Analysis Of Admissibility Of Dna Based Forensic Evidence

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ABSTRACT

The primary objective of the study is to understand the nature and characteristics of DNA based forensic evidence and to analyse grounds that affects its admissibility in the Indian Courts. This research paper analyses various types of biological samples from which DNA can be extracted to undertake DNA profiling. It analyses standard operating procedure for extraction, testing and preservation of the sample including its handling. The study doctrinally analyses various judgements of the superior courts to highlight the grounds accepted by the courts that affect the admissibility of DNA based forensic evidence for criminal trial read in conjunction of relevant statutes. The data for the research has been obtained through both primary and secondary sources in the form reported judgements on court websites, statutes in official gazettes, research papers published in reputed journal both online and offline, including edited books. The primary research objective this research paper aims to achieve is: -

(a) To develop understanding of DNA based forensic evidence.

To identify principles affecting admissibility of DNA based forensic evidence.

1. Introduction

".....Forensic evidence is often the silent witness that can make or break a case. It is essential that we use the latest forensic techniques and technologies to ensure that justice is done. …"

T.S. Thakur, Former Chief Justice of India

The admissibility of an evidence primarily means considering whether a piece of evidence can be presented before the courts and is it worthwhile for deciding the matters in hand before the Court. For forensic evidence to be admissible before the court of law it must meet some yardstick and criteria. It is pertinent to mention that the evidence being submitted before the court should have some probative value. Any evidence that is

considered inadmissible, cannot be presented before the court of law to support an argument or fact. To maintain the integrity of the judicial system some ground rules have been laid down through jurisprudence exercised by case judgments and statues together. These rules ensure that forensic evidence submitted is reliable, fair, true and trustworthy.

As per Oxford Learner's Dictionaries the word admissibility means "…how much something can be allowed or accepted, especially in court…."[1]. As per Oxford Law Dictionary the admissibility of Evidence means: -

"…. The principles determining whether or not particular items of evidence may be received by the court. The central principle of admissibility is relevance. All irrelevant evidence is inadmissible, but evidence that is legally relevant may also be inadmissible if it falls within the scope of one of the exclusionary rules of evidence...."[2]

As per the Black's Law Dictionary, Admissible evidence is: -

"…. As applied to evidence, the term means that the evidence introduced is of such a character that the court or judge is bound to receive it; that is, allowed it to be introduced at trial…."[3]

The nodal agency to promulgate Standard Operating procedures for high quality and credible forensic science practice is Directorate of Forensic Science Services (DFSS) under Ministry of Home Affairs. The DNA based forensic evidence has become an important tool for the investigating agencies to identify the criminals and re-create crime scene. The DNA-based forensic evidence has been used in solving wide variety of heinous criminal cases involving rape, murder, culpable homicides, causing grievous hurt, theft, dacoity, sexual assault etc. Some cases have been solved after many years. Using DNA analysis in forensic sciences one can identify an individual, his relationships, test parentage which can be helpful in solving a crime based on evidence collected at crime scene. The DNA is extracted from biological samples such as hair, skin cells, blood, saliva, vaginal & body fluids and semen recovered from the crime scene. The DNA in individual's blood is same as in their saliva, skin, bones, teeth, hair, tissue etc[4]. The new advances in technology have now

[1] Oxford Learner's dictionaries, *available at* https://www.oxfordlearnersdictionaries.com/definition/english/admissibility (last visited on 24 Mar 2023)

[2] Oxford Law Dictionary **as cited in** Shakil Ahmad Khan, Volume no 1, *P Ramanath Aiyars's Advanced Law Lexicon*, 140 (LexisNexis, Delhi, 5th Edition, 2017).

[3] Black's Law Dictionary as cited in Sate vs Nalini, (1999) 5 SCC 253, para 420, **Further cited in** Shakil Ahmad Khan, Volume no 1, *P Ramanath Aiyars's Advanced Law Lexicon*,140 (LexisNexis, Delhi, 5th Edition, 2017)

[4] Central Forensic Science Laboratory Chandigarh, " Working Procedures Manual Forensic DNA Testing-2019" , (2019)

enabled the agencies to extract relevant information from much degraded- DNA samples obtained from the crime scene.

2. **Understanding DNA** The DNA test of an individual can be used to create his genetic profile. The DNA is an abbreviation for Deoxyribonucleic acid, a molecule that carries genetic information unique to an individual[5]. It is a building block for human body. However, a pair of identical twins may have same DNA. Hence DNA can be used to identify an individual unless he has a twin which is a rare occurrence in a crime scene. Thus, DNA based forensic evidence has become crucial tool with the investigating agencies to identify an individual involved in crime. It therefore is also becoming important tool in victim identification and have been used to exonerated many falsely accused. In order to understand the role of DNA, the context of Chromosomes must be understood with respect to Cell.

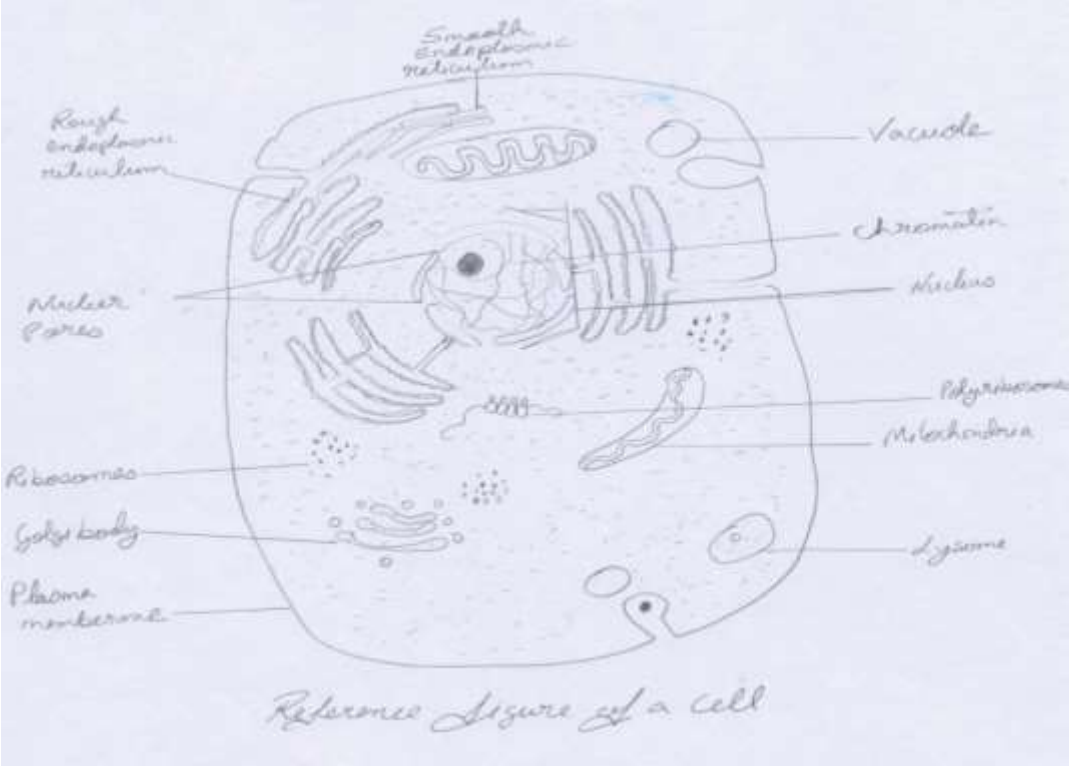
2.1. **Cell** The basic unit of all life form on Earth is a Cell. It is also the smallest living organism. A cell is a complete unit in itself, it can create its own energy and can self-replicate. A cell can function on its own. Human body is made of 50-100 Trillion cells of various kinds, size and shape having different function and properties. There are 200 types of cells in human body such as stem cells white blood cells, red blood cells, platelets, nerve cells, cartilage cells, bone cells, skin cells, fat cells, sex cells etc[6]. A sperm is a cell, and looks like a tadpole, a female egg is a cell and is of spherical shape, similarly nerve cells resemble thin tubes. A cell has different parts. The nucleus of the cell is the central location that controls various functions of the cell like a headquarter or central processing unit. It is in the Nucleus of the cell that houses majority of the DNA. The cell also has other parts like plasma membrane, Cytoplasm, Cytoskeleton, Mitochondria, Endoplasmic Reticulum, Golgi Apparatus, Ribosomes etc. The cells communicate with each other, and combine to form tissues and tissues combine to form organs of human body[7].

Fig 2.1.(a) Reference sketch of Cell structure

[5] J Neufeld, N Colman, "When Science takes the witness stand", Scientific American (1990) p22

[6] Rachel Baxter, "*Types of cells in the human body*", KenHub, 28 Dec 2022, available at https://www.kenhub.com/en/library/anatomy/types-of-cells-in-the-human-body (Last visited on 31 Mar 2023).

[7] Tim Newman, "What is a cell?", *MedicalNewsToday* , 24 Aug 2022, available at https://www.medicalnewstoday.com/articles/320878 (Last visited on 31 Mar 2023)

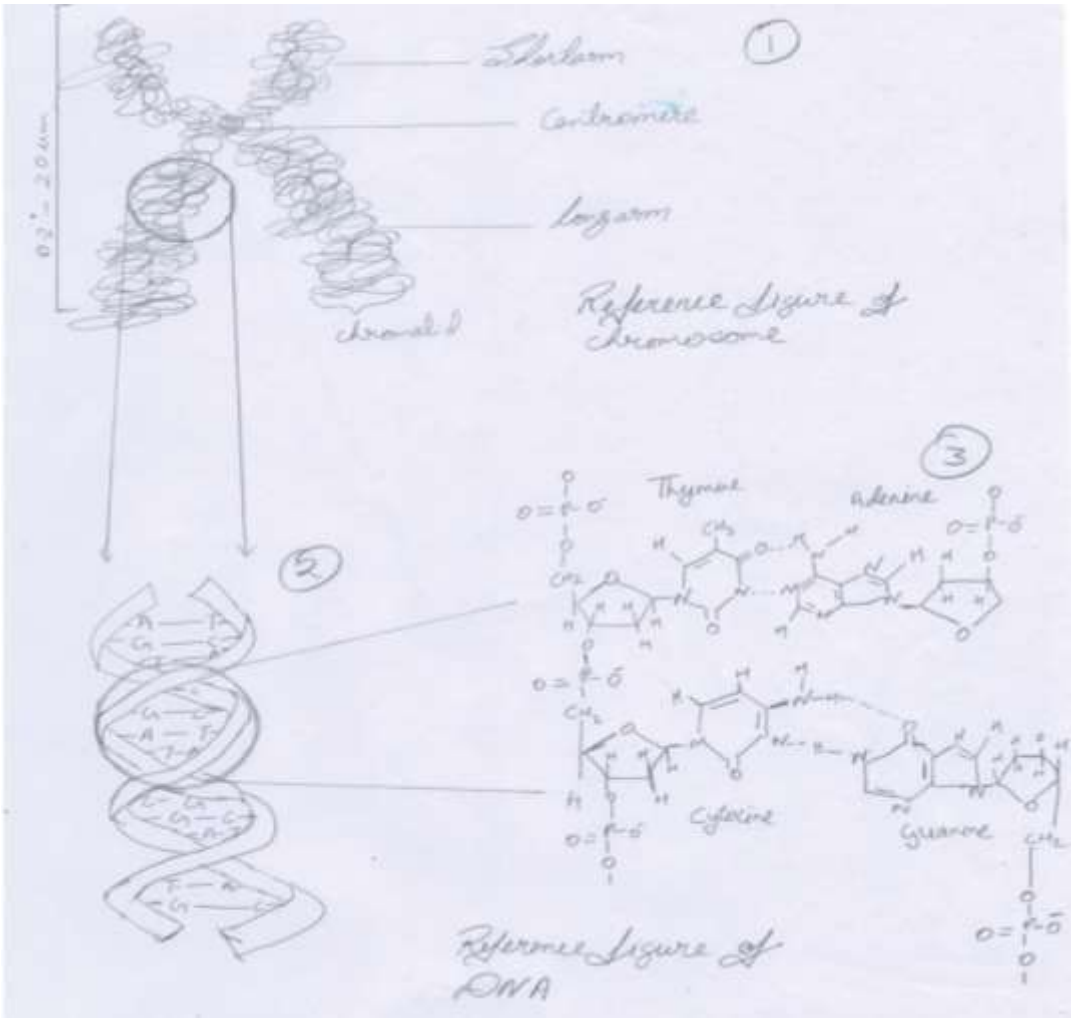


2.2. **DNA** Every cell in human body has DNA. The offspring carries genetic material of his parents in its DNA. The offspring's DNA would obtain half information from father and other half from mother. The DNA of every individual is unique unless offspring has a twin sibling. The DNA of a person remains the same throughout a person's lifetime. The DNA comprises of unique pattern of genetic code. The Human DNA or Deoxyribonucleic Acid is present in the nucleus of cell in coiled form and is approximately two meters long. The coiled structure is called as chromosome. Every Cell in the human body has a nucleus except Red Blood Cells. Inside the nucleus there are 23 pairs of chromosomes. Out of these 22 pairs are autosomal chromosomes and one pair is sex chromosome. The DNA polymer is made up of two chains in double helix -two strands twisted around each other formation of polynucleotide and carry linearly arranged genetic units. The DNA stores all the genetic instruction pertaining to life, development, growth, and reproduction of a life form. The DNA, is a macromolecule. It is a polymer consisting of a very large number molecule[8]. The basic components of DNA are R-D-2-deoxyribofuranose, phosphoric acid, 04 Nitrogenous bases i.e. 'Adenine' also referred as 6-aminopurines or 'A', 'Guanine' also referred as 2-amino-6-oxypurine or 'G', 'Cytocine' also referred as 2-oxy-4-aminopyramidine or 'C', 'Thymine' also referred as 5-methyle-2, 4-dioxypyrimidine or 'T'. In the double Helix formation 'A' of one strand always pairs with 'G' of other

[8] Justice K Kanan, *Modi a textbook of Medical Jurisprudence and Toxicology*, 420 (LexisNexis, Gurgaon, 25th, 2016)

strand and 'C' pairs with 'T' of another strand[9]. The repeated unique layout of A T G C Nitrogenous bases defines individual traits like height, sex, skin colour, hair colour etc. The Chromosomes in human DNA have regions which repeat in unique pattern to that individual.

Fig 2.2.(a) Reference sketch of Chromosome and DNA



3. **Standard Operating Procedure for Crime Scene Investigation for DNA Based Evidence** The first step in obtaining DNA based evidence is to undertake proper and effective crime scene investigation. The Directorate of Forensic Science Services, Ministry of Home Affairs, Government of India has promulgated Standard Operating Procedures (SOP)[10] for Crime Scene Investigators (CSI) to collect physical, biological, chemical and

[9] Deoxyribonucleic Acid(DNA) Fact Sheet, *National Human Genome Research Institute, available at https://www.genome.gov/about-genomics/fact-sheets/Deoxyribonucleic-Acid-Fact-Sheet (Last visited on 31 Mar 2023)*

[10] Directorate of Forensic Sciences Services, Ministry of Home Affairs, Govt. of India, CGO Complex, Delhi, "Standard Operating Procedures for Crime Scene Investigation" (2022)

digital evidence without destroying and changing its characteristics. Additionally, the SOPs ensure no relevant witnesses are overlooked.

The investigating agencies and forensic experts handling the biological-DNA evidences must follow proper protocol and procedures. The Supreme Court in the case of **State of Uttar Pradesh V. Satish**[11] upheld the principle that for the Forensic evidence to be reliable and admissible, the forensic expert should have followed proper procedures and protocols. In the above case the trial court had acquitted the accused of charges of murder under section 302 of I.P.C. The victim had died of burns, the prosecution had made a case that the accused husband had strangled the women and burned to kill and destroy evidence. The prosecution used chemical forensic examiner's report to prove presence of kerosene in victim's body. The high court had upheld the acquittal. The Supreme Court during the appeal held that Forensic Examiner's report does not inspire confidence as the forensic evidence has not been acquired through proper procedures. The chemical examiner in the case had failed to follow established protocols and procedures for extraction, testing and identification. Additionally, the chemical examiner had failed to undertake preliminary test to identify and eliminate possibilities of contamination.

In **State V. Santosh Kumar Singh**[12], in a case of rape and murder, the Division Bench of the Delhi High Court appreciated the chain of custody of the forensic evidence of the case, and reversed the judgment of the trail court, leading to conviction. The Appellate Court held the following: -

"….48. The next question that engages us is whether the DNA test conducted was proper. It is in evidence of Dr. Lalji that the method used and the test conducted in determining and arriving at the conclusion were done as per standard practice as also per scientific technology suitable for such tests. The trial court has elaborately introduced its learning based on literature which, to a large extent, was never even put to the expert witnesses and even otherwise there is no positive evidence on record to show that the test so conducted by the experts were perverse and/or not in keeping with the standard scientific methodology …….

….49. Another interesting argument raised by learned counsel was that DNA test is reliable to the extent of 99.3 percent which he supported from the evidence of the experts named above. In other words, he wanted to create a doubt that there is a possibility of the respondent being one amongst 0.7 percent of the persons whose DNA might match. We have given our serious

[11] (2005) 3 SCC 114.

[12] (2006)8 AD(Delhi)429: (2006)4 LRC 229

consideration to this aspect as well but found that the possibility is so remote that it need not detain us further. However, we are not basing our judgement and conclusions merely and solely on the results of the DNA test but have taken other highly incriminating circumstances into consideration as well. ……

….53. From the overall analysis of the circumstances that have been discussed above and held to have been proved beyond any doubt by unimpeachable evidence, we are of the view that those circumstances form a chain so complete which leads us to the only conclusion that it is the respondent Santosh Kumar Singh who had committed rape upon the deceased and then murdered her….”

It is clear that to establish proper chain of custody of evidence the established protocols and procedures must be followed to make DNA based evidence admissible. Some of the primary measures that need to be implemented in crime scene investigation are:-

3.1. **Identifying threat** Identify if there is any threat of chemicals, radiation, explosives to responders or investigators, including threat to evidence at the crime scene. This step has to be followed by attempts to mitigate the risk.

3.2. **Isolating and securing crime scene** Isolating and securing the crime scene to maintain integrity and to prevent contamination and destruction of biological evidence. An investigator may establish perimeter at the crime scene to control unwanted access by passers-by, press and media, and from curious onlookers by use of police line tape. The investigators may themselves like to wear hand gloves and face mask and head cover to prevent crime scene being contaminated from their own biological traces.

3.3. **Preliminary survey** Preliminary survey of the crime scene is done by Investigating Officer to establish initial crime scene perimeter, to identify entry and exit points of responders and investigating team to access the crime scene, recording of all items found, identifying perishable evidences, to identify what kind of documentation is required, photography, to reconstruct origin and sequence of events, taking statement of witnesses. While investigating a case of murder or suicide as far as possible a doctor should accompany the police at the scene of crime. The doctor should inspect the surroundings and look for unusual items that can help in DNA profiling of the suspect and victim like hair, saliva-semen stain, fibre, piece of cloth, wood, metal, glass etc.

3.4. **Contamination controls** The contamination of biological samples is prevented by using scientific tools. The

disposable material must be used for collection and storing of biological material. The use of personal protective equipment prevents contamination of crime scene by Investigators own traces. The promulgated entry-exit routes for personal are adhered.

3.5. **Documentation** The Investigating officer of the police station in jurisdiction shall undertake the documentation of the entire crime scene investigation, items collected from the crime scene, he will make permanent records. He will record all the videography, crime scene sketch with measurements, photography. The notes and report created by the Investigating Officer shall be created in chronological order and shall have no opinion, conclusion or analysis but plain statement of facts[13].

3.5.1. **Crime Scene Sketch** The crime scene sketch is made roughly, but in heinous crime the sketch is made to scale in proportionate dimensions as far as possible. The sketch should catch as much detail as possible without missing out on important facts, including making of north direction. It is also important that sketch as details such as title of the case, name, time date, signature of Investigating Officer. The sketch should mark exact position of two permanent fixtures, major articles, blood stains, exhibits etc.

Fig 3.5.1.(a) Reference sketch of crime scene

[13] Justice K Kanan, *Modi A Textbook of Medical Jurisprudence and Toxicology* (LexisNexis, Gurgaon 25th edn, 2016)

3.5.2. **Photography** The Photography should include dead body, injury marks, surrounding locations, Locations of stain of body fluid, skin tissues, organs etc. Afar as possible the photograph must be taken from straight above to avoid angular distance distortion. The photograph should capture every relevant evidence detail which has relation with the crime. The photographs of weapon for murder and blood stain pattern must definitely be taken.

3.6. **Searching the Crime scene for DNA evidence** After securing the crime scene and preliminary survey the Investigating officer must undertake the search of the crime scene. It is important that crime scene is searched in an orderly manner so that any area in the crime scene is not missed out, and unnecessary time is not wasted in going over the same area again and again. It is important a crime scene search pattern is adopted. The Directorate of Forensic Sciences Service has promulgated the following types of search pattern for crime scene[14]:-

3.6.1. **Line or strip method** This method is useful for outdoor and large areas. Here a searcher starts walking from one end of the crime scene and walks in straight line to opposite end and then turns around and returns in straight line.

3.6.2. **The Grid Method** Best of large crime scenes such as park, field, farm etc. The large crime scene is divided into grid and search from one end to another end is done by the searcher in vertical and horizontal axis in 2D plane.

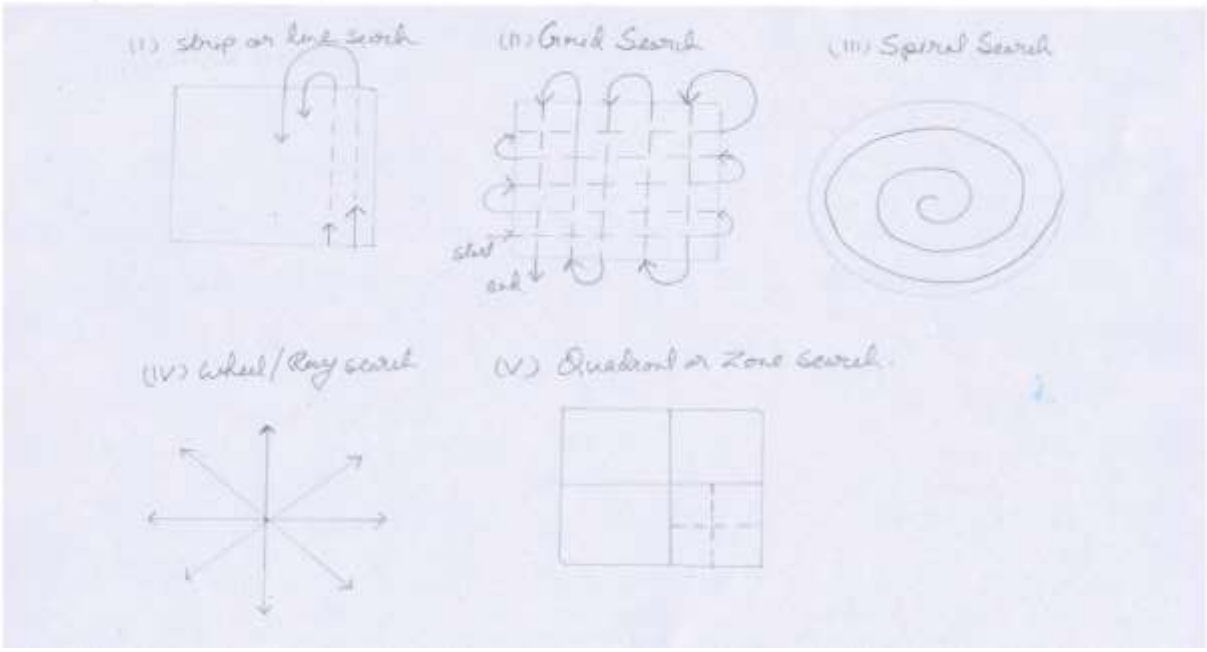
3.6.3. **Wheel or Ray method** Here the circular perimeter arc around the crime scene is created. The searchers gather at the centre and start searching in radially outward direction.

3.6.4. **Spiral method** This kind of search is done when the search area is large and there are no barriers in the crime scene such as an open field. The searcher starts from the centre of the search area and spirally moves outward in the form of expanding circle.

3.6.5. **The Zone method** This search pattern is considered most effective for closed spaces such as building and apartments. Here the crime scene is divided into quadrants or zones and then searched using any of the previously defined method.

Fig 3.6.5. (a) Search Pattern of crime scene

[14] Directorate of Forensic Sciences Services, Ministry of Home Affairs, Govt. of India, CGO Complex , Delhi, "Standard Operating Procedures for Crime Scene Investigation", 3-4 (30 Jun 2022)



3.7. **Packaging and storing the biological evidence recovered from crime scene for DNA profiling** Not only at the crime scene but damage and contamination of biological-DNA evidence can occur owing to improper packaging and storage of the physical evidence recovered at the scene of crime. Damage might be caused to biological material like skin or organ tissue, blood, body fluids which get quickly perished if not handled carefully in heat, moisture, sunlight etc.

The Directorate of Forensic Science and Services has recommended that biological samples should be stored air dried in paper bags/ envelopes to prevent deterioration. The following necessary measures must be adopted for packaging and storing of biological samples[15]: -

(a) The collected evidence should be sent to laboratories at the earliest within 24 hours.

(b) Searchers should wear gloves, must not use any preservative, and use clean surfaces.

(c) Cross contamination of objects from scene of crime should be avoided.

(d) Moist and wet biological item should not remain in plastic pouch or paper container for more than two hours. The item should be air dried and should not be subjected to heat or sunlight for drying.

(e) Preservatives like formalin should not be added to preserve biological samples.

[15] Directorate of Forensic Sciences Services, Ministry of Home Affairs, Govt. of India, CGO Complex, Delhi, "Standard Operating Procedures for Crime Scene Investigation", 6-15 (30 Jun 2022)

(f) Every item collected should be separately packaged and should be labelled, and must have details such as FIR number, section, name of Investigating Officer, date, police station, State and district.
(g) The forwarding officer must sign each package.
(h) All the packages of a case must be encompassed in one box or outer covering.
(i) The dispatching officer must ensure that all the parcel are sealed and items in the parcel cannot be accessed without breaking the seal.

Table 3.7.1. Precaution and packaging of biological evidences

Sr. no.	Item	Precautions
1	Blood and Blood stains	Sample blood from pool of blood in liquid form should be collected using clean sterile cotton cloth of gauze pad, which should be air dried at room temperature under adequate ventilation. It must be packed between clean white paper and put in paper envelop thereafter. Drying heat or sunlight must be prevented. If the blood is found on earth -one inch depth of blood-soaked earth is collected. If blood stains present in nails, the nails should be clipped without causing tear in the skin.
2	Fresh moist blood stain on cloth, sheet, blankets	Dry the stains in room temperature. The dried stain must be inserted between clean white paper and sealed in paper envelop thereafter.
3	Fresh moist blood stain on solid objects	The stain must be collected on gauge pad or filter paper and must be allowed to dry in shade and room temperature. It should thereafter be packaged in paper envelop.
4	Dried blood stain	(a) In case of dried stain on clothing, sheets, blanket the entire clothing should be sent to laboratory, protect stain with white paper and send in paper envelop. (b) In case of stain present on small solid object, the same must be packed in paper envelop, labelled and sent to laboratory. (c) In case the dried stain is present on large solid body, the same may be scrap. The stain may be scraped using freshly washed and dried knife. Separate tool must used for different stain. The scraped must be packed in paper envelop.
5.	Semen	The seminal stains are usually found in blankets, clothing's, bedsheet. The stains may be air dried in room temperature. the stain marks are to be marked with red pencil. The item containing the stain is to be packed in paper bag. Plastic bag is to be avoided.

6.	Saliva	(a) The control sample from victim or suspect should be taken in sterile plastic/glass container, kept in freezer and sent to lab immediately. (b) In case the saliva is found on the crime scene on an object, the object itself must be sent to laboratory.
7.	Bones and teeth	The teeth and bones recovered from debris must be cleaned and washed and thereafter dried. They must be rolled or packed in brown paper and sealed in cotton cloth or card boxes. Completely burned bones are not good enough for DNA analysis. The order of preference for bones should be: (1) Femur (2) Tibia (3) humerus (4) molar teeth (5) Ribs.
8.	Hair and Fibres	(a) Hair and fibres should be picked with forceps (b) Pubic hair should be collected from victim and cut close to skin. (c) Control sample from both victim and suspect should collected, and cut close to skin. (d) Hair and fibres stuck in blood, clot or object should be sent to laboratory as a whole with object. (e) Hair collected should be placed in cellophane, glazed surface, blotting paper, filter paper. This should be folded along the length of exhibit and enclosed in container.

4. **Receiving and processing of evidence specimen by Forensic laboratory** As soon as the sample evidence exhibits are received by the forensic laboratories the following task must be undertaken[16]:-

(a) The chain of custody of case parcels is ensured, and it is checked weather the parcels have been received in sealed condition.

(b) The completeness and record discrepancies of inventory is checked for each container.

(c) The plastic tags with serial number are compared to the serial numbers written on the chain of custody.

(d) The examined sealed parcels must be stored in dedicated storage area.

(e) The forensic examiner must wear hand gloves mask and cover his head all throughout the examination of evidence exhibit.

(f) The examiner must exercise handling care and avoid excessive movement of clothing articles so as to prevent spread of airborne contaminants.

[16] Directorate of Forensic Sciences Services, Ministry of Home Affairs, Govt. of India, CGO Complex, Delhi, "Standard Operating Procedures for Crime Scene Investigation", (30 Jun 2022)

(g) Integrity of the evidence should maintain and cross contamination, mixing or deleterious changes should be prevented while receiving, storing and handling of evidence.
(h) A unique identifier number / item description should be used to label each DNA test sample, this must be documented along with photo/video.

5. **Policy of storage and examination of evidence exhibit at forensic laboratories**[17] A forensic examiner carries out general examination of evidence exhibit from the time evidence exhibit is received by the Forensic laboratory till specific test is carried out on biological evidences. As a Forensic examiner one has to work with a mindset that if there is a crime committed there ought to be evidence left somewhere. He has to use his imaginations and guess work to analyse what could possibly provide the best source of evidence in a given situation. The SOP, experience, intuition and gut feeling of an individual forensic scientist undertaking the test, comes to his aid in making his decisions. The forensic examiner is required to observe, detect and identify a clue. The Examiner has to weigh the potential value of the clue vis-à-vis deterioration, make records of the clue, individualize and isolate the clue material. The examiner may be required to undertake screening test for identifying biological fluids such as blood semen, saliva, vaginal fluids etc

The first decision that a forensic examiner needs to take is to decide whether he should undertake the examination biological evidences now or later when it is feasible to undertake. The property of many evidences including that of chemical, and biological nature are such that the evidence may deteriorate very fast. In that case it is important that the examination is immediately undertaken. However, if the examiner chooses to undertake examination later he must decide on appropriate storage, sealing and refrigeration mechanism to preserve the evidence exhibit so that it remains suitable for examination later without being cross contaminated or is deteriorated. Some important points to consider during storage and examination of biological evidences are as following[18]:-

(a) Analyst must wear gloves, disposable sleeves, mask, or pexi glass shield specially when working with low- level DNA sample.
(b) All items coming into contact with biological samples must be discarded like plugged pipette tips, discard tips. Items such as scissors, scalpels, sampling handle tools sufficiently cleaned to prevent cross contamination.

[17] Central Forensic Science Laboratory Chandigarh, "Working Procedure Manual Forensic Biology- 2019" (2019)
[18] Central Forensic Science Laboratory Chandigarh, "Working Procedures Manual Forensic DNA Testing-2019" , 4-6(2019)

(c) DNA samples shall be stored in appropriate temperature to increase shelf life and prevent degradation.
(d) DNA Analyst should note and record in laboratory quality log book about inadvertent deleterious changes (loss, mixing, contamination), including corrective action taken. The DNA Technical Manager should be notified.
(e) Extracted and amplified DNA of convicted offender shall be destroyed upon completion of typing.
(f) Standard operating procedures should be followed for preparation of reagents used in testing biological samples in laboratory. The quantity and lot number of reagent shall be recorded in Laboratory's Reagent preparation log book. The reagent shall be labelled with identity of reagent, date of preparation, batch, expiration date, initials of individual preparing the reagents.

6. **General guidelines and precautions for forensic examination**[19] The Central Forensic Science Laboratory, Chandigarh under DFSS, Delhi has promulgated general guidelines to be followed by forensic examiners: -
(a) The forensic examiner should identify the biological samples during preliminary screening.
(b) All chemical reagents that will be used for scientific examination of the exhibits should be checked for quality-controlled test.
(c) The Laboratory supervisor should assign case number to all exhibits received. He should compile all relevant documents. The supervisor should compare each document with specimen received and the manifest to ensure all specimen designated of forensic laboratory have been received.
(d) The laboratory supervisor should screen documentation relevant for forensic biology cases (FB). The request for Forensic Biology test should only be made either through Investigating Officer or order of the court.
(e) The Forensic examiner should review all documents and information provided and determine what are the crucial aspects that needs to be answered. Assistance of colleague or supervisor should be taken by the examiner to in case of any difficulty or complication arising in the case.
(f) Certain evidence exhibits may have higher potential for informative and investigative value. It may be important that serologist examines them first. This would require planning the approach to the case.
(g) Before the examination, the examiner must prepare his work area. The examiner must ensure that his work area is clean and free from possibility of contaminating or damaging the exhibits. To inspect large item like bedsheet large workplace table must be selected. Adequate lighting for improved visibility and inspection,

[19] ibid

conveniently placing of tools and reagent should be ensured. The workplace table should be covered with white paper so that small particles relevant for evidence are not lost. Supplemental lighting should be available. The examiner must ensure notepad, observation sheets are available to record his observation. Low power magnification should be available to assist in observation.
(h) The examiner should wear a lab coat during the examination process over his clothing to protect from contamination.
(i) The exhibit like bedsheet or clothing should be carefully spread over workplace bench and the examiner may draw a sketch of object to describe location and size of stains. Stains are given number and letter designation. Detailed drawing is generally providing more information to interpret result. The stains on the exhibited evidence should be marked so that it can be easily located later. The crusty and flaky portion of the stain must be scraped with scalpel and preserved paper packet, and the exhibit should be handled carefully.
(j) The general examination should be carried on till the exhibit have been thoroughly searched for material that has evidence value. If such material is found the analysis of sample should be done, and the rest of the object repackaged for storage.
(k) All parcels and exhibits must be video-graphed and photo-graphed.
(l) Evidence exhibit must be initialled by the examiner with laboratory case number, date and exhibit number.
(m) Photography of the crime scene and every relevant aspect and item.
(n) Drawing of Crime scene sketch with relevant scales if possible.
(o) Collection, packaging and preservation of evidences collected from the crime scene. This may involve proper scientific techniques to be adopted, including help of expert to extract the evidence. The evidence collected has to be packaged appropriately and marked suitably.
(p) Table top whitepaper covering, hand gloves, contaminated glassware must be put in plastic bags sealed and marked as contaminated and hazardous and discarded.
(q) All biological and physical evidences for DNA testing must be stored in secure areas such as lockers, locked refrigerators till they are returned to investigating/submitting agencies. Historical work products such as bloodstain cards, stain cuttings, microscopic slides, DNA extract etc shall be retained for post - conviction DNA investigation or for possible cold cases.

7. **Minimum facilities in DNA Forensic laboratories** The Central Forensic Science Laboratory, Chandigarh has promulgated standard guidelines regarding minimum facilities that should be made available in DNA Forensic Laboratories[20]. The DNA

[20] Central Forensic Science Laboratory Chandigarh, "Working Procedures Manual Forensic DNA Testing-2019", 3-4(2019)

laboratories should have restricted access, and accessible to limited person only. Laboratories should be adequately secured. The laboratories should be facilitated with evidence storage vault, locked refrigerators/ freezers, lockers for personal evidence.

There should be separate room in the laboratory in DNA section in which evidence examination, DNA extraction, real time PCR, amplified DNA product, PCR setup could occur in separate times and in separate spaces. Single room should be dedicated to robotic workstation for analysis through amplification in initial evidence examination and DNA extraction and quantification. The Robotic workstation should undergo appropriate validation with documentation. The laboratories shall have DNA Lab cleaning logbook which shall record procedures for cleaning record and equipment maintenance. There should be clear guidelines and written procedure for cleaning and decontamination of laboratory equipment and facilities.

8. **DNA Profiling** The testing of DNA based evidence involves several steps, the first being collection of biological samples such as blood, semen, skin tissue, hair, saliva etc from the crime scene, the DNA present in all these sample is same. Second step, the DNA is extracted through scientific processes from the biological sample collected from the crime scene. To do that the DNA is amplified through a process called Polymerase Chain Reaction (PCR) using PCR Multiplex kits, which enables the forensic examiner to create multiple copies of the DNA by amplifying the regions of DNA which is known as Short Tandem Repeats (STR) so as to characterise the extracted DNA from biological samples, this enables an individual to undertake various analytical test. Numerous STR loci along with portion of Amelogenin gene which is located in Y and X Chromosome gets simultaneously amplified owing to Multiplex PCR kits. "The amplified fragments based on their sizes are separated by capillary gel electrophoresis using the Genetic Analysers, detected by laser excitation and subsequent emission spectra are captured by a charged coupled device (CCD) Camera".[21] The data resultantly received is depicted in the form of 'electropherogram' comprising of coloured peaks in relative fluorescent units (RFUs) and scan number. It is now possible to analyse much degraded sample in quality or small quantity of sample with improvement of technology. The Forensic DNA fragment analysis enables the forensic laboratory to generate DNA profile which can be compared to DNA profile of suspect or family members of victim or the suspect. The statistical methods are applied to figure out the probability of DNA profile repeating in general population. The additional autosomal or Y chromosomal STR loci if available, provide significant benefits in tasks such as human identity/ relationship testing.

[21] Central Forensic Science Laboratory Chandigarh, "Working Procedures Manual Forensic DNA Testing-2019", (2019)

9. **DNA Analysis and Laboratory Reporting** The DFSS STR analysis procedures manual guides storage of extracted DNA work. The case notes shall record deposition of extracted DNA if stored or otherwise from reference items. The case notes and reports shall describe which item(s) returned contains DNA extract, if possible, packaging of the evidence shall have label indicating DNA work product enclosed. The permanent case file of the case submitted for DNA analysis shall record the following details[22]:-

(a) Request for laboratory Examination Form (RFLE) for samples.
(b) documentation for examination, worksheet to describe flow of sample such as sample amplification, description, reagent date, reagent lot number, traceability, testing dates etc.
(c) Estimation of quantity of DNA recovered.
(d) Digital data of analysis using robots, including photographs etc.
(e) Population frequency calculation, or datasheet.
(f) Technical reviewers initial and date
(g) Final laboratory report- case identifier, description of evidence examined, Loci, tested description of methodology, results and conclusion.
(h) DNA analyst may peer review all case files. Peer review checklist may be retained in the case file.

It is important that all laboratory equipment is calibrated. If any equipment has undergone a repair, it should be tested for performance after calibration.

10. **Expertise and training of DNA forensic scientist** It is important that person handling DNA based analysis of the exhibit is adequately qualified and in know of the scientific methods involved and SOP promulgated. He may also be called in to testify before the court as a witness or expert.

As per the section 45 of the Indian Evidence Act[23] the definition of expert is as following: -

"…45. Opinions of experts. When the Court has to form an opinion upon a point of foreign law, or of science, or art, or as to identity of handwriting or finger-impressions, the opinion upon that point of persons specially skilled in such foreign law, science or art, or in questions as to identify of handwriting or finger-impressions are relevant facts. Such persons are called experts….".

The section 46 of the Evidence Act provides that "Facts, not otherwise relevant are relevant if they support or are inconsistent with the opinions of experts, when such opinions are relevant. "

[22] Central Forensic Science Laboratory Chandigarh, "Working Procedures Manual Forensic DNA Testing-2019", 15-16 (2019)
[23] The Indian Evidence Act, 1872(Act 1 of 1872)

The Supreme Court in **Najib Singh V. State of Punjab**[24] has held principally that forensic expert must have adequate experience, qualification and training which can be relied on for evidence value. In this case the expert testimony on the X-Ray report of the skull injury was questioned by the counsel whilst referring to Modi's Medical Jurisprudence. The court opined that the expert only had 11 months of experience, with no special training or education on radiology, and hence he could not be considered as an expert in accordance with section 45 of the Indian Evidence Act.

In the case of **State of UP V. Satish**[25] the Supreme had remarked and opined that experience, integrity and qualification of Forensic expert is a pre-requisite and important criteria to adjudge whether forensic evidence is admissible.

The Supreme Court in **Sunderlal Vs. The State of Madhya Pradesh**[26], **Bhagwandas Vs. The State of Rajasthan**[27], has held that findings and conclusions arrived at by an expert witnesses may not be set aside by a court simply by making a reference to some text/literature/book, without confronting the expert with them, and seeking expert's opinion on it. In **Gambhir v. State of Maharashtra**[28], it was held by the Hon'ble Supreme Court that the court should not usurp the function of an expert witness by creating its own conclusions contrary to the one given by the expert.

All the scientist in DNA Division, Central/ State forensic laboratories are required to have following qualification[29].

Ser	**Duties/ responsibilities**	**Qualifications**
1.	Forensic scientists in DNA divisions	Master's degree in Zoology, Botany, Anthropology, Human Biology, Forensic science, Biotechnology, Microbiology or Bio-Chemistry.
2.	DNA Technical Manager	(a) Master's degree in biology -related areas. and (c) Should have completed Master's course work in the area of biochemistry, genetics, molecular biology, statistics or population genetics. And (d) Minimum two- or three-years' experience as a Forensic DNA Analyst. (e) Completed NABL auditor training.

[24] 1987 S.C. Cr. R. 25 at p.27
[25] (2005) 3 SCC 114
[26] (1954) AIR(SC)28: (1954) CriLJ 257
[27] (1957) AIR (SC) 589: (1957) AllLJ 722
[28] (1982) AIR(SC)1157: (1982)2 BCR 471
[29] Central Forensic Science Laboratory Chandigarh, "Working Procedures Manual Forensic DNA Testing-2019" , 1 (2019)

3.	DNA Manager	(a) All minimum qualification of DNA Technical Manager. And (b) Minimum 03 yrs experience as a Forensic DNA Analyst along with court testimony. (c) Desirable to have working knowledge of computers, database management, networks.
4.	DNA Analyst	(a) All the minimum qualification of DNA Manager. (b) Completed course work (Post Graduate level) covering the subjects training in statistics/ Population Genetics as applied to Forensic DNA Analysis, biochemistry, genetics, molecular biology. (c) Minimum 02 yrs of forensic DNA Laboratory experience. (d) Minimum 06 months experience of forensic serology laboratory experience prior any independent serology screening and reporting on casework samples. (e) Must be aware of development in the field by reading latest scientific research papers, literatures, attending seminars/ workshops, professional meetings.
5.	DNA Supervisor (Supervising Forensic Scientist) SSO (Scientist-B)/AD (Scientist-C)	(a) Forensic Laboratory requirements for forensic scientist. (b) Minimum 3 years' experience as forensic scientist in forensic biology. (c) JSO/SSA i.e. Junior technical staff should have 03 yrs full-time paid technical experience in a forensic laboratory out of which two years should be of performing analyses of physical evidence. (d) Responsible for maintaining all records of training for analysts. (e) Must under go proficiency testing twice a year.
6	Laboratory technician	(a) Should be qualified to prepare Reagents (b) Trained in Perform Quality checks on reagent, lab equipment, instruments and DNA kits. (c) Trained in Documentation procedures (d) Should be authorized by Lab Manager or DNA technical Manager, however he will not process evidence or do casework.

It is important that training of the scientist involved in DNA forensics includes training in handling of biological evidence, and must have undergone inhouse Chemical Analysis Training Program, STR Training program and Serology Screening Training. All staff members in the DNA Forensic Analysis involved in serology testing are to undergo semi-annual proficiency testing bi-annually. Additionally, inhouse training and formal course work must include following areas for DNA scientist before undertaking examination and identify biological evidence for DNA case work: -

(a) Court testimony and Court demeanour

(b) Documentation and reporting procedure
(c) Safe lab practices.
(d) Serology screening methods for various body fluids including their mixtures.
(e) Quality assurance systems & methods and DNA quality control.
(f) Calibration, maintenance and operation of laboratory equipment.
(g) Statistical analysis and interpretation of DNA STR results.
(h) Qualitative and quantitative analysis of DNA test.
(i) Electropherogram interpretation.
(j) Acceptance policies of DNA case.
(k) Mixture Interpretation Training and DNA trouble shooting.

11. **Relevant statutes and Judicial trends on DNA profiling** The DNA profiling has now become part of statutory scheme after criminal amendment Act 25 of 2005. The section 53 of the Cr.P.C.[30] provides that a police officer not below the rank of Sub-Inspector can request the medical practitioner to examine the arrested person to afford necessary evidence if the person has been arrested on charge of commission of an offence and such medical examination can provide evidence related to the crime.

Further section 53A of Cr.P.C. further provides that in cases of rape or attempt to rape, a medical practitioner acting on the request of police officer of rank sub-Inspector and above shall medically examine the arrested person, including by use of force if necessary to prepare medical report which shall include details about nature of sample taken for DNA profiling.

The section 54 of Cr.P.C. provides guidelines for examination of arrested person including women by medical officer in the service of Central or State government. If the arrested person is a female the medical examination must be done by or under supervision of female medical officer or registered female medical practitioner.

The hon'ble Supreme Court in **Selvi and ors. V. State of Karnataka**[31] while addressing the issue of legal validity of modern scientific techniques such as Narco- Analysis, polygraph examination and BEAP etc held that: -

"….147. The contentious provision is the Explanation to Sections 53, 53-A and 54 of the Cr.P.C (amended in 2005) which has been reproduced above. It has been contended that the phrase 'modern and scientific techniques including DNA profiling and such other test' should be liberally construed to include the impugned techniques. ….."

The section 164A of Cr.P.C. provides for medical examination of victim of rape by a registered medical practitioner in a hospital run by government or local authority or any other registered

[30] Code of Criminal Procedure, 1973 Act 2 of 1974)
[31] (2010) 7 SCC 263

medical practitioner. The medical examination of the victim has to be undertaken within 24 hours of receiving information of commission of crime with her consent. The section provides for collection of samples from victim for DNA profiling. Further the report prepared by the medical practitioner shall be forwarded to investigation officer who shall forward it to Magistrate.

In **Mukesh and Ors V. State (NCT of Delhi)**[32] in para 216 and 217 the Hon'ble Supreme Court upheld the importance of DNA evidence. The court held as following:-

"…..216. In our country also like several other developed and developing countries, DNA evidence is being increasingly relied upon by courts. After the amendment in the Criminal Procedure Code by the insertion of section53A by Act 25 of 2005, DNA profiling has now become party of the statutory scheme. Section 53A relates to the examination of a person accused of rape by a medical practitioner.

217. Similarly, under section 164A inserted by Act 25 of 2005, for medical examination of the victim of rape, the description of material taken from the person of the women for DNA profiling is must. …."

11.1 **Principle of best evidence** The investigating agencies must strive to obtain best form of biological sample to use as DNA based evidence if possibility exist. Most of the time the biological samples that can be obtained from the scene of crime of handled scientifically and carefully provides the best form DNA based forensic evidence. Failure to extract and use best form of evidence when the possibility exist can be fatal to the case. That in an appeal case **Rajbir and another V. State of Haryana**[33] the Punjab and Haryana High Court failed to place reliance on Memo containing the disclosure statement of the accused, and stated that the FSL team failed to collect the earth of the pit where the body of the victim was buried and was a best source of DNA based evidence. The same could have been sent to DNA expert along with DNA of the relative of Kusum to find a match. That such an omission is grave. That only DNA test of the earth could have confirmed the fact that after commission of the crime Kusum was buried there. Thus, no reliance on memo was placed by the court.

11.2 **Clear and unambiguous evidence of presence or absence of DNA** For the court to come to just conclusion about innocence or culpability of an accused in a crime, the DNA report must be clear or unambiguous about presence or absence of the accused's DNA at the scene of crime or in the sample obtained.

[32] 2017 ALL MR(Cri) 2448
[33] (2022) 4 LawHerald 3337

The In **Hari Dobal V. State of Uttarakhand**[34] The single bench of the Uttarakhand High Court granting bail in favour of the Appellant-accused, an army man held that: -

"…prosecutrix was raped by appellant in a house, which was under construction, however, no external or internal injury was found on the body of the prosecutrix during the medical examination; DNA Report does not support the prosecution case; there are material contradiction in the statements of the prosecution witnesses, there are substantial doubt regarding the conviction ……".

In the case of **Harishchandra Sitaram Khanorkar V State of Maharashtra**[35], the Division bench of dismissed the appeal of the accused and upheld offences under 376(2)(f)(j)(i)(n) of IPC. The victim a young juvenile girl uses to stay with accused and use to call him brother. Victim girl had no father and mother had re-married. During a medical check-up it was revealed that when victim was 7 months pregnant and the victim revealed that the accused forcibly committed sexual intercourse with her. The court after analysing the DNA report and expert testimony opined that: -

"…..The prime evidence on which prosecution relied upon is the scientific nature in the form of DNA report. Evidence of PW-5-Amulya Amol Pande who is the assistant Chemical Analyzer reveals that he is expert in analysis of DNA profile as he conducted analysis of DNA profile in more than 800 cases. He had undergone special training for DNA profile. The accuracy of DNA results is 100%. On 05/12/2013, he received the requisition letter along with the DNA kit. Prior to that requisition was received for obtaining the DNA kit from Hudkeshwar police station. On 06/12/2013, the DNA kits containing the samples are received in the office which were duly sealed along with the forwarding letter Exhibit 85 with identification forms exhibit 82 to 84. Accordingly, 16 different are performed and the analysis was made by applying PCR (Polymers Change reaction) test. As per the said report, victim and the accused are concluded to be biological parents of baby delivered by the victim. ….

….17. During the cross-examination of DNA analyser attempt was made to elicit that he had not obtained any special training. He admitted that the person who is M.Sc. (Chemistry) can perform DNA test and special training is required for DNA Test. PCR is advanced test/technique. During cross-examination he narrated entire method which is applied by him that he examined 16 STR locus in DNA samples. He personally had extracted DNA from blood samples and extracted the DNA from

[34] Criminal Appeal No. 142 of 2022 Bail order dated 20-12-2022.
[35] (2023) ALLMR(Cri)151: (2023)1BomCR(Cri)51

blood by Robotic method and prepared the report. It was suggested that the result of DNA may get affected if the analyst suffering from cold, fever or other infections which is admitted by PW-5 further reveals that the extracted DNA from blood samples and done its amplification by PCR method. He obtained electro pherogram by electro phoresis on genetic analyser. Thereafter he compared the profile and lastly prepared the report. Though arduous cross-examination was taken nothing incriminating is brought on record. …."

12 **Limitations of DNA profiling** The DNA profiling can suffer from following types limitations: -

12.1. **Complexity of task** The DNA profiling though can yield high results, is technically complex. Mistakes can crop in any stage of the 07-step process and produce false results. Thus, the competency of scientist involved in laboratory work and laboratory procedures must remain open for scrutiny.

12.2. **Inadequate DNA available for test** In many cases the DNA available for testing isn't adequate in quantity or substantially degraded resulting in poor DNA test results. It is also possible that DNA stored gets damaged due to proximity or presence of chemicals, or improper storage. If the first test goes wrong, there isn't usually adequate DNA substance available to conduct second set of tests.

12.3. **Contamination of DNA and Laboratory errors** The DNA can get contaminated owing to presence of bacteria, other microorganisms, other body fluids. Contamination can also be caused by blood or saliva traces of handlers. Or handling/ storing sample in improper temperature, mixing of samples, If the DNA sample gets contaminated, the contaminant will also get amplified in PCR. As per a research paper published in Netherlands[36] The overall accuracy level of the DNA based testing is 99.8%, and the DNA testing has acquired the status of Gold Standard in forensic sciences, the forensic laboratories continue to suffer from lack of transparencies. The errors have never been published in detail level, including details pertaining to laboratory failures and contamination.

12.4. **Vested and financial interest** There are vested institutional interests in getting new methods of DNA profiling accepted by the courts. The statistics of outcome may have been inflated.

12.3. **Population Genetics Error** The population genetic error refers to statistical probability that a particular DNA Profile can

[36] Ak Marjan Sjerps, A Quak, 'Error Rates in forensic DNA Analysis: Definition, numbers, impact and communication', *Forensic Science International: Genetics* (2014).

repeat itself in a specific population race. It is important to ascertain this frequency before adjudging the biological sample match with the accused. DNA database of various Human Races, smaller communities and sub cultures, and changes arising owing to intercommunity marriage may upset the data base[37].

12.4. **Statistical and Research methodology biases[38]** Any statistical analysis or research is prone various methodological errors such as statistical variation, Interpretation errors, mental biases, presentation of complex scientific data etc.

13. **Conclusion** The DNA based forensic test has a high probability success rate in identifying the suspect or victim even with much degraded sample recovered from crime scene using PCR methods. The methodological following of standard operating procedures for extraction, collection, testing of biological samples plays an important role in ensuring the admissibility of the DNA based evidence in the court. The collection, handling and testing of DNA based evidence must be in accordance with the established protocols and procedures, the same was highlighted in the selvi v. State of Karnataka[39]. It is an important concern in admissibility of evidence that the expert undertaking the forensic test is adequately qualified, experienced and is aware about the procedures. Inspite of high accuracy the DNA profiling too has limitations, and can the DNA suffer damage, degradation and contamination, population and statistical errors. This, require strict compliance of protocols during the chain of custody to minimise errors.

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