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Forensic DNA Analysis: An Assessment of the Emerging Legal Challenges

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ABSTRACT

Ever since the advent of DNA Profiling, criminal investigation in forensic science has been completely revolutionised. Now, not only can the fingerprinting technique accurately identify and individualise the culprit, but also can it help determine paternity in civil disputes. But how is it that such a minute molecule such as DNA, help answer some major perplexing questions? The answer lies in the fact thatDNA is the basic building block of each and every organism, be it the smallest of viruses or an organism as complex as the human being itself. It is present in each and every cell of the body and surprisingly so, no two individuals share the same DNA sequence.

The paper begins bydiscussing the meaning and role of DNA and the process of conduction of DNA Profilingalong with a discussion ofthe different techniques applied thereto. It even delves into the historical aspects of DNA Analysis and critically evaluates this technique in light of the major qualitive and legal aspects. The paper is an argument as to how Forensic DNA Analysis has introduced several positive changes in the criminal justice administration, while on the other hand, it also discusses the emerging legal issues pertaining to the same in India and across the globe.

I. INTRODUCTION

DNA, often referred to as the blueprint of an individual, has emerged as a potent tool in the administration of criminal justice. Not only would it exculpate the innocent, but it would also provide a concrete proof of paternity in civil disputes. The basic premise on which DNA evidence operates is the fact that every individual has a unique genetic composition, which is exactly why DNA has become a powerful weapon in the hands of prosecutors and investigators. Yet, even though backed by a strong scientific rationale, DNA evidence is not free from drawbacks. Errors in sample collection, poor handling, contamination might result in exclusion of DNA evidence from the trial. Moreover, the approach of the courts regarding the treatment of DNA evidence has not been uniform across the country. But before one engages with the evaluation of the emerging issues, it is essential to first understand what is

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meant by DNA and what are the different techniques employed for forensic DNA analysis.

II. WHAT IS DNA?

DNA or Deoxyribonucleic acid is a fundamental building block of any individual's entire genetic make-up. It is the basic constituent present in every cell of the body. According to the Watson and Crick Model,[2] it consists of a double helix structure made up of deoxyribose sugar and a Phosphate backbone and a nucleic acid base pair connected by hydrogen bond. There are only four types of nucleic acids that are present in the DNA molecule; adenine and guanine, which are purines and thymine and cytosine, which are pyrimidine. As a general rule, a purine always pairs with a pyrimidine, hence adenine is always attached to thymine and guanine pairs with cytosine. RNA is different from DNA in the sense that it is only a single-stranded structure and instead of thymine, it contains uracil.[3]

DNA may be called as the distinguishing character between two or more individuals. Thus, in essence, two individuals cannot have the same arrangement of base pairs in the DNA strand and this forms the basis of forensic DNA Analysis. However, one exception to this principle is identical twins, who possess an identical genetic make-up.

III. DNA PROFILING

Ever since the 1970s there have been certain significant scientific, social and legal changes in the field of forensic science and criminal justice system and DNA Profiling (also known as 'DNA Typing' or 'DNA Fingerprinting') is undoubtedly one of the most important breakthroughs that has completely revolutionized the field of forensic science.[4]It may simply be referred to as the process of testing used for identification of DNA patterns or types. In forensic science, this technique may be used to exculpate or inculpate individuals using various biological evidence such as blood, semen, saliva, hair, etc. or it may even be used to establish paternity during a dispute.[5]

(A) SCOPE

It has been proven time and again that DNA evidence is much more reliable than any other form of evidence, although its fallibility cannot be completely ruled out and the primary reasons why it has emerged as being so effective is because – Firstly, it is much more

[2]J. D. Watson & F. H. C. Crick, *A Structure for Deoxyribose Nucleic Acid*, 171, 737-738 (Nature (3) 1953).
[3]Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter, *Molecular Biology of the Cell***,** (4th ed.New York: Garland Science; 2002) From DNA to RNA; Available at: https://www.ncbi.nlm.nih.gov/books/NBK26887/,
[4]Joseph L. Peterson & Anna S. Leggett, *The Evolution of Forensic Science: Progress Amid the Pitfalls*, 36 Stetson L.Rev. 621, 622 (2007).
[5]ISHITA CHATTERJEE, LAW OF FORENSIC SCIENCE, 739 (1st ed. 2015).

informative and can even be analysed through minute or degraded material, for instance, DNA extracted from a heavily decomposed body may still be used for identification purposes. Also, since only about 50 micro litre of blood, or 10 micro litre of semen or just one hair sample with intact root are sufficient for DNA Profiling, it is one of the most effective tools in identification. Secondly, the same genotype is present in any biological material of the same individual i.e. the DNA structure does not vary in blood, semen, hair, saliva, skin and bones, etc.[6]Thirdly, no two individuals possess the same arrangement of base pairs in the DNA strands. Although, it has to be noted that out of the 3.3 billion base pairs present in the human genome, only 3 million differ between two individuals,[7]which means that it is only the 0.1% portion of the entire human DNA that constitutes the distinguishing characteristic between two or more individuals.

(B) SIGNIFICANCE

Even though only a minute fraction of the DNA differs between two individuals, it is a very effective tool for identification purposes. For instance, it may be used to establish paternity or identify the blood relations of the individual, the blood samples collected from the crime scene may be used to identify the victim or the culprit, also the semen samples collected may be a potent piece of evidence in rape cases, unknown or decomposed dead bodies may be identified using this technique, etc. Furthermore, it may even be useful in determining the sex of the individual considering the fact that males have a Y chromosome, which is shorter in length as compared to the X chromosome, which is present in pairs in females.[8]This in turn would help in establishing an essential clue in investigation proceeding orthe criminal justice administration and which would ensure that the guilty are punished and the innocent are exonerated.

(C) FORENSIC ASPECT

According to Locard's Exchange Principle, whenever two entities come in contact, the traces are exchanged mutually. Therefore, whenever a crime is committed by any individual, he may leave behind some traces or he may carry some traces back with him from the crime scene. These traces, which are in the nature of biological evidence such as blood, semen, pubic hair, saliva, etc.,[9] may be used for the purposes of Forensic DNA Analysis. Thus,

[6]M.S. RAO & B.P. MAITHIL, CRIME SCENE MANAGEMENT: A FORENSIC APPROACH, 338 (2nd ed. 2013).
[7]WILSON WALL, GENETICS AND DNA TECHNOLOGY: LEGAL ASPECTS, 24-25 (2nd ed. 2004).
[8] David T. MacLaughlin & Patricia K. Donahoe, *Sex Determination and Differentiation*, N Engl J Med, 350, 367-378 (2004).
[9]PAUL L. KIRK, CRIME INVESTIGATION: PHYSICAL EVIDENCE AND THE POLICE LABORATORY (2nd ed. 1974).

accordingly, there may be a direct transfer or an indirect transfer.[10]

1. DIRECT TRANSFER

When the perpetrator comes in direct contact with the victim, some biological evidence may be directly transferred.For instance, blood may be spattered, hair particles may be left or semen may be deposited, etc. This type of evidence will directly help establish the link between the perpetrator and the crime and thus is generally more potent than indirect transfer.

2. INDIRECT TRANSFER

It may also be referred to as secondary transfer and may be a result of no direct contact between the originator of the evidence and the place of extraction. Therefore, some form of intermediate medium may be involved, for instance, a person may carry the victim's hair from the suspect's vehicle to some other place. Thus, no direct link can be established in such cases and hence an indirect transfer does not necessarily provide a positive proof of the suspect with the crime.

IV. EVOLUTION OF DNA PROFILING

The study of fingerprints for identification and individualisation goes back to as early as the 17th Century when an English Botanist by the name of Nehemiah Grew published his findings on the presence of ridges on the skin of hands and feet in the year 1684.[11] Ever since then, along with the subsequent findings of Francis Galton in 1892,[12] and later the advent of the Henry's System of Fingerprint identification in 1901 has established the primacy of fingerprint evidence in forensic science. However, as accurate as the fingerprint system may be, it is still plagued with its own set of drawbacks. Hence, a need was felt to institute an even more concrete system for identification and individualization.

In 1930, Karl Landsteiner was awarded the noble prize for identifying four distinct types of blood groups based on the presence or absence of certain factors in the blood of that person,[13] however, blood groups by themselves do not constitute a conclusive determinant of the person's identity, considering the fact that persons may possess the same blood group.

A significant breakthrough was achieved in the year 1985 when Sir Alec Jeffrey who discovered certain repeating sections in the DNA.This discovery was actually ancillary to the

[10]Rao & Maithil, *supra*, 342.
[11]NEHEMIAH GREW, ON THE PORES IN THE SKIN OF THE HANDS AND FEET, (1753).
[12] Louis Robinson, *An Ancient Reading of Finger-Prints*, 180 NAR 727 (1905)https://www.jstor.org/stable/25105400.
[13]Hans Peter Schwarz & Friedrich Dorner, *Karl landsteiner and his major contributions to haematology*, 121(4) BJH 556, 560 (2003)https://doi.org/10.1046/j.1365-2141.2003.04295.x.

initial project he was working on which was the analysis of myoglobin gene in seals. When he compared this gene with the human counterpart, he observed that it consisted of several short repeating sequences which were common to both. He developed a radioactive probe that could latch onto the repeating sequences and which could help in studying the patterns which are unique to every individual, also known as DNA fingerprint. In his paper, Professor Jeffreys and his team even defined the steps involved in DNA fingerprinting.[14]

Later he even went on to study the DNA fingerprint of an entire human family along with that of a mouse, baboon, cow and a tobacco plant and a closer inspection revealed that each consisted of short 15 to 20 bands that were different from one another. Also, it was observed thatthe DNA fingerprint of both the father and the mother had its own distinct pattern while the DNA fingerprint of the child was a mixture of both the father and the mother since he had inherited one allele from both the parents.

The use of DNA evidence in the landmark case of Colin Pitchfork ushered a new age for forensic science. In this case the DNA fingerprinting technology was used in order to exonerate a youth who had falsely confessed to two rape and murders. The police subsequently went on to take samples from several thousand male inhabitants to identify a new suspect.[15]Robert Melias became the first person to be convicted of rape in England on the basis of DNA evidence in 1987.[16] Similarly, in the US, Tommy Lee Andrews was the first person to be convicted as the DNA obtained from his blood sample matched with that of the semen obtained from the crime scene.[17] Ever since, DNA evidence has proved to be an essential piece of evidence in establishing the link between the culprit and the crime scene.

V. DNA PROFILING TECHNIQUES

DNA is present in the nucleus of almost every cell inside the human body. Hence trace evidences of blood, semen, hair particles, etc. may be more than sufficient to conduct DNA Profiling. Accordingly, various techniques have evolved ever since the advent of DNA fingerprinting.

(A) POLYMERASE CHAIN REACTION (PCR)

Sometimes the DNA samples obtained may be inadequate or of poor quality, in such a case the new DNA is synthesised in order to increase the sample size. This technique is known as

[14] Arthur Jeffreys, V. Wilson& S.L. Thein, *Individual specific fingerprints of human DNA*, Nature 76 (1985).
[15]R v. Colin Pitchfork; [2009] EWCA Crim 963.
[16]*The DNA Wars are over*, FRONTLINE, PBS, https://www.pbs.org/wgbh/pages/frontline/shows/case/revolution/wars.html.
[17]Andrews v State, 535 so 2d 841 (Fla. Dt. Ct. App 1988).

Polymerase Chain Reaction (PCR). It was developed by Kary Mullis in the year 1980.[18]This technique is not directly used for DNA Profiling itself, however, it is an ancillary procedure employed to ensure that there is sufficient quantity of DNA available for profiling.

(B) RESTRICTION FRAGMENT LENGTH POLYMORPHISM (RFLP)

Using this technique, the variations in the DNA are identified using a 'probe' that can only recognize certain specific variations.Millions of copies of DNA produced using the PCR technique are passed through a membrane containing the probe. These probes get attached to the DNA fragments containing that specific sequence. Results can be viewed using a color reaction that is used to detect the DNA fragments attached to the probe on the membrane.[19]

(C) VARIABLE NUMBER TANDEM REPEAT (VNTR)

VNTR is a location on the genome where the nucleotide is organized as a tandem repeat. It may be present in several chromosomes and differs in the number of repeats in different individuals and here each variant may act as an allele that has been inherited from the parents, hence aiding in establishment of paternity or identification.

(D) SHORT TANDEM REPEAT (STR)

In STR, the allele repeats at specific loci are compared between two or more DNA samples. An STR is essentially a microsatellite which repeats after 2 to 7 base pairs and the number of repeats is different for different individuals. Therefore, it is very effective in identification and individualization process.STR is more advantageous than the VNTR system. This is because STR can even show results in case of damaged DNA, for instance, if the DNA samples extracted from the crime scene has undergone deterioration. Also, STR is different from RFLP since it does not cut the DNA using a restriction enzyme.

VI. NEED FOR STANDARDIZATION

(A) EUROPEAN DNA PROFILING GROUP

With the increasing application of DNA Analysis in criminal justice administration, a need was felt to establish certain standards and rules on auditing and accreditation, both at the national as well as international levels. First such attempt was made by European countries wherein the European DNA Profiling Group (EDNAP) was set up in the year 1988,[20] which was soon after it was first discovered by Sir Alec Jeffrey. This group aimed at promoting co-operation amongst the European countries to facilitate the exchange of compatible DNA

[18]*Polymerase Chain Reaction (PCR),* NCBI, (2017) https://www.ncbi.nlm.nih.gov/probe/docs/techpcr/.
[19]Chatterjee, *supra*, 750.
[20]EDNAP - The European DNA Profiling Group, History, (2009) https://www.isfg.org/EDNAP/History.

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Profiling data so as to allow these countries to optimally utilize the benefits afforded by this technique. There was also a Working Group on Police co-operation and the European Network of Forensic Science Institutes (ENFSI) Working Group on DNA Profiling, which represented the society of forensic scientists and their interests.[21]

(B) INTERPOL

Later, the 25th Regional Conference at Warsaw, also endorsed the European Business Plan, which prioritised the promotion of good practices in the use of DNA Profiling as an investigative technique and in order to implement this, the INTERPOL European Committee decided to set up the INTERPOL European Working Party on DNA Profiling in November 1996. Subsequently, it submitted its final report, which was discussed in the 67th General Assembly Session in Cairo.[22]

(C) STANDARDIZATION ATTEMPTS IN THE UNITED STATES

In 1988, the Technical Working Group on DNA Analysis Methods (TWGDAM) was established under the FBI Laboratory Division and consisted mainly of government and private sector DNA Analysts. It issued various guidelines as to the standardisation on quality assurance in DNA analysis. However, in 1994, the DNA Identification Act was passed which led to the creation of the DNA Advisory Board (DAB). It formulated the "*Quality Assurance Standards for Forensic Testing Laboratories*" which was later approved by the FBI Director and which became effective from 1998.Subsequently, a new set of guidelines were formulated and issued by the DAB, which were approved and took effect from April 1, 1999. These standards currently govern DNA testing in US, and they prescribe a relatively greater degree of quality in DNA Analysis.[23]

VII. CHALLENGES TO DNA PROFILING

As accurate and efficient as DNA Profiling is, it is plagued by its own set of challenges. Some of these have been mentioned herein:

(A) CONTAMINATION

Improper collection, preservation or packaging could lead to inaccurate results. The examiners need to be very thorough and careful when it comes to DNA samples as these are

[21]History, European Network of Forensic Science Institutes, (2018) http://enfsi.eu/history/.
[22]Anne Leriche, Daniel Vanek, Hermann Schmitter, Uwe Schleenbecker, Janos Woller, Paola Montagna, Luciano Garofano, Wim Sprangers, Ellen Wolf, Nils Moe, Jan Matusek, José Andradas Heranz, Ana Maria Garcia-Rojo Gambin, Luis Serra Utrilla, William Grahamslaw, Peter Fifka, Mark Branchflower,*Final Report of the Interpol European Working Party on DNA Profiling*, (2012)https://www.promega.com/.
[23] Lawrence A. Presley, *The Evolution of Quality Standards for Forensic DNA Analyses in the United States*, PROMEGA, (Sept 1999) https://www.promega.com/.

mostly only present in minute quantities and may easily be damaged, destroyed or misplaced. The defence may raise this as a very important argument, and which may even result in exclusion of DNA evidence from the trial.

(B) Presence of Cell Populations From Multiple Contributors

If there are more than one contributors to the cell population, then it may result in reduced statistical strength of the STR profile and thus may result in a potential loss of evidence. Although several methods have been developed to separate the contributor cell populations before the commencement of DNA Profiling, including – laser capture microdissection; micro-fluidic manipulations; flow cytometry based techniques, including fluorescence activated cell sorting, etc. one major drawback still remains, which is, that these techniques have largely been used on mixtures with only two contributors and applied to mixtures which are fresh or uncompromised.[24]

(C) Comparison With Inadequate Population Sample Size

This may also be raised asa defence by the accused, which could in turn challenge the reliability of the DNA evidence. If the sample is not compared with adequate population sample size, then the probability calculations may be hampered.

Yet, despite these challenges it has to be noted that DNA testing is still considered as being one of the most effective means of identification in criminal justice administration. In 2009 U.S. National Research Council issued a very important report on forensic science. In this report, it was observed that except for nuclear DNA Analysis, no other method has proven to have the ability to consistently demonstrate a very high degree of certainty in establishing the link between the specific evidence and the individual or the source.[25]

VIII. Emerging Legal Issues

(A) Evidentiary Standard – A Judicial Approach

There has been an ongoing debate about the admissibility of DNA evidence in criminal trials. But before we delve into this legal debate, it is important to note that there is a difference between relevancy and admissibility. All that is relevant to the case at hand may not necessarily be admissible. Hence, in order to become admissible,it must comply with certain legal evidentiary standards.However, in the United Kingdom the courts had ruled that there is

[24]Katie Horsman, Joan Bienvenue, Kiev Blasier & James Landers, *Forensic DNA Analysis on Microfluidic Devices: A Review*, 52(4) JFS 784 (2007).

[25]Committee on Identifying the Needs of the Forensic Sciences Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward*, (Aug 2009) http://www.nap.edu/catalog/12589.html.

no requirement for a threshold or a special test in order to determine the admissibility. All that is required is that the evidence must only meet the criterion of relevancy and helpfulness.[26] This is in consonance with the view that all relevant evidence is admissible unless it has been expressly excluded on the ground of public policy.[27] Therefore, it can be observed that in UK, it is left to the discretion of the judges to determine whether the science has progressed to such an extent that a competent individual could give evidence upon it.

In United States, on the other hand a more formal approach has been prescribed. In the landmark case of *Frye v United States*,[28]the court observed that it is difficult to exactly determine when the scientific principle surpasses the line of merely being experimental or demonstrative. Somewhere in between the courts would have to accept the evidentiary force of the expert testimony, however, this testimony would have to be based on generally accepted, well determined scientific principles. Based on this principle of 'general acceptance, many courts went on to adjudicate upon the admissibility of DNA evidence, with most courts ruling in favour of admissibility. In another case, the court accepted that the technique of DNA Profiling had been generally accepted by the relevant scientific community,[29] hence satisfying the Frye test. However, in an unreported case the court doubted the reliability of the Polymerase Chain Reaction technique, thus discarding the DNA evidence.[30] The court emphasised that reliability of the evidence is of utmost importance and the fact that tests conducted by the laboratory in question are prone to errors, the reliability of the DNA evidence would only be as good as the reliability of the testing procedures used by the laboratory.[31]

In 1993, in another landmark case*Daubert v. Merrel Dow Pharmaceuticals Inc*.,[32]a more flexible approach was given to the reliability of scientific evidence.[33] The court sought to resolve the discrepancy that existed between the 'generally accepted' standards and the Federal Rules of Evidence by stating that the judge plays the role of a 'gatekeeper' and must ensure that the scientific evidence admitted must not only be relevant but also reliable.

Therefore, while the Frye test required the court to determine whether the scientific technique in question is generally accepted or not, the Daubert test on the other hand mandates the judges to rule on the validity of the scientific theory or technology. Thus, only if the theory or

[26]R v. Das, (1986) 31 CCC 3d 353.
[27]R v Abbey, (1982) 68 CCC 2d 394.
[28]Frye v. United States, 293 F, 1013 (1923).
[29]State v. Woodall, 385 S.E. 2d 253 (W. Va 1989).
[30]People v. Martinez, C.S. No. 709321, (March 1989, Los Angeles Co. Ct).
[31]State v Schwartz, 447 N.W. 2d 422 (Minn SC 1989).
[32]Daubert v. Merrel Dow Pharmaceuticals Inc. 509 U.S. 579 (1993).
[33]Cella v. United States, 998 F. 2d 418 (7th Cir. 1993).

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technology has been adequately tested, can it be admitted in evidence. However, it has been observed that merely laying down the admissibility standards is not sufficient. The concern is no longer about the validity, it is more in the nature of proficiency.

(B) FALLIBILITY OF DNA EVIDENCE

Although, DNA evidence is considered much more reliable as compared to mere identification through blood group, it is not true to say that DNA evidence is infallible. As has been discussed earlier, there may be discrepancies in collection, preservation or packaging which may result in contamination of the sample and hence deliver an erroneous result. Moreover, DNA evidence is dependent on probability. Even though the probability that the sample came from personX is one in 1 crore, one must not rule out the possibility that the sample came from another person. This is the very nature of probability. Most importantly, DNA evidence cannot be considered in isolation. It is always a corroborative piece of evidence and must not be solely relied upon.

(C) EXPERT EVIDENCE AND PROSECUTOR'S FALLACY

Judicial procedure dictates that DNA evidence be substantiated by expert testimony;therefore, this also gives rise to challenges associated with presenting opinion of experts. In India, it has to be noted that adequate provisions have been made for presentation of expert evidence in the Indian Evidence Act, 1872. Section 45 provides for testimony of experts in general,[34] while section 46 deals with facts bearing on the opinion of experts[35] and section 51 further provides for the relevancy of the grounds of expert opinion.[36]However, when it comes to expert opinion, the experts are only entitled to answer questions pertaining tothe facts and circumstances of the case. Thus, where an expert goes on to declare that the accused is an offender based on the results of the DNA Analysis, he is assuming the role of a judge and his testimony cannot be accepted.[37]He must merely explain the nature of the DNA match and the random occurrence ratio.

IX. APPLICATION IN THE INDIAN CONTEXT

(A) JUDICIAL APPROACH

In India, the judicial courts have not given any guidance as to how the trial courts need to approach DNA evidence. There are no guidelines as to how DNA Evidence needs to be evaluated. Different judges have rendered different rulings on whether the DNA Evidence

[34]The Indian Evidence Act, 1872, Act No. 1 of 1872, s. 43 (1872).
[35]*Id*., 46.
[36]*Id*., 51.
[37]R v Dohney and Adams, (1997) 1 Cr App R 369.

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was properly presented or not.[38]However, it has to be noted that the Indian courts have largely accepted DNA evidence and expert testimonies with respect to the same. One case where DNA Profiling was considered for convicting the accused was *Chandradevi v. State of Tamil Nadu*.[39] It involved the rape and murder of seven girls in the ashram of the accused. The Madras High Court applied the Frye test in determining whether DNA evidence has been generally accepted by the scientific community. In another case, court acquitted the accused on the premises that requisite amounts of DNA of high molecular level was not present to make the test conclusive and accurate.[40]Although, no convictions are solely based on DNA evidence. It is merely used as a corroborative piece of evidence.

In the *PriyadarshaniMattoo case*, where the victim was a law student who was allegedly raped and murdered in her house in Delhi, the prosecution had relied upon the DNA evidence from the vaginal swabs which tested positive, while the defence argued that the test was not conducted in accordance with the rules of procedure. In fact, initially the post-mortem report stated that there were no semen stains, however, subsequent analysis revealed that there were in fact semen stains. This disclosed the lacunae in the mode of conduction of DNA Analysis, thus severely jeopardising the prosecution's case. The Trial judge acquitted the accused stating that the prosecution could not establish the case beyond reasonable doubt, however, the High Court reversed the acquittal and sentenced the accused to death penalty stating that the facts had been improperly presented in the trial court. Recently, in 2010, the Supreme Court commuted his death penalty into life imprisonment.[41]

(B) NEED FOR DNA LEGISLATION IN INDIA

A detailed study of the Indian Criminal Legislations reveals that no specific provisions have been made with respect to inclusion of DNA evidence or the conduction of DNA analysis. Although, a 2003 amendment to the Indian Evidence Act, included the conduction of DNA tests in paternity disputes and which is in consonance with the recommendations of the 185th Law Commission.[42]However, this amendment is limited to paternity only. There is no other specific provision in the Criminal Procedure that governs the DNA Analysis. Although, section 53 of Cr.P.C provides for the medical examination of accused person on request by the police, it does not specifically provide for the collection of DNA samples. Thus, even though, the court has ruled time and again that collection of blood samples from the accused

[38]Chatterjee, *supra*, 736.
[39]Chandradevi v. State of Tamil Nadu, manu/TN/2335/2002.
[40]M.V. Mahesh v. State of Karnataka, 1996 Cr.L.J 221 (Kant).
[41]Santosh Kumar Singh v State through CBI, (2010) 9 SCC 747.
[42]*185th Report on Review of The Indian Evidence Act, 1872*, LAW COMMISSION OF INDIA (2001) www.lawcommissionofindia.nic.in/reports/185thReport-PartI.pdf.

does not violate his constitutional right against self-incrimination under article 20(3),[43] the investigating officer has to face a lot of hurdles in collection of these evidences in absence of a proper, specific legislation provisioning for the same.

Thus, in a bid to curb this shortcoming, recently the government had introduced the DNA Technology (Use and Application) Regulation Bill, 2018.The Bill seeks in aiding the identification of persons in civil and criminal matters using the DNA technology. It also provides that consent is not necessary for obtaining DNA samples from an individual. It even contains provisions for setting up of a National DNA Data Bank, Regional DNA Data Banksas well as a DNA Regulatory Board. Every laboratory conducting DNA Profiling would have to be accredited by the board.[44]

Even though this bill appears to be landmark in the field of DNA legislation, it has to be noted that it was only passed by the Lok Sabha and is still pending in the Rajya Sabha. Only if the Rajya Sabha affirms the same, can we expect a significant breakthrough in the field of DNA legislation.

X. CONCLUSION

Through the aforementioned analysis, it is apparent that Forensic DNA Analysis has emerged as a major breakthrough in the field of forensic science and has facilitated a smoother criminal justice administration in general. DNA Analysis techniques have now become faster, better, easily accessible and more user friendly, ever since the first conviction was made using DNA evidence.There was a time when it used to take six to eight weeks for the conduction of the entire DNA Profiling,[45] when now the same is possible only in a span of couple of hours. These days, many governments also maintain DNA Databases, which has made the process of suspect identification even more easier.[46]Yet, even then, many challenges continue to prevail when it comes to DNA Profiling. Although the Indian Courts have recognised the importance of DNA evidence in solving crimes, there exists still no legislation that can comprehensively cover the conduction of DNA Analysis. The passage of the DNA Technology (Use and Application) Regulation Bill could offer some relief, yet there are several other challenges that need to be addressed, and we can only remain hopeful that a further advancement in technology would help us combat the same.

[43]Swati Lodha v State of Rajasthan, 1991 Cr.L.J 939;Ram Lal Narang v State of Delhi (Admn.), AIR 1979 SC 1791.
[44]*The DNA Technology (Use and Application) Regulation Bill, 2018*, PRS LEGISLATIVE RESEARCH, (2018) https://prsindia.org/billtrack/dna-technology-use-and-application-regulation-bill-2018.
[45]Celia Henry Arnaud, *Thirty years of DNA forensics: How DNA has revolutionized criminal investigations*, 95 c. & en. 16 (2017) https://cen.acs.org/articles/95/i37/Thirty-years-DNA-forensics-DNA.html.
[46]*Id.*

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