptability of DNA profiling as evidence in a criminal prosecution. The subject matter emerged from a serious crime where the accused, Lilu Ahmed, was implicated in a murder investigation. The prosecution sought to use DNA evidence obtained from biological samples collected at the crime scene to establish a link between the accused and the victim. One of the primary legal issues in this case was whether DNA profiling could be considered reliable and admissible as evidence in court. The defence raised concerns regarding the integrity of the DNA testing process, including potential contamination and mishandling of samples. Additionally, there were questions about the chain of custody for the biological materials used for testing. The court undertook a comprehensive analysis of existing scientific literature on DNA profiling, its methodologies, and its reliability as forensic evidence. It acknowledged that while DNA profiling is a powerful tool for establishing identity, it is not infallible. The court emphasized that proper protocols must be followed during sample collection, storage, and analysis to ensure accuracy.

In a landmark case (Manoj v. State of Madhya Pradesh, 2022) [20] the Supreme Court of India deliberated on crucial matters pertaining to the dependability and acceptability of DNA evidence in criminal trials. Three appellants, including Manoj, were found guilty of murder under Section 302 of the Indian Penal Code (IPC) and were given the death penalty for killing three men during a heist in 2011. The trial court's conviction was primarily based on circumstantial evidence, including DNA analysis, fingerprint evidence, and witness testimonies. The Supreme Court raised significant concerns regarding the DNA evidence presented. It highlighted the absence of a "random match probability" (RMP) in the DNA report, which is essential for determining the distinctiveness of a DNA profile within the population. The Court's skepticism regarding the DNA evidence arose from the absence of this information, which raised concerns about its trustworthiness and the possibility of contamination. The Court stressed the significance of preserving an accurate chain of custody for DNA samples. It noted that the procedures for collecting, storing, and transporting DNA samples were not adequately followed, which undermined the integrity of the evidence. The Court found that the failure to document each step in handling the DNA samples made the evidence unreliable. Ultimately, the Supreme Court's decision underscores the critical need for stringent protocols in the management of DNA evidence in criminal cases. The judgment

serves as a reminder that while DNA profiling can be a powerful tool in forensic science, its admissibility as conclusive evidence must be carefully scrutinized to prevent miscarriages of justice.

(Pattu Rajan v. State of Tamil Nadu, 2019) [21] the Supreme Court of India addressed significant issues surrounding the evidentiary value of DNA profiling and the use of superimposition techniques in criminal investigations. The key legal questions involved whether the conviction was valid despite the lack of DNA evidence and reliance on the superimposition technique. The appellant contended that the courts had acted on conjectures and that the identification of the body without DNA testing was improper. The Supreme Court, in its judgment delivered on March 29, 2019, upheld the conviction and clarified that DNA evidence is considered opinion evidence under Section 45 of the Indian Evidence Act. It noted that while DNA testing is increasingly reliable, it is not infallible, and its probative value can vary depending on the context and other corroborative evidence present in the case. The Court further determined that the lack of DNA evidence does not inherently result in a negative presumption against the prosecution, particularly in cases when there is substantial other evidence.

8. Reliability and Accuracy

Reliability refers to the consistency and dependability of DNA evidence in producing the same results under consistent conditions. The meticulous processes involved in DNA collection, preservation, and analysis are designed to minimize contamination and degradation, ensuring the evidence remains untainted. The use of standardized protocols and advancements in technology, such as Polymerase Chain Reaction (PCR) and Short Tandem Repeat (STR) analysis, contribute significantly to the reliability of DNA evidence.

Accuracy refers to the correctness of the DNA profiling results, meaning how precisely the evidence can identify or exclude individuals. DNA profiling techniques have advanced to such an extent that they can differentiate between individuals with a high degree of accuracy. The statistical probability of a DNA match is essential for accurately representing the strength of the evidence.

Multiple factors affect the technical reliability of DNA evidence. These include the amount and quality of the material that was tested, as well as the laboratory equipment and technique that was employed for the study, and so on. The concerns over the admissibility of DNA evidence are as follows.

i. Quality and Quantity of the sample

An analysis of a DNA sample can be conducted if the sample contains enough amount of DNA and if the quality of the DNA is satisfactory. Examining low-quality DNA samples might result in inconclusive findings that necessitate extensive study by the forensic expert, increasing the likelihood of human error or divergent interpretations of the data.

ii. Performance in the Laboratory

Forensic laboratories must adhere to stringent quality control and assurance procedures to guarantee the accuracy of DNA analyses. All DNA analysis results (and their interpretations) must meet a quality standard, and quality control includes the processes that ensure it. Quality assurance involves the systematic process of monitoring, verifying, and documenting the performance of a laboratory.

iii. Specimen handling

An inaccuracy in the study itself is less likely to compromise a DNA analysis than sample contamination, mislabelling, or improper handling. Any step in the DNA sample's life cycle, from collection to transit to analysis, carries the risk of contamination. The nature of the crime may cause the mingling of bodily fluids or tissues from multiple victims, which is one of the many potential sources of DNA contamination. Handling the sample either at the scene of the crime or in the lab also poses the risk of contamination. The amplification products from one PCR test can transfer to the next test's mixture, which is another potential source of contamination during PCR-based testing.

iv. Alternative hypotheses for a correlation

A defendant's culpability for a specific offense cannot be proven just because their profile matches the crime scene profile. A match could have occurred due to a laboratory mistake producing a false positive, the sample could have been deliberately left at the crime scene, or it could have been accidentally put there before, during, or right after the incident. It is also possible that the sample was taken from someone who is closely connected to the suspect or from someone completely unrelated yet sharing the suspect's DNA profile.

v. Error

Potential sources of error in DNA analysis include mistakes made by laboratory personnel during the process, such as errors in doing the analysis, interpreting the results, or reporting the findings. Additionally, errors can occur when inputting the resulting DNA profile into a DNA database system. This could arise due to non-compliance with a prescribed method, an error in judgment by the scientist, or some other oversight. Although processes and measures can be implemented to reduce the likelihood of errors during analysis or interpretation, it is impossible to completely remove the possibility of human mistakes.

vi. Manipulation of Data

The DNA profile of a suspect may match the profile discovered at a crime scene due to either tampering with the crime site or the replacement of DNA samples afterward. This situation can arise when the real perpetrator, a law enforcement officer, or another individual intentionally plants a suspect's genetic material at the location of the crime. Alternatively, it is possible for a crime scene sample to be illegally substituted with a suspect's sample in order to falsely implicate the suspect in the crime.

9. Recommendations

i. **Standardized Guidelines**

Standardized procedures must be implemented for DNA analysis in forensic laboratories, encompassing methods for sample collection, handling, storage, and analysis. These guidelines should include optimal methods to reduce the likelihood of contamination and maintain the authenticity of DNA evidence.

ii. **Standards for Quality Management**

The government should prioritize the deployment of stringent quality control procedures in DNA analysis methods. This encompasses routine assessment of proficiency, accreditation of forensic laboratories, and strict adherence to global quality benchmarks.

iii. **Chain of Custody**

It is crucial for forensic laboratories and their personnel to prioritize the maintenance of a meticulous chain of custody for DNA samples. Precise record-keeping and unwavering compliance with established procedures will guarantee the reliability and acceptability of DNA evidence in a court of law.

iv. **Expert Testimony**

Legal professionals must improve their comprehension of DNA analysis. Training programs and workshops can provide stakeholders with knowledge about the concepts, constraints, and importance of DNA evidence. This would enhance the understanding and evaluation of DNA reports in the context of judicial procedures.

v. **Collaboration and Peer Review**

It is necessary to encourage cooperation among forensic laboratories, DNA experts, and legal professionals in order to facilitate the exchange of knowledge and the evaluation of each other's work. Implementing this will facilitate the maintenance of rigorous standards in DNA analysis and guarantee ongoing enhancement in the sector.

10. Conclusion

DNA profiling has become a cornerstone of forensic science due to its ability to provide unique identifiers for individuals. The scientific methods used in DNA analysis are generally regarded as reliable, provided they adhere to validated protocols. Courts require that DNA evidence not only demonstrates a match but also provides a statistical probability of such a match, which must be communicated clearly to the court. For DNA evidence to be admissible in court, it must be accurate and reliable. Continuous advancements in forensic science, rigorous standards, and adherence to proper protocols are essential to maintaining the integrity of DNA evidence. The admissibility of DNA evidence has evolved since its introduction in the 1980s. Over time, most courts have accepted DNA evidence, recognizing its probative value in establishing connections between suspects and crime scenes. In order to address new challenges and uphold basic justice principles, the legal system must evolve in tandem with technological progress. Ultimately, the judicious use of DNA evidence enhances the ability to accurately identify perpetrators, exonerate the innocent, and reinforce public confidence in the criminal justice system.

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