Chapter

DNA Finger-Printing: Current Scenario and Future

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Abstract

Linearly arranged chemical structure in chromosome is known as DNA. It is a double helix made up of two strands of genetic material spiraled around each other. Each strand has a sequence of bases. There are four types of basis namely adenine, guanine, cytosine and thiamine which are very unique to each individual just like their actual fingerprint. The nitrogen base adenine always binds with thymine and cytosine also always binds with guanine. Thus the DNA profiling unique to each individual is collectively known as DNA fingerprinting. DNA determines individuality or uniqueness of the each human being except in uniovular twins. The chances of complete similarity are one in 30 billion to 300 billion i.e. half the population of world. The technique of DNA fingerprinting was first developed by Dr. Alec Jeffery's from Britain in 1984. He discovered a minisatellite region close to the human myoglobin gene. He isolated this sequence and used it as a probe to investigate human DNA. He found that the minisatellite probe result was a complex band pattern for each individual. In India, initially it was done at CCMB, Hyderabad by Dr. Lalji Singh. Now there are various centers where DNA fingerprinting is carried out. In Maharashtra it is carried out at Sate Forensic Science Laboratory, Vidya Nagar, Kalina, Mumbai – 400 098 (Phone 022–26670755). Using this technique FBI formally concluded the participation of Mr. Bill Clinton in Monica Lewyninskey case. In India more than 79 cases have been solved by using this technique including important case of Dhanu and Shivarasan alleged assailant of Late Priminister Shr. Rajiv Gandhi, Tandori case, Madhumati murder case etc.

Keywords: DNA, restriction fragment length polymorphism (RFLP), polymerase chain reaction (PCR)

1. Introduction

Linearly arranged chemical structure in chromosome is known as DNA. It is a double helix made up of two strands of genetic material spiraled around each other. Each strand has a sequence of bases. There are four types of bases namely adenine, guanine, cytosine and thiamine which are very unique to each individual just like their actual fingerprint. The nitrogen base adenine always binds with thymine and cytosine also always binds with guanine. Thus, the DNA profiling unique to each individual is collectively known as DNA fingerprinting [1].

DNA determines individuality or uniqueness of each human being except in uniovular twins. The chances of complete similarity are one in 30 billion to 300 billion i.e., half the population of world [2].

"DNA fingerprinting", is a fingerprinting of exclusive type as there is no specific method to modify it known as it remains the same in all body parts. In every DNA of there is about 0.1% differences but among every individual person, 99.9% are identical but as the DNA sequence is just like a fingerprint [3]. It was once thought that there are many bases of nucleotide which were consuming time to detect in olden days but now scientist have introduced some techniques which were quicken in the identification process. This (DNA fingerprinting) technique is one of them it is like an individual's bar-code. DNA present in every cell of an individual person has histone proteins which are found tightly bound to the DNA present in chromosome [4]. DNA fingerprinting in Forensic Science had a tremendous impact. Forensic genetic science is an intersection between science and crime. It helps the police/judicial to aid justice. It is an important tool for court outcomes and all the serious and unsolved mystery cases. The police investigation progress clearly depends on forensic science services; Forensic genetic science in its own way requires understanding the importance, scope, and limitation of DNA fingerprinting. It made the court to accepts as pivot evidence [5–7]. When other methodologies failed, DNA fingerprinting was kept as the last resort and it played a supportive role when strong evidence in support is needed. In both at small-scale and large-scale disasters. In Criminals identification it provides an approach to the victim in an impressive way. For Victims and Criminals identification it became a gold standard. The National Laboratories of National Research Council of USA had issued on February 2009, in a Forensic Science major report showed with the exception of nuclear DNA analysis, no Forensic method thoroughly shown to have the capacity to consistently demonstrate a connection between evidence and a specific individual or source with a high degree of certainty [8–10]. Therefore, Variable Number Tandem Repeats (VNTRs) have been identified. These are non-coding sequences and do not have any regions with unravel information about genome. Absence of genetic material in these regions, hence helpful in identifying an individual person [11, 12].

DNA profiling is also known as DNA fingerprinting, Typing, DNA Genetic typing, Genetic Fingerprinting, Genotyping or Identity testing. It is DNA base pair sequence method of isolation and identification. The technique of DNA finger-printing was first developed by Dr. Alec Jeffery's from Britain in 1984 [13–15]. He discovered a minisatellite region close to the human myoglobin gene. He noticed that these minisatellites are not useful for genetic transformation as genes and have repetition. Jeffreys also documented that minisatellites have unique pattern in each person [16–19]. He isolated this sequence and used it as a probe to investigate human DNA. He found that the minisatellite probe result was a complex band pat-tern for each individual [20].

In India, initially it was done at Centre for Cellular and Molecular Biology (CCMB), Hyderabad by Dr. Lalji Singh. Now there are various centers where DNA fingerprinting is carried out. In Maharashtra it is carried out at Sate Forensic Science Laboratory, Vidya Nagar, Kalina, Mumbai – 400 098 (Phone 022–2667075).

Using this technique FBI formally concluded the participation of Mr. Bill Clinton in Monica Lewyninskey case. In India more than 79 cases have been solved by using this technique including important case of Dhanu and Shivarasan alleged assail-ant of Late Prime Minister Shri. Rajiv Gandhi, Tandori case, Madhumati murder case etc.

2. Collection and preservation of material

1. In living persons:

   i. Blood: The blood should be collected from peripheral vein with EDTA as an anti-coagulant in two tubes and should be transported to the laboratory as early as possible at −20°C [21].

   ii. Vaginal swabs/smear: It is to be air-dry and put it in clean autoclave glass/plastic container.

2. In dead bodies:

On the basis of priority all required biological samples must be taken in order as mentioned below.

   i. Skeletal muscle/Tissue: On duty doctor should collect the least putrefied part of the muscle or tissue and must send it without any delay to avoid further putrefaction [22].

   ii. Hard (Tough) Tissue: Dead bodies in which the putrefaction has already present, collect hard tissues where putrefaction rate is comparatively less. Muscle tendons, foot, heel skin, scalp skin, palm skin, stomach wall is observed to have lesser degree of decomposition [23].

   iii. Tooth: On duty doctor must send complete set of teeth present in deceased body [24].

   iv. Scalp hairs with roots: Small quantity of scalp hairs along with roots should be sent. One important precaution must be taken i.e., hairs must not be cut but should be plucked [25].

   v. Blood of deceased should be taken.

   vi. Bones: In cases of completely skeletonized bodies and if no other tissues are present, send the longer bones such as humerus, femur etc. Occasionally portion of muscle or tendon may be present on long bones, do not remove them, send it with bones as it may contain the cells where DNA traces can be detected [26].

3. Scene of crime and other important evidences:

   i. Blood stains: In homicidal, accidental or suicidal manners, blood stains present at scene of crime, scrapings of blood stain on floor, blood-stained clothes, weapons and other relevant evidences must be collected and sent for further analysis [27].

   ii. Semen stains: In sexual assault cases all wearied garments especially undergarments of both survivor and suspect, also bed garments should be collected. In addition, collect condom and other important circumstantial evidences [28].

Type of biological evidence and accurate preservatives for particular evidence:

Biological evidence	Important biological and other evidences	Preservative
Blood	a. In living, blood samples should be collected in tubes supplied by FSL [29]. b. Post mortem blood collected in clean sterile glass vial. (Samples should be kept in ice)	4% EDTA solution
Tissue/muscle piece/scalp skin etc.	Sample must be kept in clean sterile plastic or glass container add the correct preservative as suggested. (Samples should be kept in ice)	DMSO or normal physiological saline or 4% ETDA solution or keep the tissue as it is in −20°C refrigerator
Teeth	Air dry all the teeth available. Keep samples in dry clean and sterile plastic or glass container and then handover it. Must Keep any tissue stuck up to teeth as it is.	No preservative
Scalp hair	Air dry the sample, put in dry clean and sterile plastic or glass container	No preservative
Bone	Air dry and rap in clean brown paper. Do not grind it or apply any chemical on it. If the issue or tendon is stuck up to the bone keep as it is. Do not separate or disturb it.	No preservative
Blood-stained clothes and scrapping, etc.	Clothes must be air dried and should be kept in clean brown paper. Avoid packing damp clothes. New sharp blade must be used for scrapping the blood stains from the wall or floor. Take care that paint on the wall should not get mixed with blood. Keep all scrapped blood stain material on clean white paper and then place it in the packet [30].	No preservative
Semen stains	Clothes must be air dried and should be kept in clean brown paper. Avoid packing damp clothes. Take sterile, clean and dry piece of cloth, make condom inside out put all the material on cloth. Condom also must be dried first and then to be packed it in brown packet.	No preservative
Vaginal swabs/ smear	Air dry and put it in clean autoclaved glass/plastic container.	No preservative

Apart from material mentioned above; perspiration, oil, urine (when concentrated) and feces are also can be used to analyze DNA; as all these contain nucleated cells.

3. Authentication and forwarding

1. All samples collected and preserved as indicated above should be delivered to laboratory without undue delay preferably within 48–72 hours after collection [31–33].

2. Blood samples in cases of paternity disputes and in cases where they are used as control samples for identification purpose should be collected in the presence of judicial officer.

3. The sample should be sealed and the specimen of seal on paper should be sent along the sample for verification.

4. The identification card and the forwarding note should be filled, certified and sent to the lab along with samples.

5. In person who had blood transfusion within 3 months preceding the date of collection. The samples are not useful.

6. Collected and preserved material can be forwarded to the laboratory by executive magistrate or senior inspector of police.

4. Technique of DNA fingerprinting

The technique essentially involves [34, 35] (**Figure 1**):

i. Isolation of DNA from nuclei.

ii. Fragmentation of DNA by treating with restriction endonucleases.

iii. Gel electrophoresis of the fragments after alkalinization.

iv. Blotted on to sartorious nitrocellulose filter.

v. P^{32} labeled probe hybridization.

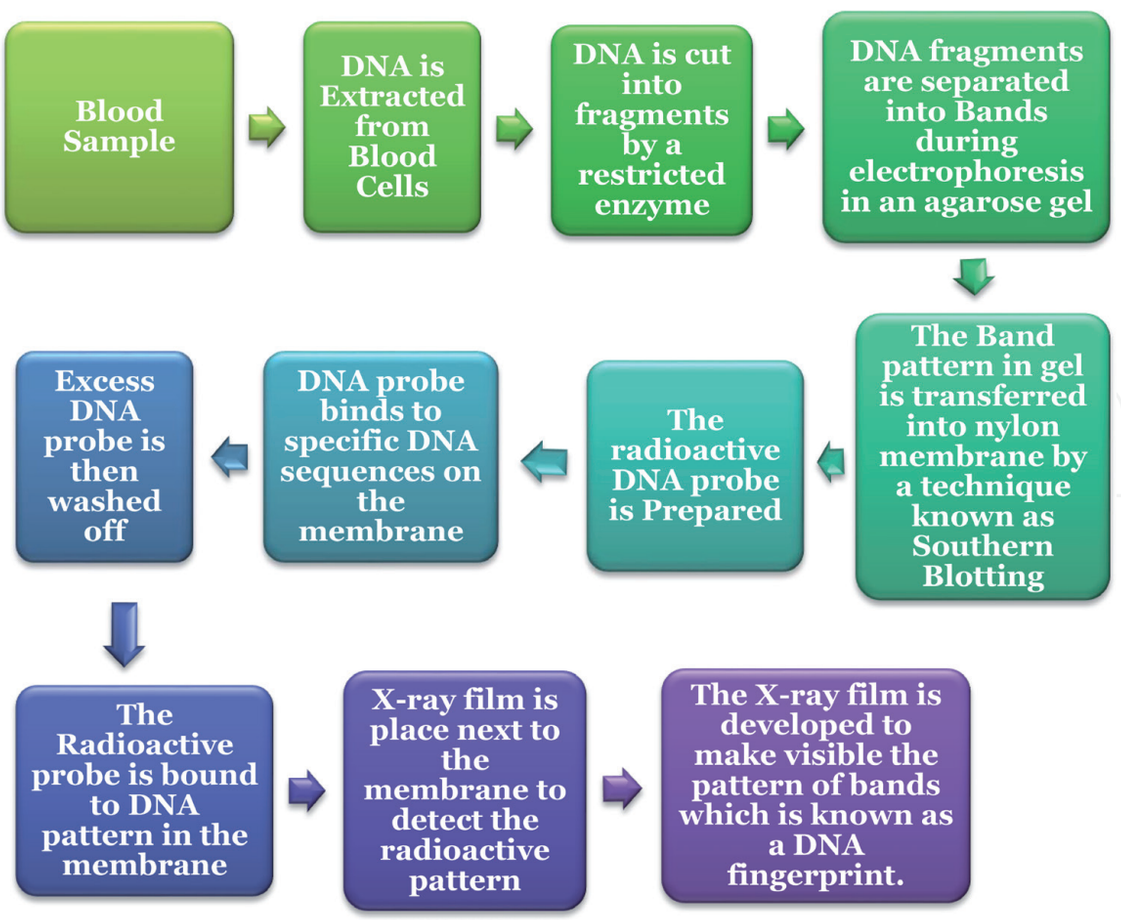

Figure 1.
Steps in DNA fingerprinting technique.

vi. Autoradiographed at room temperature on to an X-ray plate.

vii. Bands appearing on the X-ray plate as dark lines are the permanent Band Patterns where the probe had attached.

The various techniques in use at present are [36–40]:

1. Restriction fragment length polymorphism (RFLP):
   - Using Multi locus probes (MLPs)
   - Single locus probes (SLPs)
   - Variable Number Tandem Repeat (VNTR) sequences.
2. Polymerase chain reaction (PCR)

4.1 Restriction fragment length polymorphism (RFLP)

This was first Forensic DNA analysis technique adopted for analysis. This kind determines variation in the length of a defined DNA fragment. The pattern looks like a very simple super market bar code.

Basic requirement of DNA fingerprinting is nucleated cells. DNA is present in the nucleus of cell, so it can be only extracted from body fluid or tissues having nucleated cells. All the samples should be frozen at −20°C before use. Isolation or extraction varies according to the type of biological evidence present; the amount of evidence and the kinds of cells present.

DNA molecules are segregated by following steps:

a. Cell membranes are broken down and different cellular organelles are fragmented.

b. DNA molecules are detached by using soap and salt solution.

c. DNA molecules are separated from remaining proteins.

d. RNA and polysaccharide are detached with the help of enzymes.

The secluded DNA is passed through ultraviolet spectrophotometry for measuring its quantity.

DNA is completely broken-down by using enzymes named as restriction endonucleases. Restriction endonucleases identifies the unique sequence and cut the double stranded DNA at several fragments. It is known as 'restriction fragments length polymorphism' (RFLP). RFLP's are product of dissimilarities present in DNA molecule. This dissimilarity in restriction fragment length is because of variable number of tandem repeats (VNTR) [41].

Fragmented DNA molecules are run on agarose gel electrophoresis. The different restriction fragments are separated varying in length in between 0.5 to 25 kb which varies from one individual to another. The length of smaller fragments is less so naturally it moves for longer distance as compared with larger fragments.

The gel is later stained with ethidium bromide for 40 minutes which tightly binds to DNA and fluoresces under ultraviolet light.

By using capillary transfer technique of southern DNA is transferred from the agarose gel to nylon membrane. With this technique it creates mirror image replica of fragment distribution. Commonly vacuum blotting of transfer technique is applied because it takes less time. DNA is then fixed by hit at 80°C or cross-linked by the cation of UV irradiation [42].

With application of hybridization technique, pairing of two single stranded DNA is done to convert it double stranded DNA. It involves the addition of probe to the nylon membrane. DNA is created with specific technique hence it goes to specific programmed locus on an exact chromosome. Normally, probe is also labeled with radioactive marker like P^{32}. Firstly, probe identifies its matching sequence, then it hybridizes with it. Due to presence of radioactive marker, hybridized fragment turns into radioactive. Generally, four probes are used to analyze four different DNA regions at same time.

Loosely bound probes are removed by washing it with 0.05% SDS. Subsequently membrane is wrapped in the saran wrap and kept in the X ray cassette along with X ray film and exposed to 80°C. The probes are exposed depending on its specific activity and exposure time ranges from few hours to days (maximum 10 days). X ray films are then developed and fixed in the respective reagent and finely washed in water and dried. Finally developed autoradiograph is the DNA pattern of that particular individual seen as black bands. These black brands are radioactive hybridized unique fragmented sequences. X-ray film shows unique band pattern known as AUTOROD. This unique band pattern is nothing but the DNA fingerprint of that individual whose biological material is tested. It also serves as permanent unique record of that individual (**Figure 2**) [43, 44].

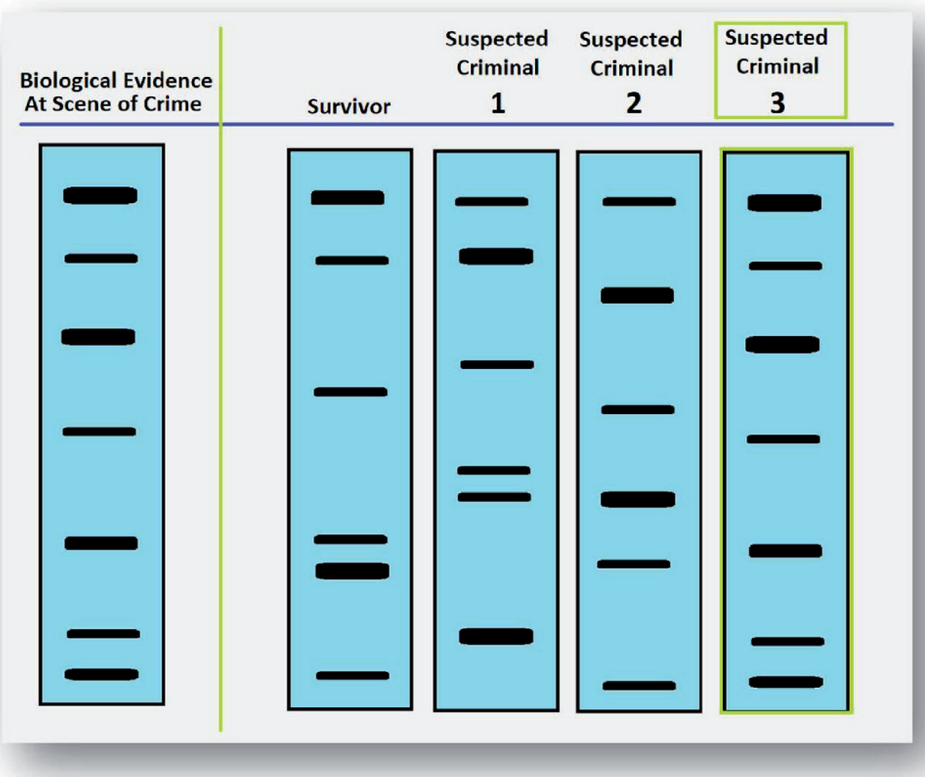

Figure 2.
DNA fingerprint band pattern.

4.1.1 Multi locus probe (MLP)

The probe used detects variations at several genetic regions simultaneously. The Band Pattern produced on X-ray plate produced a strip of 30–40 dark bands. The MLP Method was originally described by Sir Jefferys. He used three minisatellite regions turned 33.5, 33.6, 33.15 after previously cloning and characterizing them.

33.5 and 33.15 contain repeats of a similarly version of the core sequence and consequently produce similar but not identical DNA fingerprints. Probe 33.6 is comprised of a shortened derivative of the core and hybridizes to a new set of resolvable hypervariable fragments per individual in the 4–20 kbs range, 33.6 detects 6 additional and 33.5 detects two additional hypervariable fragments, 33.15 detects 15 fragments [45].

4.1.2 Single locus probe (SLP)

Further modification of this method led to the development of SLPs which analyze only single hypervariable location in human DNA. These play a very major role in Forensic practice as they have far greater detection sensitivity than the MLPs. Each SLP detects just two bands (One maternal and one paternal). It is so sensitive that it identifies even a single hair root. Results can also be obtained from degraded DNA, often found in Forensic samples as SLP detects the remaining, non-degraded alleles among the DNA fragments. As they detect only two bands/SLP, using single SLP reduces the probability to 1/10000 population as compared to 1 in 02 MLP. Using multiple SLPs is therefore the practice now a days. SLPs are human specific. MLPs detect DNA fingerprint in all vertebrates. 80% of Forensic work depends on SLPs [46].

4.1.3 VNTR

This method uses set of probes which detect specific variable number tandem repeats of a sequence. These also remember the minisatellite in that they consist of a repeated sequence with the number of copies of the sequence varying from one person to the other. However, where there are usually many minisatellites of a given type in a genome, there is only one VNTR of each type. These probes therefore produce simpler banding patterns. Several VNTR probes are used. Each of which recognizes one VNR site to characterize a DNA sample. After the frequencies of the various bands produced by each VNTR probe have been established for each ethnic group. This can be used to calculate the probability of any particular combination of patterns occurring in each individual [47].

4.2 Polymerase chain reaction (PCR)

This is general technique routinely used for increasing amount of a specific section of DNA in a sample. This is called DNA amplification. PCR more often referred to as molecular Xeroxing.

It was devised by Kary Mullis and his colleagues in 1985 in Henry Elrichs Laboratory at the Caus Corporation in California. It is test tube method of copying simultaneously the two complementary strands that make a gene sequence. In this method millions of similar DNA fragments can be synthesized within hours. Primers are used to amplify specific segment of DNA. Primers finds the DNA ends that can be duplicated. After heating DNA sample, there is detachment of two strands. Then two new strands which matches to the both original strands are produced by enzymatic action of DNA polymerase. DNA polymerase is originally

obtained from *E. coli*, but it is heat unstable. Hence original DNA polymerase gets inactivated at high temperature, recently new heat stable DNA polymerase is derived from bacteria *Thermus aquaticus*. By using heat stable DNA polymerase, PCR technique can amplify DNA sequence up to 1 million in 20 cycles and up to 1 billion in 30 cycles. This amplified DNA can be now explored by any of the standard molecular biological method [48, 49].

5. Methods

5.1 HLA DQa/HLA DQ A1

This was the first system among the PCR based variation in DNA sequence, is detected using specially designated to be complementary to and thus target, a particular sub region within this locus. The original probe detected 6 common DQ alpha alleles that in combination, determine 21 possible genotypes.

The final results are seen as series as blue dots on a paper like strip. A comparison of the pattern of the dots between typing strips indicates whether two samples may have originated from the same source [50].

5.2 Ampli type PM + DAQ A1

Commonly known as poly marker with all advantages of PCR. This increases power of discrimination. Several markers at different loci were analyzed at the same time (procedure known as multiplexing).

Each of the fine additional markers contains less individual variation than DQ A1. power of discrimination increases from 1:200 to 1: 2000. Disadvantages of PM loci are that is often difficult to interpret from samples containing DNA from more than one contributor because of low power of discrimination per locus [51].

5.3 D1 S 80

Also known as Amplified Fragment Length Polymorphism (AMP-FLPs, AFLPs, AMFLPs). In D1 S 80 analysis, fragment in the range of 100 s of base pairs are amplified, about on order of magnitude smaller than fragments normally analyzed in RFLP typing.

In D1 S80, PCR amplified sections are efficiently purified before DNA analysis. In RFLP technique complete DNA is analyzed and then important sections of DNA molecule are distinguished with help of molecular probes.

D1 S80 loci are found as distinct alleles and easily compared with allelic ladder which is run on the same gel [52, 53].

5.4 Short tandem repeat (STRs)

This is similar to D1 S80, except that repeat units are shorter. For Forensic purpose loci selected usually have tandem repeat unit of 2–5 bp and it can be repeated up to dozens of times. The number of alleles varies from 5 to 20 bp depending on the locus. The size of DNA fragment produced by amplification of STR loci is in the range of 200–500 bp (base pair). Due to above specifications STRs is an ideal for degraded DNA. Also, PCR amplification of many different loci performed simultaneously in same test tube saves material, time and most important sample. STR loci also can be analyzed manually by silver stain by using fluorescence to detect the bands either during or after separation [54].

5.5 Gender identification

For tooth pulp tissue an Amelogenin locus is used which detects the variation of length in male and female. In female gene one of part contain a small detection (6 bp) in nonessential DNA and gives a shorter product by amplification with use of PCR. When this region analyze female with 2 X chromosomes will show one band and male with both X and Y chromosomes show two bands (one is same size as female the other one is slight larger) [55].

5.6 Y-STRs

STRs found on Y-chromosomes are amenable to typing small degraded samples of DNA and can be analyzed on the same instrumental platform. Male specific information thus obtained.

i. Can be helpful for non-sperm containing samples comprised of both male and female contributions such as mixtures of blood or male saliva deposited on female victim.

ii. Information from Y-STRs can also be successful where only incomplete separation has been achieved using a differential extraction produced, particularly where only a few sperm are present among many non-sperm cells.

iii. Sometimes detect male profile where only single female profile was evident using standard automated STR typing.

iv. Also helpful in determining number of male donors by eliminating any information contributed by female resources [56].

5.7 Mitochondrial DNA

Mitochondria in human cells contain an autonomous circle of DNA that codes for some protein that control function like cellular respiration. The mitochondrial genomes are about 16.5 kb and of interest to Forensic scientist and contain a non-coding hyper variable control region.

Mitochondrial DNA sequences are highly variable between unrelated individuals. Complete 16,569 nucleotide sequences of mitochondrial DNA have established for a reference individual [57].

Mitochondrial DNA circle is a genetic element that lacks a homogenous counterpart in the genome and it can be described as hemizygous. Mitochondrial DNA is haploid hence these genes survive for many generations and transfer to many generations intact, without change and retain its uniqueness. Up to thousands of copies of mitochondrial DNA genome present in small, old, badly degraded sample, and if no results obtained with any other systems. Mitochondrial DNA is commonly used to type the dead cells in hairs, shafts of bone and teeth.

5.8 Interpretation

Detection of allele specific sequences difference was in the form of Dot blot. This is constructed in such a way that a particular sequence was either present (signal on) or (signal of) each dot is represented for one allele.

In length-based system – PCR products are run on a gel through capillary and they are visualized as bands, similar to RFLP or as peaks on automated equipment [58].

5.9 Disadvantages of RFLP

1. The samples have to be in good condition to be analyzed.

2. Fragments isolated/identified by this method are in the ranges of 2 to 20 kbps.

5.10 Disadvantages of PCR

1. It is susceptible to contamination.

2. Most PCR loci have fewer alleges than the VNTR areas utilized in RFLP.

3. Some of PCR loci are functional genes.

5.11 Advantages of PCR over the RFLP

1. It is technically easy.

2. The reports can be given in short time.

3. It permits analysis of extremely tiny amounts of DNA.

6. Forensic application of DNA fingerprinting

1. Homicide: In homicidal cases, blood stains on clothes and weapon can be compared with the blood of victim. Also, hair roots present on weapon may be compared with the blood of suspected criminal and victim. In sexual assault cases, identification of accused by analysis of semen samples obtained from the vagina of the survivors of rape, blood stains or hair found at the scene of crime or on clothes.

2. Disputed paternity: The DNA samples of child are compared with that of alleged father and similarity is noted. With this technique paternity can be confirmed 100%.

3. Maternity testing: This technique is also used for maternity testing specially in cases where the child is exchanged, misplaced, stolen or kidnapped from the hospital.

4. Identification of mutilated remains: As in cases of accidents, mass disasters, bomb blasts, burnt bodies, putrefied bodies etc. The DNA fingerprint obtained from such remains can be compared with previous prints if available or with that of close blood relative of the disease which can establish link between family members.

5. Extortion cases: Saliva samples from envelope, face mask, nasal secretion, saliva from cigarettes butts etc.

6. To acquit a falsely implicated person of any crime.

7. Identification of bodies in exhumation cases.

8. For tracing pedigree and for establishing familiar relationship.

9. Diagnosis of inherited disorders: DNA fingerprinting is used in diagnosis in inherited disorders in prenatal and newborn babies.

10. Migration of population: DNA fingerprinting can be used in determining how the races migrated from one region to another by comparing the DNA fingerprint. Thus, it helps for study of history and confirmation of races.

7. Discussion

DNA fingerprinting can be proved for one's innocence as well as a guilty person. Most of the errors can be made during the samples collection. If the DNA samples have not been contaminated only then DNA evidence is completely conclusive. The advancement in molecular genetics avoids the types of contamination but sometimes lack of suitable tests might leads to the wrong perception. Allowing the trained person to educate about standardized tools and technologies of DNA fingerprinting [59]. Collection of profiles DNA of previous culprits' cases, victim, offenders and as well as the witness of the crime scene is known as DNA database. United State America (USA) has the major DNA databank known as Combined Index DNA System (COIDS). Combined Index DNA System (COIDS) is used for identification. Forensic Science DNA Database also contains evidence of persons DNA pieces who have been involved in a crime (victim, offender, crime affected, witness of the crime scene and crime suspect related). There is also human remains and missing person database. Databank of DNA is much useful in solving with its help many old cases are resolved. Country likes U.S.A and Great Britain which has DNA database, but they totally do not dependent on this technique to cracking out all the crime scene. Gattaca (1997) dystopian American science fiction film written and directed by Andrew Niccol in which Ethan Hawke (as Vincent Freeman) who becomes a cosmonaut. But due to his genetic problem, he would not get some essential benefits like insurance, etc. For becoming superhuman he found genius Genetic Engineer who can transform him completely. He knew that a hair like structure known as DNA creates overall personality of human being. He is aware that if his genetic defect is exposed, people will know about his true identity. Moral of this movie states that DNA databank is unsafe [60].

As most of the People are afraid by computer systems hackers who exploit the systems and easily gain someone's personal information and as a result get profit through black-mailing. Databank is the heart of whole this mechanism, any hacking or tempering of data by the corruption and dishonesty person such as DNA finger print experts can ruin an individual's life.

Sometimes wrong interpretations are identified in fake or synthetic DNA identification. The limitation to believe in DNA evidence as truthfulness in these fake DNA's and causes incorrect perceptions. In one of the, A Canadian physician (DNA fraud case), Dr. John Schneeberger alleged that he raped one of his patients in 1992 and at the crime scene semen left as a DNA evidence. Police investigated the case and matched the Schneeberger bloods with crime scene semen, never showing a match results drew totally different.

In another case, police identified the DNA samples from the same woman on different crime scenes in Austria, Germany, and France among them robberies, burglaries, and murders. Only after the DNA sampled from the burned body of a male asylum seeker in France exactly matched with that of the "woman". Investigators had serious query about DNA traces, then after careful investigation they found that these DNA traces was already present on cotton swab. These Cotton swab found at the scene of crime was manufactured by an Austrian Company. The Product description of cotton swab mentioned that swabs were sterilized but were not DNA free. The technique for differentiating false DNA and original DNA was afterwards developed by a company in Israel.

In India many cases were solved by DNA fingerprinting. Rajiv Gandhi former Prime Minister of India was killed in bomb blast. His body remnant and accused suicidal bomber remnant were also confirmed by DNA fingerprinting in 1991.

In 1995, Naina Sahani was murdered by husband Sushil Sharma, he chopped her body in to pieces and burnt in tandoor. Even from burnt body remnants, DNA fingerprinting was done and confirmed that it was of Naina Sahani. Naina Sahani case was solved with conviction to the accused.

Priyadarshini Mattoo was raped and murdered by IPS Officer's son in 1996. Trial court in 1999 acquitted him, but due to this it became sensitive case. In 2006, accused was convicted to death sentence due to DNA fingerprinting. The traces found on victim's undergarments matched with accused. This were possible due to DNA technology only.

United States Supreme court in its recent judgment clarified that in serious life-threatening offenses, investigating officer can take cheek swab for DNA analysis as routine procedures like taking photograph or simple fingerprint.

For Forensic analysis DNA database is very useful. Familial DNA Database Searching for matching of crime scene stain with near relative helps reaching up to accused. In 2004, US first familial DNA search was done in Craig Harman's case. He was convicted due to partial match with his brother's DNA.

In 2009, bollywood actor Shiney Ahuja raped the maid. Maid. In court Ahuja became hostile and witnessed that she was not raped but DNA traces from her private parts matched with Ahuja. Due to DNA evidence, Court convicted him.

The public outrage sensitive Nirbhaya case, six men raped college girl with brutal way, she died during treatment. All six men sentenced to death with DNA evidence.

In Hyderabad Blasts Case (2014), first intelligence agencies searched suspected house in Zephyr Heights in Mangaluru, but the team got no evidences. Afterwards Forensic team found DNA evidences collected DNA samples from the same house. Five accused was caught and DNA evidences collected from house were matched with all five accused.

Rohit Shekhar Tiwari alleged that Shri Narayan Dutt Tiwari is his father. Shri Narayan Dutt Tiwari was Chief Minister three times of Uttar Pradesh state, and a famous political leader. At first, he denied for DNA sampling but afterwards by compulsion of Delhi High Court, DNA mapping was done and subsequently confirmed his fatherhood.

8. Future

8.1 United States of America

The Federal Bureau of Investigation developed the Combined DNA index system (CODIS). DNA database in United States. Supreme court in Mayland v. King

Sentenced that if the officers made an arrest for serious offense, DNA samples like cheek swabs can be legally taken. The DNA samples can further be used in the Law of Court under the Fourth Constitutional Amendment and the Individual's privacy is valid.

Thus, in USA 28 states and federal government, swabs can be taken for DNA fingerprinting from any accused as a part of normal investigating procedure. These swabs can be compared to Combined Index DNA System database to identify the person and for creating links to unsolved cases. Due to technical advances DNA is one of the confirmatory and quickest methods of Identification [61].

8.2 United Kingdom of Great Britain and Northern Ireland

National DNA Database (NDNAD) in United Kingdom is based on The Criminal Justice and Public order Act. In case of certain offenses mentioned, Police are duty-bound to take the DNA samples of the arrested person. The samples are supposed to be taken before the Investigating process begins in order to make it faster [62].

8.3 China

A Law was passed by China which allowed Ministry of Justice and Ministry of Interior to setup DNA Banks.

The fundamental points integrated in this legislature are:

1. The Offenders – The accused and who are sex offenders have to provide DNA Samples willingly.

2. If the offender refuses to provide DNA samples, the Prosecutor can compel the person to do so.

3. The written and photographic samples of DNA can be preserved for 10 years.

4. If the accused is suspected of committing a crime for which, the punishment period is more than 5 years, are required to give non-intimate samples.

In India the DNA Technology (Uses and application) Bill is introduced some silent features are [63]:

1. The main goal is to establish identity in relation to many civil and criminal cases.

2. Establishment of supreme regulatory board of 12 members called as DNA Profiling Board.

3. Formation of National DNA Data Bank and various Regional DNA Data Banks.

4. Usually Consent of the person is required for collecting DNA samples, but if the person has done serious offenses where custody is more than seven years or death, then DNA samples can be taken without any consent. In this special circumstance the magistrate can order to take biological material for DNA analysis.

5. Labs are allowed to do DNA fingerprinting only after permission of DNA profiling board.

There is always conflict between the technology and ethical issues. In India article 21 gives Right of privacy in all aspects. To avoid conflicts, the court must use its powers only after balancing the interests of the parties and on due consideration whether for a just decision in the matter, DNA test is extremely needed.

Universally Right of privacy is accepted as one of the most important Basic Human Right. The Universal Declaration of Human Rights, 1948 states that 'no one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, attacks upon his honor or reputation. Everyone has a right to protection by law against such interference or attacks. Also, shall not be forced to admit the culpability.

The International Society of Forensic Genetics has laid down guidelines which are to be followed by DNA laboratories while dealing with such cases in order to adhere to the moral obligations on them. The Establishment of DNA Database has many ethical and legal concerns which are to be handled properly in order to avoid possible violation of Fundamental Human Rights [64].

9. Conclusion

DNA evidence is a reliable and confirmatory tool for victim/criminal investigation, but many experts have warned because there are few instances of man-made mistakes. It has led to the wrong consequences as the DNA evidence can be tampered. As few studies have found that DNA analysis reports can have personal variation in opinion and is likely to make mistakes. Bias may arise due to presence of trace amount of DNA in biological evidences and also burden of conviction based on report. Although the margin to biological challenges is near to nothing, the room for human mishandling the sample always cannot be over ruled here. False results can be seen in poor laboratory practices. There is a possibility that DNA at crime scene could also be replaced by another person, who was not a criminal actually. Forensic DNA fingerprinting had a tremendous positive impact in the criminal judicial system but its reliability should not be taken for granted. DNA is a God's signatures in each and every person which discriminate every individual. DNA technology is now becoming an integral part of any investigation all across the world. It is now accepted universally in solving many mysterious cases with motto *Do Not Ask, it's DNA, stupid!*

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