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FORENSIC SCIENCE
PAPER No. 1: GENERAL FORENSIC
MODULE No.1: Introduction to Forensic Science
1. Learning Outcomes

After studying this module, you shall be able to

- Know the definition of forensic science
- Learn the function of forensic science
- Evaluate the scope of forensic science
- Analyse the future of a forensic scientist

2. Historical Background

The roots of Forensic Science can be traced back to ancient Greek and Roman civilizations which brought great advances in the field of various disciplines of science including the science associated with criminal investigation. Poisoning being one of the earliest methods of killing a human being, widespread knowledge was gathered regarding its production and use. Symptoms caused by various poisons were identified making it possible to detect their use in previously undetected murders. The first recorded autopsy was also conducted by a Roman physician Antistius in 44 B.C on the body of a slain king Julius Caesar to reach the conclusion that though the king was stabbed 23 times, only one wound through his chest caused his death.

In the beginning of the seventeenth century, also known as the age of enlightenment, advancements in sciences and awakening of the social conscience resulted in revitalized interest in the field of forensic science. This inquisitiveness necessitated new means to identify evidences for the purpose of solving crimes. Further, in the eighteenth and nineteenth centuries, a large number of incidents of collection and scientific analysis of evidences in order to solve crimes and convict the culprits were recorded. Evidentiary techniques included identifying foot prints, matching a piece of crumbled newspaper used for wadding in a pistol to a torn piece of paper in a suspect's pocket, matching clothing fibers and grains etc. collected from a crime scene to those found on a suspect of a murder. In the 19th century, it was observed that contact between someone's hands and a surface left barely visible marks called fingerprints. Fine Powder Dusting technique was used to make the marks more visible.

Modern fingerprint identification technique dates back to 1880 when a British scientific journal Nature published a letter from the Englishmen Henry Faulds and William James Herschel disclosing the characteristics of uniqueness and permanence of fingerprints. Their observations were verified by the English scientist Sir Francis Galton, who introduced the first elementary system for classifying fingerprints based on grouping the patterns into arches, loops, and whorls. Galton's system was improved upon by London police commissioner, Sir Edward R. Henry. Known as Galton-Henry system of
fingerprints. It was published in June 1900 and officially introduced at Scotland Yard in 1901. It is the most widely used system of classification even today.

Surprisingly, while the use of scientific methods and techniques in criminal investigations in some manner or another has been around since before the Roman Empire, the idea of forensic science as a discipline and a career is hardly 100 years old. It has only been within the last century that law enforcement agencies and the court systems have come to rely so heavily on the use of scientific practices in crime scene investigations. Throughout history, there exist examples of analysis of various pieces of evidence leading to convictions or acquittals that seem to fall in line with what we know and recognize as Forensics.

Fingerprints Forge the Way:

There have been a number of important advances in the proliferation of forensic science as a discipline. The most significant advances, however, have emanated from the independent works of Englishmen Henry Faulds and William Herschel; and of American scientist Thomas Taylor. These scientists in their works detailed the uniqueness of human fingerprints and their potential use in identifying people leading to the codification and standardization of accepted practices within forensic science.

Dr. Edmond Locard, the Pioneer

Fig 1. Dr. Edmond Locard

No mention of the history of forensic science would be complete without discussing the tremendous contributions made by Dr. Edmond Locard, a French scientist and criminologist who had studied law and medicine. Locard proposed the notion that "everything contact leaves a trace," a principle that prevails in crime scene investigation even today. The Exchange Principle proposed by Locard espoused the idea that everything and everyone that enters a crime scene leaves some piece of evidence behind.
Likewise, everyone and everything takes some piece of the crime scene with them when they leave.

The First Crime Lab

Locard's beliefs and research in the field of Forensic Science made him convince the police department in Lyon, France to provide him with an office and staff to analyze evidence obtained from crime scenes. The two attic rooms and his two assistants soon became the world's first crime laboratory.

Specialties in Forensic Science

Today, research in the field of forensic science has come of ages. Advancements in technology have allowed better analysis and understanding of scientific principles in all types of evidence, for example, crime scene investigators have branched out and gained expertise in areas such as bloodstain pattern analysis and ballistics.

DNA Analysis

The advancements of the twentieth century were built largely upon the groundwork laid in the nineteenth century, perfecting techniques in both analysis and preservation of evidence. In the late 1900s, perhaps the largest breakthrough in crime scene investigation since fingerprinting became standard practice with the advent of DNA analysis and identification.

3. Introduction to the term Forensic

The word Forensic owes its origin to Latin word *forēnsicus* which means "of or before the forum" signifies belonging to court of justice or is any aspect of science, which relates it to the law. Typically, it is just about any area of science, which could be called into question in the court of law. Forensic means FORUM i.e. the public place or market-place of a city which provides an opportunity for conducting debate or to give sympathetic hearing to anyone’s case. It originated from Roman times; when a criminal charge meant presenting the case before a group of public individuals in the Forum. Both the person accused of the crime and the victim would give speeches based on their sides of the story. The individual with the best argument and delivery would determine the outcome of the case. This origin is the source of the two modern usages of the word forensic as a form of legal evidence and as a category of public presentation. In modern use, the term forensics in the place of forensic science can be considered correct, as the term forensic is effectively a synonym for legal or related to courts. However, the term is now so closely associated with the scientific field that many dictionaries includes the meaning that equates the word forensics with forensic science. When a need to identify and compare the physical evidence was felt and certain scientists developed the required principles and techniques for the purpose. Then a need was felt to develop a coherent system that could be practically applicable to criminal justice system as well.
The gathering and scientific analysis of evidence is fundamental to successfully solving crime. Popular fictional character *Sherlock Homes* coined by Sir Arthur Covan Doyle was, perhaps; the first person who introduced scientific crime detection methods to its readers. Doyle described methods of detection much before they were discovered and implemented by the scientists in real life. He used principles of serology, fingerprinting, firearm identification, and questioned document examination in his fiction.

4. Definition

Broadly the Forensic Science is any science used for the purposes of the law, and therefore provides impartial scientific evidence to be used in the courts of law i.e. in criminal investigations and trials or it may also be defined as *it is the application of scientific knowledge to law* or in other words it is the applications scientific principles and techniques for the purpose of Justice. Forensic science has emerged as a significant constituent in an effort to control crime while maintaining a high quality of justice. The law enforcement officials have started becoming dependent on the laboratory results.

Presently, it is one of the fast developing into a technology, which is strongly backing up the legal system to impart justice (through its various disciplines) to innocents.

In order to realize the concept of 'society' a 'law' was needed to be reinforced by developing and applying the knowledge and technology of a science. Forensic Science gradually developed and fulfilled the requirement.

5. Nature and Scope of Forensic Science

Forensic science draws upon the principles and methods of all the traditional sciences, such as biology, physics, and chemistry. But in last few years, it has developed its own branches like fingerprints, anthropometry, crime scene investigation, track marks, questioned document examination and forensic ballistics. These are exclusive fields of Forensic Science. Recently significant advances have been made in the field of serology, voice analysis, brain fingerprinting, criminal profiling and narco analysis test etc.

The term *forensic science* is sometimes used as a synonym for *criminalistics*. Both terms cover a diverse range of activities. Forensic science, in a broader sense, includes forensic medicine, odontology; anthropology; psychiatry; toxicology; questioned documents examination, and firearm, tool mark, and fingerprint examinations, as well as criminalistics.

The brief detail about the major specialty areas included in the wider definition of forensic science is discussed as under:
5.1 Criminalistics

This branch of science is mainly concerned with the recognition, identification, individualization, and evaluation of physical evidence using the methods and techniques of the natural sciences in issues of legal significance. It includes examination of trace-evidence like glass, soil, hair, fibers, blood, and physiological fluids like semen, saliva, urine etc. and the reconstruction of events based on physical evidence analysis. Different forensic scientists define the scope of the field differently. Some include firearm and tool mark examination and questioned documents as a part of criminalistics. Despite the implications of the name, criminalistics activities are not limited to criminal matters. They are used in civil law cases and in regulatory matters also. People who are engaged in criminalistics as a profession are called criminalists.

Criminalistics also includes arson accelerant and explosive residues, drug identification and the interpretation of different patterns and imprints. It is the broadest of the subdivisions of forensic science.

5.2 Forensic Anthropology

This branch of science is related with personal identification based on bodily (particularly skeletal) remains and its practitioners are known as physical anthropologists, who are interested in handling the forensic problems. Alphonse Bertillon was a French police officer who applied the anthropological technique of anthropometry to law enforcement creating an identification system based on physical measurements. Other areas of forensic anthropology include establishing databases on relationship between bodily structures as functions of sex, age, race, stature, and so forth. Interpretation of footprint or shoe-print evidence might also be included to find relationship with stature of the person.

5.3 Forensic Odontology

![Alphonse Bertillon](image)
Also known as forensic dentistry is the application of dentistry to solve human identification problems from teeth. Forensic odontologists are dentists who specialize in the forensic aspects of their field. They are concerned with the identification of persons based upon their dentition, usually in cases of otherwise unrecognizable bodies or in mass disasters or explosion cases. They also analyze and compare bite mark evidence in several types of cases.

5.4 Forensic Medicine (legal medicine; medical jurisprudence)

It is the application of medicine and medical science to solve the legal problems. Practitioners of forensic medicine are doctors of medicine with specialty certification in pathology and forensic pathology. Most of them are medical examiners. They are concerned with determining the cause and circumstances in cases of questioned death. They have to deal with matters relating to insurance claims, and sometimes in cases of medical malpractice also.

5.5 Forensic Toxicology

This branch of science deals with the determination of toxic substances present in human tissues and organs. Most of the work concerns the role of toxic agents (chemicals or plant or others) that might have played a role in causing or contributing to the death of a person. Also perform qualitative and quantitative analysis of the poisonous products present in the viscera.

5.6 Firearm and Tool mark examination

In most of the laboratories in India the firearm and tool mark division is a part of Physical section but in some others it varies according to convenience and number cases referred to the lab. Tools in the form of comparison microscope and others required for firearm identification, comparison of markings on bullets and other projectiles, cartridge cases, and shell cases, especially for the purpose of determining if a bullet has been fired from a particular weapon. Tool mark examinations are concerned with the association of particular impressions with particular tools.

5.7 Fingerprint examination

It is mostly performed at Finger Print Bureau, which is mostly concerned with the classification of fingerprints and the organization of sets of prints into usable files. Development of latent prints at crime scene and comparisons of known and unknown fingerprints are a major part of the work besides storing and building data base of criminal finger prints.
5.8 Questioned Documents examination

This branch of Forensic science deals with the comparisons and interpretation of handwriting, signatures, mechanically produced material (typed or printed), and photocopied material. Analysis of papers, inks, and other materials used to produce documents may also be analyzed.

Some of the forensic science activities can be classified under more than one of the major subdivisions as above. Tool mark comparisons, for example, are sometimes considered as part of criminalistics or physical section and sometimes as part of the separate firearms and tool mark specialty. Similarly, hair comparison is usually considered a part of criminalistics, but it could just as well be considered a part of Forensic Biology. Any classification scheme for all the different activities is, therefore, somewhat arbitrary. No one person can be expert in all the sciences and their methods, and it is for this reason that forensic science have develop subspecialties. The subspecialties developed for a particular type of physical evidence, or around a particular group of methods and procedures. Some forensic scientists are generalists. They have broad training and experience in most of the basic areas of criminalistics, so can carry out a variety of different physical-evidence examinations knowledgeably or more importantly, refer specific aspects of a case to specialists.

The range of human activity is so diverse that almost anything can be consider physical evidence under one circumstance or another. In any civil, criminal, or regulatory matter, there can be physical evidence if recognized, properly handled, and knowledgeably interpreted, can contribute significantly to an understanding solving crime cases.

6. Functions

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The Forensic expert has to perform dual important functions:

**Scientific** - The forensic scientist has to play a scientific function i.e.

- Recognize the physical evidences
- Document the crime scene and evidences
- To collect or preserve and prepare inventory of evidences,
- Packaging of evidences properly depending upon the type of evidence along with the list of queries
- Transport evidences to the laboratory
- To analyze and to evaluate the physical evidences

**Forensic** - The forensic scientist has also to perform forensic function i.e. to interpret the results of scientific investigation to form an expert opinion, and communicating that opinion in layman’s terms (i.e. in simplest possible language without using many technical terms) both in the form of written statements and oral presentations to the court of law.

A strong relationship exists between the crime-scene investigators and laboratory examiners for collection, preservation, packaging and analysis of evidences. The expert's role is essentially one of impartiality and the main directive is to assist the court in arriving at the truth.

In every forensic science investigation, the main function is to provide useful information to link the suspect and the victim with each other or with the scene of crime through physical evidence. Physical evidence analysis and interpretation can provide following types of information:

### 6.1 Information on the Corpus Delicti

The *corpus delicti* (literally, the "body of the crime") it refers to those essential facts that shows that a crime has taken place. Ransacked furniture in the rooms, tool marks, broken doors or windows, and missing valuables are examples of physical evidence that would be important in establishing a burglary. Similarly, in another assault case, a weapon, or torn clothing and the victim's blood, could be important pieces of physical evidence.
6.2 Information on the Modus Operandi

Many criminals or gangs have a particular *modus operandi* or method of operation, MO, which consists of their characteristic way of committing a crime. Physical evidences can help in the establishment of an MO. For example in cases of burglary, the means used to gain entry, the tools used; types of items taken; and other telltale signs, such as urine or footwear left behind at the scene, are all important. In cases of arson, the type of accelerant used and the way in which fires initiated constitute physical evidence that helps in establishing the patterns or "signature" of the arsonist. Cases that have been treated separately can sometimes be connected by useful documentation of similar MO.

6.3 Linking a Person/Suspect to a Crime Scene

This is another very common and significant linkage provided by physical-evidence analysis. Perpetrators as well as victims often leave finger and glove prints, blood, semen, hairs, fibers, soil, bullets, cartridge cases, tool marks, footprints or shoe prints, tyre tracks, and objects at the crime scene are examples of *deposited evidence*. Depending on the type of crime, various kinds of evidences from the scene may be carried away. Stolen property is the most obvious example, but two way transfers of trace evidence can be used to link a suspect, a victim, or even a witness, to a crime scene.

6.4 Linking a Suspect with a Victim

Physical evidence can help to establish decisive link between a suspect and a victim in particularly in violent crime. Blood, hairs, clothing fibers, and cosmetics may be transferred from a victim to a perpetrator or vice-versa. A suspect can be found to be in possession of items, which may be linked to a victim, such as a comparison of bullets or an analysis of blood found on a knife. Trace evidence can also be transferred from a perpetrator to a victim or vice-versa. Clothing and other belongings of a suspect and a victim should be thoroughly searched for trace evidence.

6.5 Identification of a Suspect:

Two best evidences for identifying a suspect conclusively are fingerprint and DNA. A fingerprint found at a scene, and later identified as belonging to a particular person, results in an unequivocal identification of that person. Similarly any bodily material left at the crime scene can be used to extract and analyze DNA, help in the identification of a person conclusively. The term *identification* as used here really means "individualization". Although in common usage people often say "identification of a suspect" or "identification of a fingerprint," this is not strictly correct.

6.6 Supporting or Disproving a Witness's Testimony:

Physical evidence analysis can often indicate conclusively whether a person's version about a set of events is credible or not for example a driver whose car matched the description of a hit-and-run vehicle. An examination of the car might reveal blood on the underside of the bumper. The driver explains the findings by claiming to have hit a dog. Testing species origin from blood can reveal whether the blood is from a dog or from a human.

6.7 Providing Investigative Leads:

Physical-evidence analysis can play an important role in directing the investigation along a productive path. For example, in a hit-and-run case, a chip of paint from the vehicle can be used to narrow down the number and kinds of different cars that may have been involved.

6.8 Eliminating a Suspect:

Physical evidence has exonerated many more suspect than it has convicted.

A substantial part of the work in a forensic analysis of physical evidences consists of making comparisons between questioned and known samples. Depending upon the degree of individuality exhibited by the samples, various conclusions can be drawn to associate the people and the physical evidence in a particular case.

As science and technology continue to advance, the capabilities and importance of Forensic Science Laboratories also continues to grow. At present, in India almost all the states have their own such laboratories and some of them are strengthening further others are in the process of establishment. The existing central forensic science laboratories are vying to improve further.

7. The Future of Forensic Science

The recent application of DNA technology in crime investigations has led not only to positive identification of innumerable criminals, but has also led to overturns of a large number of prior convictions and the release of hundreds of innocent people (Innocent Project). With new advances in the techniques related to voice, psychology and computer science, crime scene investigation and analysis of evidences at forensic science laboratory have received major breakthrough.

7.1 Working in the field of Forensic Science

Working as a crime scene investigator can be an extremely rewarding prospect as this avenue is still relatively new. Careers in forensic science can put you on the cutting edge...
of new techniques, technology and research. Moreover, you will have a sound sleep knowing you're working to bring justice and help others.

8. Summary

- Locard proposed the notion that "everything leaves a trace," a principle that prevails in crime scene investigation even today.

- The roots of Forensic Science can be traced back to ancient Greek and Roman civilizations which brought great advances in the field of various disciplines of science including the science associated with criminal investigation.

- The word Forensic owes its origin to Latin word *forēnsics* which means "of or before the forum" signifies belonging to court of justice or is any aspect of science, which relates it to the law.

- Forensic science draws upon the principles and methods of all the traditional sciences, such as biology, physics, and chemistry.

- In every forensic science investigation, the main function is to provide useful information to link the suspect and the victim with each other or with the scene of crime through physical evidence.