# IMPACT OF TECHNOLOGY ON FORENSICS EVIDENCE & CASE LAW JURISPRUDENCE.

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# DNA ANALYSIS

## DNA Profiling:

- Earlier called as "DNA fingerprinting" was introduced in 1984 by British geneticist Alec Jeffrey.
- First used in a case of rape & murder of two girls, one in 1983 & another in 1987. Since then, science of DNA profiling has undergone developments and will continue.
- Now in great demand in the process of criminal investigation & administering justice in criminal cases/civil dispute

## What is DNA (Deoxyribo-Nucleic Acid)?

- Whole human body is made up of multiple cells each having a nucleus & each of these nuclei having chromosomes, containing linearly organised genetic units known as DNA.
- Combination of biological maternal & paternal DNAs in equal proportion.
- Genetic material distinguishing each individual; except in few instances of identical twins, each individual's DNA molecules differ from one another, considered as one of the most effective methods of identification.

- In **Dharam Deo Yadav v. State of U.P.**, [(2014) 5 SCC 509, Para 36] it was observed that "*DNA stands for deoxyribonucleic acid, which is the biological blueprint of every life. DNA is made up of a double stranded structure consisting of a deoxyribose sugar and phosphate backbone, cross-linked with two types of nucleic acids referred to as adenine and guanine, purines and thymine and cytosine pyrimidines.*". "*Most important role of DNA profile is in the identification, such as an individual and his blood relations such as mother, father, brother, and so on. Successful identification of skeleton remains can also be performed by DNA profiling. DNA usually can be obtained from any biological material such as blood, semen, saliva, hair, skin, bones, etc.*"

- Thus, DNA analysis is used for quite a lot of purposes in forensics, some of which are :

**A) Civil Cases:**

- Determination of paternity/ maternity
- Inheritance cases
- Immigration cases

**B) Criminal Cases:**

- Blood, semen, saliva, bone, hair & other body tissues encountered in physical & sexual assault, murder, accident, concealment of birth.

- Establishing biological relationships between two or more people.
- Identification/ restoration of kidnapped/ exchanged babies & babies born out of wedlock or sexual assault.
- Identification of mutilated bodies in mass disaster cases, when conventional method of identification fails.
- Identification of plant materials & microbes & species of biological evidence material in poaching cases.
- In linking cases, example: different rape cases - serial rapist.
- Social microbial DNA profile represent the site of collection- proves a link between suspects & crime scene.
- Transplantation of organs (in medical science).

## Sources of DNA:

- Blood/semen/ saliva & their stains on any surface.
- Organs & tissues including soft tissues like liver, kidney etc.
- Bones, teeth, hair (with root), nail clippings, urine & faeces matter, dandruff etc.
- Sweat, tears, ear wax, finger print (touch DNA)
- Samples of plant origin, microorganisms
- Vaginal Cells transferred to the outside of a condom during sexual intercourse
- Tobacco spits, cigarette/ bidi stubs, chewing gum.

## Process of DNA Analysis in Investigation

- First a DNA molecule from the suspect is disassembled and then the selected segments are isolated & measured.
- Afterwards, the suspect's DNA profile is compared with one derived from a sample of physical evidence to see whether the two match.
- If a conclusive non-match occurs, the suspect may be eliminated from consideration. If a match occurs, a statistical analysis is performed to determine the probability of the sample of physical evidence coming from another person with the same DNA profile as the suspect's.

## Types/ Techniques of DNA Testing Procedures

- DNA profiling/ forensic genetics is a technique employed by forensic scientists to assist in the identification of individuals or samples by their respective DNA profiles.
- Restriction Fragment Length Polymorphism (RELP) & Polymer Chain Reaction (PCR) are the two techniques that are widely used for DNA profiling.
- Of these, (PCR) technique is considered to be more effective in terms of DNA profiling as it allows even the smallest biological molecule to be tested. Double stranded DNA isolated from biological material is separated into single strands during PCR, which involves incubation at a high temperature. Each strand acts as a template for the reproduction of their complementary sequences. "Template DNA" and "DNA Polymerase" are the two components of this technique.

## First Case Accepting DNA Report as Evidence

First case relating to DNA which came before the court related to the paternity dispute. In **Kunhiraman Vs. Manoj, II** [(1991) DMC 499], the petition was filed seeking maintenance of the child from the respondent claiming that the child was born from the relationship of the two. Respondent denied paternity & thus the paternity test was directed by the CJM resulting him being the putative father of the child. This decision of CJM was upheld by the Kerala High Court stating that the result of DNA test by itself could be deciding paternity.

## DNA Legislation in Context of India

- Indian Parliamentary Affairs Board has set up an Advisory committee to give a comprehensive report on all aspects of DNA testing.
- The Law Commission in its 185th report recommended the inclusion on DNA testing in the Indian Evidence Act by amending Section 112. The 185th Report of the Law Commission of India states that law of evidence is likely to undergo radical changes with standardization of new technologies. The judge would find himself (or herself) in a difficult situation if he/she is unable to appreciate the probative value of new standards and concepts of evidence.
- In modern world the technology of DNA fingerprinting has been accepted method of proving the paternity and other disputes of similar nature. The modern technologies of genetics and reproduction are solving many complicated questions of fact & DNA fingerprinting is considered as such a revolutionary step in the related field.

# JUDICIAL APPROACH

A lot of cases like paternity disputes, sexual abuse/ harassment, rape, murder, claiming maintenance & DNA identification etc. can be solved with the help of DNA analysis. Some of which are as follows:-

A. **Gangrape & Murder**

*i.* Mukesh & Another Vs. State (NCT Of Delhi) & Ors. [(2017) 6 SCC 1]

**Background:** The Appellants were convicted and sentenced to death for gangrape & murder of the prosecutrix. Along with other evidence, the prosecution relied on DNA evidence to convict the appellants. While confirming the conviction and sentence, the Supreme Court discussed the importance of DNA evidence.

**Observation:** DNA technology as a part of Forensic Science and scientific discipline not only provides guidance to investigation but also supplies the Court accrued information about the tending features of identification of criminals. 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 Code of Criminal Procedure by the insertion of Section 53A by Act 25 of 2005, DNA profiling has now become a part of the statutory scheme. (Para 213).

- It is quite clear that DNA report deserves to be accepted unless it is absolutely dented and for non-acceptance of the same, it is to be established that there had been no quality control or quality assurance. If the sampling is proper and if there is no evidence as to tampering of samples, the DNA test report is to be accepted. (Para 224)
- The DNA report and the findings thereon, being scientifically accurate clearly establish the link involving the accused persons in the incident. (Para 450)

ii. Santosh Kumar Singh Vs. State through CBI [(2010) 9 SCC 747]

**Background:** The Appellant was tried for the offence of rape and murder. The Trial Court rejected the DNA report & other evidence acquitting the accused. The High Court further reversed the findings of the Trial Court, including on DNA evidence, and sentenced the accused to death. The Supreme Court upheld the conviction but commuted the death sentence to life imprisonment.

**Observation**: The Court cannot substitute its own opinion for that of an expert, more particularly in a science such as DNA profiling which is a recent development.

- The two scientists gave very comprehensive statements supported by documents that the DNA of the semen stains on the swabs and slides and the underwear of the deceased and the blood samples of the appellant was from a single source and that source was the appellant. (Para 24).
- The trial court has referred to a large number of text books and has given adverse findings on the accuracy of the tests carried out in the present case. We are unable to accept these conclusions as the court has substituted its own opinion ignoring the complexity of the issue on a highly technical subject. (Para 24)
- We feel that the trial court was not justified in rejecting the DNA Report, as nothing adverse could be pointed out against the two experts who had submitted it. We must, therefore, accept the DNA report as being scientifically accurate and an exact science. (Para 25)

B. **PATERNITY**

i. Goutam Kundu Vs. State of West Bengal [AIR 1993 SC 2295]

**Observation:** Ordinarily the Courts have enough power to direct the parties to undergo medical test, or give sample of blood for DNA test, but Hon'ble Supreme Court has held that:

- The Courts in India cannot order blood test as a matter of course;
- Wherever applications are made for such prayers in order to have roving inquiry, the prayer for blood test cannot be entertained;
- There must be a strong prima facie case in that the husband must establish non-access in order to dispel the presumption arising under section 112 of the Evidence Act;
- The Court must carefully examine as to what would be the consequence of ordering the blood test; whether it will have the effect of branding a child as a bastard and the mother as an unchaste woman;
- No one can be compelled to give sample of blood for analysis. (Para 26)

*ii.* Sharda Vs. Dharam Pal [AIR 2003 SC 3450]

**Background:** The question for consideration was whether a party to the divorce proceeding can be compelled to a medical examination in this regard.

**Observation:** The Apex Court held that:

- A matrimonial court has the power to order a person to undergo medical test. Passing of such an order by the Court would not be in violation of the right to personal Liberty under Article 21 of the Constitution of India.

- However, the Court should exercise such a power if the applicant has a strong prima facie case and there is sufficient material before the Court. If despite the order of the court, the respondent refuses to submit himself to medical examination, the court will be entitled to draw an adverse inference against him.

iii. Nandlal Wasudeo Badwaik Vs. Lata Badwaik [(2014) 2 SCC 576]

**Background:** The petitioner claimed maintenance for herself and her daughter. The husband disputed the paternity of child and requested for DNA test.

**Observation:**

- The Apex Court held that the DNA test is an accurate test. (Para 16)
- In this maintenance petition, husband's plea that he had 'no access' to the wife when the child was begotten was proved by the DNA test. The Court observed that the appellant cannot be compelled to bear the fatherhood, when the scientific reports prove to the contrary. (Para 19)

## C. IDENTIFICATION OF DEAD BODY

Sushil Sharma Vs. State (N.C.T of Delhi) [(2014) 4 SCC 317]

**Background:** Appellant murdered his wife by firing bullets and thereafter attempted to burn her body in a tandoor. Police recovered revolver and blood-stained clothes and sent them to forensic test. The blood sample of parents were taken. The DNA report confirmed that the charred body was of their daughter.

**Observation**: Since this is a case based on circumstantial evidence, we must see whether chain of circumstances is complete and points unerringly to the guilt of the Appellant. In this connection, it is important to note that the DNA Report confirms that the dead body which was burnt at Bagia Restaurant was that of the deceased, who was the biological offspring of CW-1 & CW- 2. (Para 26)

- Thus, the prosecution has successfully established that the dead body was of wife of the appellant. (Para 32)

# MITOCHONDRIAL DNA & Y-STR DNA

**DNA PROFILING METHODS**

- **Short Tandem Repeats:**
  - Principal method is to consider the profile of the STRs. Only small sections of an individual's DNA are analysed routinely for forensic evidence. The parts analysed are called short tandem repeats (STRs).
  - Mutations that affect the number of repeats are relatively common so within a population there are usually several different versions of the DNA at an STR locus with different repeat lengths. The different versions are called alleles.
  - If only one STR section of DNA were analysed, many people would share the same DNA profile. Therefore, it is necessary to analyse a number of different STRs to ensure that the chance of two unrelated people's STR profiles matching is infinitesimally small.

- **Mitochondrial DNA:**
  - Helpful to analyse mitochondrial DNA (mtDNA) which is contained in small structures (called mitochondria) within cells. They are found in the cell body, rather than in the nucleus.

- In contrast to the presence of only two parental copies of the nuclear DNA, there are thousands of copies of mitochondrial DNA in the same cell. Both males and females have mitochondrial DNA but it is exclusively inherited from the mother/ maternal line.
- As with Y chromosome analysis, and in contrast to nuclear DNA profiling, there are always more individuals who would have the same mitochondrial DNA profile. This is because relatives in the same female line over many generations share the same mitochondrial DNA.
- Many copies of such DNA are present in each cell, so mitochondrial DNA analysis is useful when there are very small amounts of DNA present (such as in hair shafts without roots), or when a DNA sample is very old and has broken down.
- Scientists assess part of the DNA sequence rather than the length of a region of repeated blocks.

**Y-Chromosomal DNA:**

- Second form of DNA analysis involves study of loci found only on the male specific Y chromosome. This type is inherited by sons from their father with little change between the generations. As a consequence, the profiles generated from Y chromosome DNA are very similar between males with a shared direct male ancestor, with only very rare mutations.

- Analysing Y chromosome STRs can be helpful where there is a mixture of DNA from male and female contributors, for example, in a sexual assault case.
- When conventional methods using autosomes profiling fail to resolve cases, Y-STR typing gives specific information about the suspected male. Although differential lysis allows autosomal profiling in rape cases, vasectomized or naturally azoospermic men leave no sperm at crime cases.

## Judicial Approach w.r.t. STR Analysis

- **Ravi Vs. State of Maharashtra** [2019 9 SCC 622]
  - Though there were overwhelming eye-witness account, medical evidence as also circumstantial evidence conclusively proving that it was the appellant and him alone who committed the crime, the defence argued that the method of DNA analysis "Y STR" is unreliable.
  - Supreme Court observed that traditional DNA analysis techniques like "autosomal STR" are not possible in such cases.
  - Although Y STR does not distinguish between the males of the same lineage, it can be used as a strong circumstantial evidence to support the prosecution case. *"Y-STR techniques of DNA analysis are both regularly used in various jurisdictions for identification of offender in cases of sexual assault and also as a method to identify suspects in unsolved cases. Considering the perfect match of the samples and there being nothing to discredit the DNA analysis process, the probative value of the forensic report is very high. Still, it is not the case of the Appellant that crime was committed by some other close relative of him. Importantly, no other person was found present in the house except the Appellant".*

# ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Ability of machines or computer programs to perform human-like tasks such as visual perception, cognitive thinking and decision making with a higher speed and lower error rate than humans. The rise of AI technology has been integral to detect and prevent crimes. Advanced algorithms pave the way for detection of crime scenes, identifying criminal patterns and anomalies and also uncovering criminal networks.

1. **Artificial Olfaction**
   - The advent of aroma sensor technology in conjunction with the use of AI and biochemistry has led to the development of devices and machines being capable of measuring and characterizing volatile aromas released from different sources at the scene of a crime.
   - Such devices are known as E-noses and are designed to mimic an olfactory system within an instrument thereby allowing identification and classification of aroma mixtures. Not only do such advancements prove useful at the stage of investigation, but further bolster the claims of experts at the time of trial by successfully detecting explosive materials.
2. **Bite Mark**
   - Considered as crucial evidence during sexual assaults/ abuse, homicide and child abuse. In a study on using artificial neural networks a high accuracy model was mainly designed to overcome human bias during the process of bite mark identification through artificial neural networks.

- This model was trained by selecting some specific features of the bite marks, following which the trained networks gave a reasonable result for the matching accuracy.

3. **CONVOLUTIONAL NEURAL NETWORK (CNN)**
   - A type of artificial neural network used in image recognition & processing.
   - A neural network is a system of hardware and/ or software patterned after the operation of neurons in the human brain/ Traditional neural networks are not ideal for image processing as they are required to be fed images in reduced resolution pieces. CNN have their "neurons" arranged more like those of the frontal lobe (which processes visual stimuli in humans and other animals). The layers of neurons are arranged in a manner to cover the entire visual field avoiding piece meal image processing as in traditional neural network.
   - Most often used in computer vision and image recognition. This technology uses x-ray, MRI images and CT scans of the head or other bones to successfully identify the age of its subject and other measures including weight and size of the parts.

4. **AGE ESTIMATION**
   - Using hand-wrist and panoramic jawbone X-rays, professionals estimate a person's age.
   - The use of AI through CNN algorithms in determining the age of individuals through X-rays and MRI data have yielded accurate results and in fact, studies show that this technique is employed most often by the courts in criminal cases and has outperformed all other conventional approaches.
5. **HUMAN FACE RECOGNITION**
   - It is a method for verifying or identifying a person from different digital sources, such as an image or video.
   - Facial contours are the most important characteristics to look at and compare when trying to ascertain the identity of an individual.
   - Thus, in cases where only a rough estimation of the facial characteristics of the accused are known, facial reconstruction technologies coupled with AI help in investigation

6. **STANDALONE DEVICE**
   - Artificial Intelligence has boosted face recognition technology. The newest breakthrough in this sector is a 'box camera.' It is capable of face recognition and in real-time, it analyses a face and delivers a solution.
   - It stores face characteristics and expressions. This technology may help detect suspects before an event occurs. If this gadget has criminal, known scammers and other offender profiles, it may spot a suspect right away.
   - Such devices require connection with both provincial and federal databases to improve accuracy. Though its employment during criminal trials has been relatively less, it is still an effective tool which renders accurate recognition.

# NOVEL TECHNOLOGIES

1. **AUTOPSY**
   - Specialized procedure to determine cause and manner of death or to evaluate the presence of a disease present in the body by thorough examination of a corpse.
   - "Virtopsy" (combines "virtual" and "autopsy") is a new alternative to ordinary autopsy's for broad examination of the whole body by using 3D imaging in post-mortem victims.
   - This technique uses computed tomography (CT) and MRI to identify entry and exit wounds, pathological gas collections and gross tissue injuries.
   - As compared to conventional autopsy, it allows examiners to notice fracture lines and visualize primary and secondary trauma.
   - Magnetic Resonance Spectroscopy (MRS), is another technique in virtopsy assists in determining metabolic concentrations in tissues thus helping in estimating the approximate time of death.

2. **FORENSIC PALYNOLOGY**
   - Uses pollen grains collected from crime scene or suspects to ascertain where a person or object has been. Pollen grains are utilized since they remain at a crime scene long after the event under investigation and also become embedded in clothing.

- Pollen from crime scene can help to identify a specific plant species that may have had contact with the victim or point to evidence that does not ecologically belong in the area. This aids in the determination of whether the scene where the pollen was found was the primary or secondary scene.
- Helps to create ties between crime scene, individuals and even determine possession and trade of endangered species.

3. **DRONE FORENSICS**
   - Also referred to as Unmanned Aerial Vehicles (UAV's), referred to as drones are aircrafts with no pilots and can be controlled remotely or autonomously, capable of capturing images & videos of target regions and transferring them to remote servers.
   - Often used to launch illegal actions, including voyeurism, invasion of privacy of citizens and sensitive places, smuggling activities and also espionage.
   - Components of drones which constitute physical evidences during a forensic investigation can be scattered in various locations and thus association between a seized drone and associated controller to ascertain ownership is a tumultuous task.

- The potential misuse of drones to launch illegal or criminal activities led forensic analysts to pay increased interest in exploring the forensic aspects of these devices.
- Forensic investigation on seized drones done to extract as much incriminating material as possible which includes determining ownership and extraction of path flight history.

4. **DIGITAL VEHICLE FORENSICS**
   - Involves the acquisition and analysis of digital data from electronic systems of motor vehicles. This also includes any data which may be stored in devices such as dash cam's as also the data taken on infotainment and location systems in cars.
   - Helps investigating agency to understand when and where a vehicle has been used, current and past location history of the said vehicle. This also includes a physical examination of the car in crash cases.
   - Black boxes are most widely used source of digital data during forensic investigation of traffic accidents. They are also known as Event Data Recorders (EDR) and are activated when vehicles head for collision.

5. **BIOSENSORS**
   - Analytical devices used to detect biological materials. Biosensors are highly valuable devices for measuring a wide spectrum of analytes including organic compounds, gases, ions and bacteria.
   - Glucometers used to monitor blood sugar levels in human body is a type of biosensors.
   - Biosensors are used to analyse traces of bodily fluids found in fingerprints thereby facilitating identification of criminals.
6. **IMMUNOCHROMATOGRAPHY**
   - Testing method for detecting disease by dropping sample containing an analyte onto testing strip, produces result within 10 – 15 minutes.
   - Immunochromatographic Rapid Test (IRT) devices are often used to detect human blood as also to differentiate between human and non – human soft tissue remains. Such devices can be employed directly at the site of discovery.
   - SERATEC PMB, an immunochromatographic test has proven useful in interpretation of samples containing human menstrual and/or peripheral blood.
   - First commercially available test for a multiplexed immunochromatographic assay for body fluid identification targeting 2 different body fluids in one single test.

7. **BLOCKCHAIN FORENSICS**
   - Involves tracking and interpreting the flow of crypto-currency assets on block-chain. Anonymity and decentralized nature of block-chain allows criminals to use a variety of methods to deliver large sums of money
   - Popular techniques propagated by launderers includes Wash Trading whereby one's own Non – Fungible Token (NFT) is put up for sale, purchased multiple times by the individual themselves thereby manipulating value to increase sale prices.
   - A combination of blockchain investigative tools and expertise can increase protection of cryptocurrency transactions and identify their provenance.
   - Most effective strategy is to follow the money-trail made available by blockchain which documents all transactions irrespective of their complexity to hide its origins.

8. **GEOLOCATING ISOTOPES**
   - As remains of 'missing' individuals are found, forensic interventions are required to provide identification. Tissues of hair, teeth and bones pave the way for isotopes to track migration of individuals.

- Stable Isotope Analysis (SIA) is applied as a means of eliminating investigative possibilities, such as whether a person is likely native to a particular area as compared to a traveller or foreign-born individual. It serves as an important tool for narrowing down search parameters in missing person investigations.
- Data from various isotope analyses provides additional lines of evidence for human identification including a decedent's possible region of birth, long term residence history and even recent travel history.

# Thank You!