

Application of forensic science in crime detection

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Abstract— Forensic science applies logical innovation to give exact data dependent on the occasions that happened in the wrongdoing scene. Scientific researchers are required to show up in court as master observers. The DNA investigation is utilized for distinguishing proof from little measures of proof which saved for long time or at present at wrongdoing scene under the steady gaze of recuperation by law authorization. Measurable science is a field of information and abilities which is useful and helpful for criminal examination. Measurable science applies specialized abilities to recognize, distinguish and indict guilty parties. The attention to legal science is developing among individuals. The eventual fate of criminological science relies upon defeating the imperatives and reinforcing the formative elements. The basic limitations incorporates customary states of mind, absence of execution, absence of assets, absence of preparing staff, gear and research centers. Through measurable science, examination is conceivable if police receives new expert culture, morals of demonstrable skill, logical strategies and apparatuses, justify based enrollment and advancement, discouraging political obstruction, improving preparing inputs and setting up the scientific research centers. Criminal Investigation is characterized as a legal scan for individuals and things helpful in remaking an unlawful demonstration or oversight and the psychological state going with it. It is a testing from the known to the obscure, in reverse in time.

Keywords— *Forensic, DNA Analysis, evidences, forensic applications.*

I. INTRODUCTION

Forensic science is the application of scientific methods and techniques to subjects under investigation by a court of law. In recent days, it can be seen as the major developing tool in solving crime by involving witnesses, victims and the experts in the court of law. Forensic science, 189 years old, helps to integrate criminal investigators and scientists to objectively analyze the evidence found on the crime scene(Wright and Miller, 2005)^[1].

In scope and application, forensic science is a very vast field. Forensics, Forensic/medical jurisprudence and its other disciplinary interlinkages like Forensic Anthropology, Forensic Archeology, Forensic toxicology, Forensic odontology, Forensic Psychology and Forensic Hypnosis are the several identities of forensic science.

The forensic science helps in determining the identity(who) of the suspect who committed the crime. Through the evidences obtained from investigation, it clearly indicates the type (what) of the crime committed. The circumstances or the surrounding speak out about the time (when) of the incident. The forensic evidence manifest the location of the offence(when/crime scene).The forensic investigation finds out the cause of the offender for having committed the crime. Then through the evidences collected, it establishes the motive behind the crime. And lastly, forensic investigators reconstruct identity of the offender and the victim. Depending on the incident, there can be primary,secondary,tertiary crime scenes. In these ways, forensic science depicts a clear picture of the type of the crime,motive underlying it and the person responsible for it.

The forensic techniques and forensic laboratories play a significant role in solving crimes. In order to solve the queries of crime, the forensic science engages pathologists, biologists, physicists, chemists and medical officers as forensic scientists. These Forensic scientists through their knowledge in particular field can effectively help find missing persons, reveal their true identities, relate and prosecute through testimony who victimized whom through production of scientific evidences.

Forensic scientists collect the evidence at the scene of a crime, preserve it and perform scientific and technical analysis in laboratories or offices. The materistic things such as knife, gun etc found at the crime scene also provides meaningful leads in investigation. By careful examination of the data, the scientists could be able to relate the suspect's identity, victim's circumstances (like rape, murder). And also the inspection of the fingerprints, footwear impressions and tool marks collected technically helps in depth case study. The casting kit and other related forensic science tools are used (MacDonnell, 1983)^[1]. The trace evidence may also provide clues in identification of the suspect and victim. There are biological fluids (body fluids) which include blood, semen, urine, vaginal secretions, saliva, feces and vomit (Lyman, 2002)^[1]. They provide the DNA and they are collected in sterile container for laboratory analysis through a scalpel (Red sicker, 1991)^[1].

II. APPLICATION OF FORENSIC SCIENCE

A. Forensic anthropology

Forensic anthropology is the execution of the anatomical exploration of human studies and its different subfields, including scientific paleohistory and measurable taphonomy^[1]. An anthropologist can help in the ID of expired people whose remaining parts are unrecognizable in instances of mischances like plane accident and so on. An injured individual's age, sex, stature, and family line can without much of a stretch be controlled by legal anthropologist utilizing a markers which are available on the skeleton. Legal anthropologists distinguishes physical qualities of the person as well as decides reason for death, past injury, for example, broken bones and some other diseases(ex: bone malignancy).

The distinctive techniques that are utilized to perceive a man from a skeleton is fundamentally founded on the past commitments of various anthropologists and the investigation of human skeletal contrasts. Recognizable proof of an arrangement of stays dependent on their physical appearances is done through the gathering of thousands of examples and the investigation of contrasts inside a populace. Amid the twentieth century the field of measurable science developed into a perceived criminological forte which included prepared anthropologists and in addition various research establishments which gathers information on decay and the impacts it can have on the skeleton.

The learning of osteology is one of the vital apparatus in the field of legal human studies which is utilized in the ID of remains and contrasts by which the human skeleton vary. Amid examination at specific case the anthropologists are regularly allowed to decide a person's sex, stature, age, and parentage. This can be accomplished if the anthropologist knows about the distinctions that the human skeleton can vary between people.

B. Forensic psychology

Forensic psychology is the crossing point among brain research and the legitimate framework. It includes understanding central legitimate standards, especially as to master observer confirmations and the particular substance zone of concern (e.g., youngster care and appearance, or work environment segregation), and additionally pertinent jurisdictional contemplations (e.g., in the United States, the meaning of craziness in criminal preliminaries varies from state to state) with the end goal to have the capacity to associate properly with judges and other lawful experts. An important aspect of forensic psychology is the ability to testify in court as an expert witness, reformulating psychological findings into the legal language of the courtroom, providing information to legal personnel in a way that can be understood [3]. Further, with the end goal to be a dependable observer, the legal therapist must comprehend the logic, tenets, and principles of the legal framework. The most essential guideline is the exclusionary rule and furthermore there are leads about gossip proof. A scientific analyst experiences a preparation in various fields, for example, clinical, social, hierarchical, or some other part of brain research.

All in all, a measurable clinician is assigned as a specialist in a specific field of study [3]. With increment in experience and notoriety, a scientific analyst qualifies as a specialist in a particular field. In some unmistakable issues, for example, with that of the mind or cerebrum harm, measurable neuropsychologists are by and large requested to show up as master observer in court to talk about the issue.

Forensic psychologist by and large makes inquiries in regards to brain science in a court and they are lawful inquiries and the reaction must be in dialect the court gets it. For instance, the court oftentimes designates a scientific analyst to evaluate the perspective of the respondent or a suspect at the season of the offense. A forensic psychologist must be able to translate psychological information into a legal framework. Forensic psychologists may be called on to provide sentencing recommendations, treatment recommendations, or any other information the judge requests, such as information regarding mitigating factors, assessment of future risk, and evaluation of witness credibility [3]. Forensic psychology also involves training and assessing police or other law enforcement personnel, providing law enforcement with criminal profiles [3].

C. Forensic odontology

It is the use of dental information to criminal laws that are forced by security drive in a criminal equity framework. Scientific dental practitioners recognize the entire or divided bodies as well as included directing the insightful offices to distinguish recuperated human stays dependent on dental records. Notwithstanding these criminological dental practitioners are additionally requested to decide people age, race, occupation, past dental history and financial status of unrecognized exploited people.

"Forensic odontology" is gotten from Latin, which means a gathering or where legitimate issues are talked about [4].

Odontology is the best possible taking care of, examination and assessment of dental proof that will be then introduced in light of a legitimate concern for equity. The verification that are gotten from teeth is the age and acknowledgment of individual to whom teeth have a place. This can be accomplished utilizing dental records which additionally incorporates radiographs, risk mortem (before death) and posthumous (after death) photos and DNA [4].

The other type of proof is that of bite marks. Criminals are often known to leave bite mark on the victim or bite mark can be found on the attacker done by the victim for self defence which is known as perpetrator. Bite marks can be divided into several categories they are:

1. Flaemorrhage: a small bleeding spot.
2. Abrasion :undamaging mark on the skin.
3. Contusion:ruptured blood vessels,bruising.
4. Laceration:tear in skin.
5. Incision :cut made in skin.
6. Arulism:removal of the skin.
7. Artefact: bitten of piece of the body.



Fig1: Bite mark analysis

Forensic dentists are responsible for six main areas of practice [4]:

- Identification of found human remains
- Identification in mass fatalities
- Assessment of bite mark injuries
- Assessment of cases of abuse (such as child, spousal or elder abuse)
- Civil cases involving malpractice
- Age estimation.

D. Forensic hypnosis

Forensic Hypnosis is the application of the science of hypnosis in civil and criminal research where hypnosis is the tool used to evoke proof or information. Hypnosis is an altered state of human consciousness which involves focused attention and the mind is in an enhanced receptivity to suggestion.

There are different theories explaining what occurs during hypnosis they are mainly categorized into two groups: 1) Altered state theories 2) Non state theories.

Altered state theories: This theory sees hypnosis as an altered state of mind which is marked by a level of awareness different from the ordinary conscious state. On the other hand, nonstate theories see hypnosis as a form of imaginative role enactment.^{[5][6][7]}

Forensic hypnotist is the one who is trained in investigation techniques and hypnosis. It utilizes the state to collect evidence which later becomes the subject of legal proceedings.

E. Forensic toxicology

Forensic toxicology mainly deals with inspection of toxic substances, environmental chemicals and poisonous products. It is the application of toxicology and other fields such as analytical chemistry, pharmacology and clinical chemistry which is used in the investigation of death, poisoning and drug use. The objective of forensic toxicology is not only the legal outcome for the toxicological investigation or the technology that has been utilized, but the outcome and explanation of results. A forensic toxicologist can analyse by considering the different kinds of samples that are found at crime scene which reduces the work of research. Samples can be of different types like pill bottles, powders, trace residue, and other chemicals. With the samples that forensic toxicologist collect must determine the substances that are present and concentrations of the toxic and the effect it had on the individuals.

Determination of the substance or toxic that are present in the human body is very difficult since the toxic will not remain in their original form once they are injected in the human body. Now let us consider an example on one of the drugs called heroin. Once the heroin is injected into the human body it is metabolized immediately into another substance and further to morphine. Hence to confirm any diagnosis it is important to make detailed investigation into factors such as injection and chemical purity. The different chemical substances have been diluted by its dispersal through the body, while a pill or dose of a drug may have grams or milligrams of the active constituent^[8]. The sample which is collected of an individual may only contain micrograms or nanograms

III. EVIDENCES

A. The Crime Scene:

It is any place where the evidences are gathered for the offence committed. While processing a crime scene, deductive and inductive reasoning should be done in order to gain knowledge of the events occurred at the crime scene. The objectives of crime scene investigation are to collect, preserve, package, transport and document all physical evidence found at crime scene^[10]. It also establishes the relationship between crime scene and suspects by comparing the information obtained to the crime scene, witness and by victims' interviews. When the crimes are committed; investigators try to investigate on what has happened and who was to be found guilty. In order to avoid contamination of the evidences and Personal protective equipments (e.g. helmet, gloves etc) should be used and crime scenes has to be secured safely. The investigators usually takes account on appropriate packaging and use warning labels during processing the crime scene in order to minimize hazards to forensic laboratory technicians^[11].

B. Biological evidences:

Biological evidence are the evidences that are commonly obtained from crime scenes like bodily fluids, hair, tissue, bones, teeth, skin cells, blood etc individual to be linked to a scene and a specific biological sample. Additionally the biological material can be a DNA source, which allows a By examining the biological evidences, it not only provides exact identification of the offenders but also gives us an excellent indication on what had happened at the crime scene. Due to the environmental factors, biological evidence should be collected from the crime scene as soon as possible in order to avoid contamination^[11]. The samples collected are examined by using specific techniques for identification through Forensic DNA analysis.

C. Chemical evidences:

The chemical evidences are the chemical substances obtained at a crime scene. Chemical substances can be fluids such as toxic, drugs etc., Forensic chemists analyses drugs, radioactive substances, chemical weapons and biological toxins obtained from a crime scene.

D. Trace evidence:

There are certain evidences or objects found at crime scene and they provide clues that lead towards the suspect and victim identification. Such evidences are called trace evidence. The common trace evidences that are found at the crime scene are fingerprints, footprint, handprint cut marks, criminal tools and guns. The forensic department investigate and inspect the evidences. The evidences collected at crime scenes should be documented carefully and sealed in special containers to keep it away from contamination or degradation^[11]. In the beginning, the samples found at crime scene must be identified whether are for human, animal or plant in order to precede further investigation.

E. DNA Molecule

The DNA (deoxyribonucleic acid) molecules are the genetic material of all living cells and many viruses^[12]. DNA is unique to each person, except identical twins. It is used for solving crimes, in paternity test, identification of missing persons and unidentified dead bodies.

In forensic science, the researchers or scientists use two types of DNA for analysis such as nuclear DNA (nDNA) found in the nucleus and mitochondrial DNA (mtDNA) which found in the mitochondria. Their diagrammatic representation is shown in (fig2). These two DNA differ from each other by their structures. In degraded, burned, old samples and hair sample without root nDNA does not produce any results but mtDNA can generate evidences. The nDNA is paternal and maternal inheritance but mtDNA is maternal inheritance^[11]. The ages from mother's genealogy convey the equivalent mtDNA. The mtDNA is used to predict the ethnicity or race of an individual. The DNA analysis may be used for identification from small amounts of evidence which deposited for long time or currently at crime scene before recovery by law enforcement^[13].

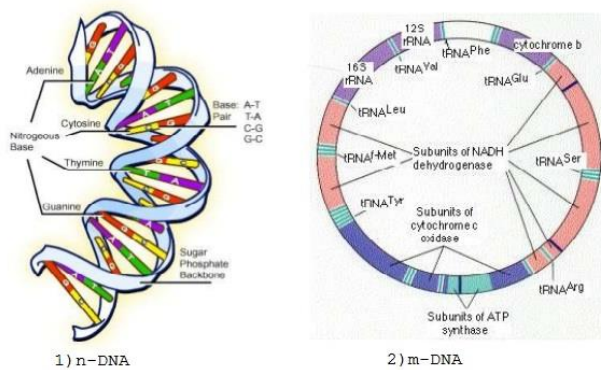


Fig.2: Diagrammatic representation of n-DNA and m-DNA

F. Forensic DNA analysis:

The forensic scientists use the DNA analysis to identify the individuals by matching the genes from personal's items and stored samples with those for criminal suspects (Jeffreys *et al.*, 1985). The process begins by taking sample of an individual's DNA (also called as "reference sample"). Reference tests are generally gathered through a buccal swab. If this is not available then there is a need to collect a sample of blood, saliva, semen, vaginal lubrication, or other fluid or tissue from personal use items (for example, a toothbrush, razor) or from stored samples (for example, banked sperm or biopsy tissue) for analysis. Samples obtained from blood relatives can indicate an individual's profile, as could previous profiled human remains. Once a reference sample is obtained, it is then analyzed to create the individual's DNA profile using specific techniques (fig.3). The DNA profile is then compared against another sample to find out whether there is a genetic match or not.

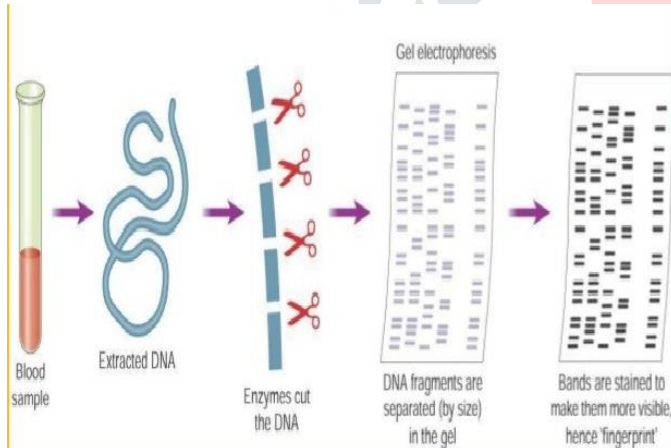


Fig 3: Steps involved in creating individuals' DNA profile

G. Y-chromosome analysis:

The examination of rape has been the definitive issue and impactfully affects exploited people's wellbeing by causing a few maladies, physical wounds, sexual and regenerative issues, and also mental clutters.

It depends on four distinct information sources: information from the police, from populace by reviews, from legal DNA investigation and from legal framework.

The Y chromosome is discovered just in guys and it is acquired from guardians. It is transmitted from dad to his child and it can give data from male line; that implies the child to his dad. The analysis of genetic markers on the Y chromosome in a mixture of male-female DNA samples such as sexual assault can be specific to the males evidences. It may be used also when sexual assault committed by more than one offender to identify between the Units^[1].

IV. CONCLUSION

Forensic science is a versatile and an intense instrument utilized in the investigation of a wrongdoing scene. Legal apparatuses and strategy is helped by the information, encounter, instinctive criminologists, police and other specialists' job. The cops gather the confirmations got from a wrongdoing scene and present these confirmations to the criminological division for examination. The procedural advances engaged with each procedure are broke down painstakingly. The confirmations are vital linkages that gives indicate towards suspects and unfortunate casualties associated with the wrongdoing scene. When the hunt activity is done, the physical and different confirmations gathered are submitted to the scientific division or examinations. By utilizing specialized apparatuses and packs, the DNA specialists can recuperate fingerprints that can recognize criminal. The shoeprints and tire tracks got are additionally vital confirmations in examination as they give imply in knowing criminal personality, sort of vehicle, stature and stride of the criminal.

Forensic science can give help to indicators in exploring manslaughter, assaults and mischance related occurrences. Aside from this scientific science used to illuminate cases including recognizable proof of unidentified dead bodies, distinguishing proof of missing people, misrepresentation cases and researching mishaps, for example, prepare or plane mischances. In criminal cases, the gatherings are observed to be blameworthy dependent on the test reports delivered by measurable science specialists. In this manner before criminological proof is conceded in the court, the systems to discover that proof must be appropriately considered and their exactness must be checked.

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