

DKG24 - FORENSIC SCIENCE AND FORENSIC MEDICINE

Unit-I: Forensic Science

Forensic Science-definition, history, development and scope. Principles and Methods of Forensic Science. State and Central Forensic Science Laboratories. Mobile Forensic Science Laboratory. Counterfeit Coins and Currency notes. Scene of Crime: General crime scene procedure – notes of observation, photography, sketching. Questioned documents-writing materials. Ballistics.

Unit-II: Physical Evidence

Classification of physical evidence – class and individual characteristics. Identification and individualization of physical evidence. Locards Principle of exchange Varieties of trace evidence. Footwear impressions: Tyre marks, skid marks – tool marks and their significance.

Unit-III: Personal Identification

Finger Prints-history, development, patterns, ridge characteristics, primary and single digit classification, counting and importance. Developing, Lifting, Foot prints comparison and identification development, lifting and comparison of Track prints. The study of blood, semen etc. body fluids. Blood tests, Inheritance of blood groups. Structure and Identification of Human. Medico legal importance of Age.

Unit-IV: Forensic Medicine

Forensic Medicine - Definition, nature and scope. Inquests. Medico Legal documents-Evidences- Dying declarations- Identification of dead and living persons. Medico-legal autopsy. Infamous conduct, Consent – Euthanasia. Examination of decomposed and mutilated bodies. Death, types, modes and signs. Death-medico-legal importance. Medico-legal aspect of violent deaths. Post mortem changes: Immediate, Early and Late changes after death. Preservation of bodies- Presumption of death- Exhumation. Toxicology.

Unit-V: Injuries and Sex related issues

Wounds and injuries. Definitions- Mechanical Injuries: abrasions, contusions, Lacerations, Incisions, Cut Wounds, Punctured wounds, Thermal Injuries, Electrical Injuries, Asphyxial death: Hanging, Strangulation, Smothering, Gagging, Choking, Dry and wet Drowning. Sex related issues: Potency- Sterility- virginity.

RECOMMENDED READINGS

1. Apurba Nandy (2002) *Principles of Forensic Medicine*.
2. Bann, Polson C.J., *Knight Bernard, Essentials of Forensic medicine*
3. Barry A.J. Fisher., (2000) *Techniques of Crime Scene Investigation*, 6th Edition, CRC Press, New York
4. Basu S.C., *Handbook of Forensic Medicine and Toxicology*

5. Brian H. Kaye (1995) *Science and the Detective*, VCH, Weinheim, Federal Republic of Germany.
6. Camps F.E, *Gradwohl's Legal medicine*
7. Peter R. De Forest et.al (1983) *Forensic Science: An introduction to Criminalistics*, McGraw Hill Book Company, New York.
8. Peter White (Ed.,) (1998) *Crime Scene to Court – The essentials of Forensic Science*, The Royal Society of Chemistry, UK.
9. Saferstein R., (2001) *Criminalistics: An introduction to Forensic Science*, Prentice Hall, Eaglewood Cliffs, New Jersey, 2001.
10. William G. Eckert., (1997) *Introduction to Forensic Sciences*, CRC press New York.

UNIT- 1

FORENSIC SCIENCE

The term “forensic science” refers to a group of scientific disciplines which are concerned with the application of their particular scientific area of expertise to law enforcement, criminal, civil, legal, and judicial matters.

Forensic science (often shortened to forensics) is the application of a broad spectrum of sciences to answer questions of interest to a legal system. This may be in relation to a crime or a civil action. The word *forensic* comes from the Latin *forēnsis*, meaning "of or before the forum."

The Simplest definition of Forensic science is any science used within the Criminal justice system. Crime scene investigators and lab technicians use specialized skills and tools to collect, analyse and present evidence in order to solve a crime or successfully convict the offender. The increased use of scientific methods to collect and examine evidence has led to the closure of many criminal cases that could not be solved through old fashioned detective work alone. New testing methods are even being applied to cold cases, or cases from many years ago that remain unsolved.

Forensic Science can be used to

1. Prove elements of crime
2. Verify or discredit victim or suspect statements
3. Identify decedents or suspects
4. Establish a connection to a crime or crime scene

History and development of forensic science in India.

The application of science and technology to the detection and investigation of crime and administration of justice is not new to India. Although our ancestors did not know forensic science in its present form, scientific methods in one way or the other seem to have been followed in the investigation of crime. Its detailed reference is found in Kautilya's ‘Arthashastra,’ which was written about 2300 years ago. Indians studied various patterns of the papillary lines, thousands of years ago. It is presumed that they knew about the persistency and individuality of fingerprints, which they used as signatures. Even Mr. KM Kata, a frequent contributor to ‘Nature’, stated that the Chinese records proved the use of fingerprints in an ancient kingdom of southern India. The Indians knew for long that the handprints, known as the Tarija’, were inimitable. The use of fingerprints as signatures by illiterate people in India, introduced centuries ago, was considered by some people as

ceremonial only, till it was scientifically proved that identification from fingerprints was infallible.

Chemical examiner's laboratories:

During the nineteenth century, when the cases of death due to poisoning posed a problem to the law enforcement agencies, a need was felt for isolating, detecting and estimating various poisons absorbed in the human system. The first Chemical Examiner's Laboratory was, therefore, set up for this purpose at the then Madras Presidency, under the Department of Health, during 1849. Later, similar laboratories were set up at Calcutta (1853), followed by one each at Agra (1864) and Bombay (1870). These laboratories were equipped to handle toxicological analysis of viscera, biological analysis of stains of blood, semen, etc. and chemical analysis of food, drugs, and various excisable materials to provide scientific support to the criminal justice delivery system within their limited means. These laboratories also provided analytical facilities to the neighbouring States and Union Territories.

Anthropometric bureau:

While some progress was made in the identification of poisons, the identification of people, specifically criminals, was still being done in a rather haphazard manner. Policemen would try to memorize convict's face so that they could recognize him if he got involved in another crime later. With the introduction of Photography, the Criminal Investigation Department (CID) maintained records of every known criminal including a detailed description of his appearance. With the invention of Bertillon's anthropometric system in 1878, India, along with the other countries of the world, adapted Bertillon's system of personnel identification and thus an Anthropometric Bureau, for maintaining anthropometric records of criminals, was established in 1892 at Calcutta.

Finger print bureau:

William Herschel, the Collector of the District of Hooghly (Bengal) found that markings on the fingertips of a person never changed during his lifetime. Herschel applied his knowledge and skill in devising a system of registration of finger or thumb impressions of native contractors to safeguard the interests of the Government against the repudiation of contracts by them. Thereafter, he extended his registration procedure to prison regulations for identifying convicted criminals. In 1877, Herschel sought the consent of his superior officers in putting his ideas into practice, but did not succeed. In 1891, Edward Richard Henry's appointment, the Inspector General of Police in Bengal, introduced the thumb impressions in the record slips, containing anthropometric data, to avoid wrong identification. Long before 1897, he introduced maintenance of duplicate criminal records with impressions of 10 fingers

separately.

Henry employed few selected Indian police officers, viz. Khan Bahadur Azizul Huq and Rai Bahadur Hem Chandra Bose to work under his general supervision till the classification was evolved, which remains the basic system even to-day. It was Khan Bahadur Azizul Huq who evolved a mathematical formula to supplement Henry's idea of sorting slips in 1024 pigeon holes, based on fingerprint patterns. Rai Bahadur Hem Chandra Bose made further contribution to the fingerprint science by evolving an extended system of sub-classification, a telegraphic code for finger impression and a system of single-digit classification.

Henry approached the Government to seek approval for replacing the anthropometric data by fingerprints for the identification of habitual criminals. Government readily agreed, and the first fingerprint bureau in the world was officially declared open at Calcutta in July 1897, although the collection of record slips had started a few years earlier. Thus, the personnel identification solely on the basis of fingerprints commenced in India.

Department of explosives:

When the use of explosives for subversive activities became common, it was found necessary to detect the causes of explosion, either accidental or intentional. The foundation of the Department of Explosives was laid when the first chief inspector of explosives was appointed in the year 1898, with his headquarters at Nagpur. Later, five regional offices at Calcutta, Bombay, Agra, Madras and Gwalior, and three sub-offices at Shivkashi, Gomia and Asallsol were opened. They developed competence to provide scientific clues in respect of explosives as well as the possible causes of explosions. Their expertise came handy in police investigations in the crimes related to explosions and for evolving various provisions under the Explosives & Petroleum Act.

Government examiner of questioned document, Shimla:

The British Government of Bengal felt the necessity of identifying the handwritings on the secret documents connected with the Indian independence movement and, therefore, created the post of Government Handwriting Expert of Bengal. Mr. CR Hardless, the then Superintendent in the A.G.'s office in Bengal, was appointed to this post in 1904. This set-up was shifted to Shimla in the year 1906 and was placed under the control of the Director, CID. A post of Handwriting Expert for the Government of India was created and Mr. CR Hardless was appointed to this post. He was replaced by Mr. F Brewster, a police officer from the West Bengal CID, and was designated as the Government Examiner of Questioned Documents (GEQD). At first, the work of this office was mainly confined to the identification of writings on secret documents. Later, as the application of this branch of

science was felt in many other cases, the services of this office were thrown open to criminal as well as civil court cases. During the World War II, this organization took up the additional work of secret censorship, including the detection of invisible writings and training of military personnel in this field of science.

Serologist to the Government of India:

When the science of examining human blood developed in India, it became possible to examine blood and seminal stains in criminal investigations. Realising the importance of Forensic Serology, an institute named as 'Serology Department' was established in Calcutta in 1910. The head of this institute was designated as Imperial Serologist to the Government of India. Dr. Hankin helped in establishing this department. Though the scientific techniques for serological examination were at the infancy stage, this institute provided valuable scientific support by analyzing biological materials for crime investigations. After independence, the department was renamed as 'Office of the Serologist and Chemical Examiner to the Government of India'.

Footprint section of criminal investigation department:

During the year 1915, a Footprint Section was established under the CID, Government of Bengal, which helped the police authorities to identify criminals through the examination of footprints collected from the scene of crime. SM Edwardes recorded the following instance in his book 'Bombay City Police' showing the use of the footmarks in police work. 'On several occasions, Indian constables distinguished themselves by acts of bravery and examples of professional acumen. The detection of a burglary in the showroom of an English firm was entirely due to the action of a Hindu constable, who noticed on a piece of furniture the marks of a foot possessing certain peculiarities, which he remembered having seen before in the foot of an ex-convict.'

Note forgery section in criminal investigation department:

During 1917, a Note Forgery Section was set up under the CID, Government of Bengal, to undertake the examination of forged currency notes. The Revenue Department also started its own laboratory for identification of opium and narcotics, liquor analysis and estimation of purity levels of precious metals like gold, silver, etc. Similarly, Government Mint and Security Printing Departments at Nasik also established their own laboratories for detecting cases of counterfeit and forged currency notes.

Ballistics laboratory:

In 1930, an Arms Expert was appointed and a small ballistic laboratory was set up under the Calcutta Police to deal with the examination of firearms. As the menace of firearms

grew, other State CIDs also established small ballistics laboratories to help them in the criminal investigation.

Scientific sections in the criminal investigation department:

During 1936, a Scientific Section was set up under the CID in Bengal and facilities were created for examination of bullets, cartridge cases, firearms, etc., used in committing crime. Few other states also started scientific sections in their CID, where investigations on fingerprints, footprints, firearms and questioned documents were also carried out. Gradually, more and more branches of science were embraced and the laboratories gained maturity over the years.

State forensic science laboratory, Calcutta:

The first state forensic science laboratory in India was established in the year 1952 at Calcutta. This laboratory became fully operational in the year 1953. The Medico-legal Section of the Chemical Examiner's Laboratory was also transferred to this laboratory. During the year 1955, a small unit of Physics was established in the West Bengal State Forensic Science Laboratory to deal with various physical examinations of exhibits encountered in crime investigation. During the year 1957, the Physics unit developed into a full-fledged Physics Section. In the same year, the Footprint and the Note Forgery Sections of Criminal Investigation Department were transferred to this laboratory and in the following year General Chemistry Section of the Chemical Examiner's Laboratory was also transferred to this laboratory. Thus the first multidisciplinary forensic science laboratory came into existence in the country.

Central finger print bureau:

On the recommendations of the Royal Police Commission of 1902-03, the first Central Finger Print Bureau (CFPB) in India was established in 1905 at Shimla. It, however, suffered a setback and was abolished in 1922 as a result of retrenchment proposals of the Inchaape Committee. The CFPB restarted functioning from 1955 in Delhi under the administrative control of Intelligence Bureau (IB). The major role envisaged for CFPB was to coordinate the activities of State FPBx in tracing/locating inter-state criminals. During August 1956, the CFPB was shifted to Calcutta and remained under the administrative control of IB. During September 1973, it was transferred to the Central Bureau of Investigation and during July 1986, the administrative control of the CFPB was transferred to the National Crime Records Bureau (NCRB) and was again shifted to New Delhi.

Central detective training school at Calcutta:

CDTS, Calcutta, a premier detective training school in India, was established during 1956 and was located (in the same premises) with the CFPB, Calcutta. The aim of establishing such a school was to impart training in scientific investigation of crimes like drug abuse, terrorism, explosion, crime against women, investigation of road accidents and enforcement of traffic laws, etc.

Central forensic science laboratories:

The first Central Forensic Science Laboratory was established at Calcutta during 1957. To begin with, this laboratory was organised into four basic disciplines viz. Forensic Physics, Forensic Chemistry, Forensic Biology and Forensic Ballistics. For application of nuclear methods of analysis to criminal investigation, the Neutron Activation Analysis Unit of CFSL, Calcutta was set up in 1970 at the Baba Atomic Research Centre, Bombay. During the year 1965, the second central forensic science laboratory was established at Hyderabad, The CFSL, Hyderabad initially established analytical facilities in the disciplines of Forensic Physics, Forensic Chemistry and Forensic Biology. The Central Forensic Science Laboratory, Chandigarh, was established, in the year 1933 at Lahore was shifted to Chandigarh during 1961. Over the years many full-fledged forensic science laboratories were established in various states.

Central forensic institute, Calcutta:

With the establishment of CDTS and CFSL, (later on GEQD also) in the same premises, under the control of Intelligence Bureau, the whole set up was named as the Central Forensic Institute (CFI), Calcutta. A post of Commandant was created during 1958 to look after the overall functioning of all these establishments, which had different roles but with the common larger goal of providing appropriate scientific inputs to the criminal investigation process and administration of criminal justice in the country.

CDTS at Hyderabad & Chandigarh:

The Central Detective Training School, Hyderabad was established in 1964, on the pattern of the CDTS, Calcutta, followed by another one at Chandigarh, during 1973. Their main objective was to train the operational police personnel in modern scientific techniques of crime investigation, with a view to improve their professional standard and efficiency.

The role of central advisory committees:

The Union Government, during 1959, appointed two committees for the purpose of giving a lead to all the States in establishing new forensic science laboratories and improving the existing ones, and for improving the study and application of Forensic Medicine. These

committees were (i) Central Forensic Science Advisory Committee and (ii) Central Medico-legal Advisory Committee. The Central Medico-legal Advisory Committee was to advise the Central and the State Governments on matters pertaining to medico-legal procedures and practices. The Central Advisory Committee on Forensic Science considered the issues related to the sphere of Forensic Science (excluding forensic medicine). The Central Medico-legal Advisory Committee was discontinued whereas the Central Forensic Science Advisory Committee was converted into Standing Committee on Forensic Science during the year 1972, which is functional even today in BPR&D.

Indian academy of forensic science:

The Indian Academy of Forensic Sciences (IAFS) was established in the year 1960. This academy started a biennial scientific journal, which served as a forum for the exchange of ideas in forensic science with the other international bodies. The role of the Academy was also to hold annual scientific meetings/seminars or assist in holding seminars in forensic science. In fact, it was at the instance of this Academy that the Government of India established the Neutron Activation Analysis Unit to cater for the forensic needs in the country.

Teaching of forensic science in the universities:

The question of introducing criminology and forensic science as the courses of study at the university level in India was taken up with the Vice-Chancellors of various universities during 1950, but the progress made in this direction was not encouraging. The need for university teaching of criminology and forensic science was also stressed in various annual meetings of the Central Advisory Committee on Forensic Science. A deputation headed by Shri KF Rustamji met the Chairman, University Grants Commission in August 1961 and the matter was again taken up by Shri DP Kohli, the then Director, Central Bureau of Investigation in 1967. As a result of these discussions, Dr DS Kothari, the then Chairman, University Grants Commission set up a high level committee to advise the Commission on the steps to be taken for introduction of Criminology and Forensic Sciences in university education. It recommended that universities should be encouraged to introduce courses in Criminology at the under-graduate level and postgraduate courses in Criminology and Forensic Science should be started only in a central autonomous institution, which should be affiliated to a university. Consequently three Universities viz., University of Sagar, Madras and Patiala started undergraduate and post-graduate courses in forensic science. It was further suggested that, as an initial step in this direction, one institute under the Central Government should be established in Delhi. The Committee recommended those two courses viz. Master's

Degree in Criminology and Master's Degree in Forensic Science should be organised in this Institute, besides Diploma courses for in-service personnel. The institute should also be developed as a center for research in Criminology and Forensic Science and should act as a clearinghouse of up-to-date information in these fields.

Institute of criminology & forensic science at New Delhi:

After a series of debates at the Government level, it was decided that initially the Institute of Criminology and Forensic Science should be established only for training the in-service personnel and for conducting research in the field of forensic science. It was felt that unless the State governments and the consumer organizations agreed to participate in the scheme, it would not be wise to start courses for granting postgraduate degrees. However, the ultimate objective of the Institute was to develop into a full-fledged academic institution affiliated to a university. With the above aim in view, the Institute of Criminology and Forensic Science (ICFS) was established in Delhi during 1971 with the limited objectives of imparting training to the in-service personnel and conducting research in Criminology and Forensic Science. It was also envisaged that the Institute should have two distinct faculties viz. the Faculty of Criminology and the Faculty of Forensic Science and both should have a number of eminent teachers and researchers with adequate background and field experience.

Creation of forensic science division at BPR&D:

On an invitation from the Government of India, Dr. VK Street, an eminent forensic scientist from the Department of Forensic Medicine, University of Edinburgh, UK, visited different Indian forensic science institutions during 1972 and submitted a report to the Ministry of Home Affairs, Government of India. He strongly recommended for creation of a post of Chief Forensic Scientist in the Ministry of Home Affairs to look after its forensic science activities and to pay whole time attention for the development of this science in India. The Standing Committee on Forensic Science, during 1973, also recommended for the creation of a post of Chief Forensic Scientist so that the activities, which needed scientific inputs at the Union Government level, could be properly coordinated. The post of Chief Forensic Scientist was finally sanctioned during 1983, and the Forensic Science Directorate was created in BPR&D.

Recommendations of scientific advisory committee to the cabinet:

During 1983, the then Scientific Advisory Committee to the Cabinet (SAC-C) under the overall guidance of an Expert Committee chaired by Prof. M. M. Sharma, FRS, recommended that the laboratories in Delhi, Calcutta and Hyderabad must be developed as S & T institutions, functioning in an autonomous fashion, with complete modernization of

equipment and manpower capabilities. In pursuance of these recommendations, the Government of India declared the forensic science institutions, at the central Government level as Science and technology institution.

Based on the observations of the Expert Group of the SAC-C, BPR&D evolved a master plan for restructuring each CFSL of the BPR&D into fifteen scientific divisions. In the first phase, the three Central Forensic Science Laboratories at Calcutta, Hyderabad, and Chandigarh were restructured into six scientific division viz. Biology, Ballistics, Chemistry, Explosive, Physics, and Toxicology. Similarly, the offices of the Government Examiners of Questioned Documents at Shimla, Calcutta, and Hyderabad were strengthened in terms of manpower. Besides augmentation of staff, all the BPR&D laboratories registered significant progress in the acquisition of sophisticated analytical equipment and updating/modernizing the laboratory and library facilities for smooth working of these institutions.

A new mandate to the CFSLs of BPR &D:

During mid 1990's, it was realised that most of the States have established their own forensic science laboratories and hence the role of CFSLs to provide forensic analytical support to different states has got diluted. Hence the utility of three CFSLs at the national level was questioned.

During 1997, this realization led to the process of defining the role of the CFSLs of BPR&D, de novo. The justification for the existence of the three Central Forensic Science Laboratories under the BPR&D was thought to be two folds. One, they should act as epitomes of quality and high standards for the State Laboratories to emulate. They should not only set visibly higher standards in quality of analytical processes and reporting accuracy, but also should be the repository of Standards and benchmarks against which the performance of all the State FSLs can be judged. BPR&D should, therefore, have a decisive say in the process of accreditation, not only of its own CFSLs/GEsQD, but also of all the State FSLs. Secondly, since forensic science is one of the most dynamic sciences, CFSLs should provide R&D support to this field of science. Every new research, development and invention in any discipline of science should have a potential of application in forensic science. Newer, better and more reliable technologies developed in all the disciplines need to be harnessed for the fight against crime. The BPR&D CFSLs should scout around for new developments outside the realm of forensic science and adapt them for use in Ms, standardize the processes and disseminate them to the State FSLs. In order to perform this yeomen service, the CFSLs need to maintain very high standards and specialization, way beyond what is possible in the State FSLs.

Strategy was evolved to bring about a complete paradigm change in the structure of the three BPR&D CFSLs and provide them a new focussed mandate of R&D and specialized training. It emerged that while preserving their composite structure, the three laboratories should have subject-specific exclusiveness and be developed as the 'Centers of Excellence' for research and development and specialized training in the designated fields. Consequently, during 1998, the three CFSLs were reorganized with an aim to generate synergy and focus attention on research and development activities in the thrust areas of forensic science. This was possible only if all the available resources are pooled in the designated Centers of Excellence, rather than spread them very thin on the whole ground. Besides focussing on their core activity of R&D and specialized training in the designated field of forensic science, these laboratories also undertake crime case examination in all the fields of forensic science. However, the routine forensic analysis case work has now been restricted to those received from the Central Government organizations and State Governments/Union Territories, which have not yet established their own forensic science facilities. These laboratories also act as the referral centers for handling forensic analysis of crime cases requiring extensive investigation and high expertise, received from the courts of law, state and central forensic science institutions and other crime investigating agencies in India. The designated fields were chosen as follows:

CFSL, Calcutta Forensic Biological Sciences

CFSL, Hyderabad Forensic Chemical Sciences

CFSL, Chandigarh Forensic Physical Sciences

The Neutron Activation Analysis Unit of CFSL, Calcutta, operating at the BARC, Mumbai, was brought under the administrative control of CFSL, Hyderabad.

Establishment of DNA typing laboratory at CFSL Calcutta:

In response to the rising demands of providing high technology to the crime investigation process, BPR&D established the first Forensic DNA Typing facility at CFSL, Calcutta, during 1998. The implementation of this state-of-the-art technique represents significant advancements in the forensic biology in the country. The DNA Typing Unit at CFSL Calcutta is equipped with the most contemporary techniques of DNA typing, namely, Polymerize Chain Reaction (PCR) based method, HLADQ alpha and Polymarker technique, and Locus Specific Restricted Fragment Length Polymorphism technique. This laboratory, after being functional, has been referred many crime cases pertaining to murder, rape, rape and murder,

paternity disputes, organ transplant, exchange of babies in hospitals etc. DNA Typing facility has further been upgraded to conduct 'Short Tandem Repeats Sequence based DNA Typing.

Mobile Forensic Van (MFV)

MVU helps in reaching crime scene at the earliest to assist the investigating officers (IOs) in identifying and collecting relevant forensic evidence from crime scene, victims and from suspects which are the primary sources of forensic evidence. The mobile forensic team assists the Investigating officer in linking the crime with the perpetrator through the forensic evidence, collected from the crime scene, victims and suspects.

Counterfeit coins and currency notes:

Counterfeiting most commonly applies to currency and coins. It is illegal to manufacture, possess, or sell equipment or materials for use in producing counterfeit coins and currency. The production of counterfeit money is a form of fraud. Counterfeit money has been around since the intervention of money. Before paper money, the main method of counterfeiting was to mix gold or silver with other base metals to form "fool's gold." During World War 2, the Germans would produce counterfeit American dollars and British pounds. In 2002, after the launch of the Euro, the amount of counterfeiting increased considerably. Euro banknotes and coins were mostly forged.

Detection of Counterfeit Currency:

First Line Inspection Methods: These methods are used on the spot by vendors and retailers to determine the authenticity of the currency. However, this method is not always accurate. The counterfeit marks are both visible to the counterfeiters and the verifier therefore resulting in the spotting of a fraudulent note.

First Line inspection techniques includes

Varied Density Watermarks: Thin watermark can be applied to the paper of banknotes due to the varied density. Watermarks are visible when a bright light shines on the back of a banknote. The varied paper density causes the light to intensify resulting in the watermark to appear on the other side.

Ultraviolet Fluorescence: Embedding fluorescent fibres or printing ultra-violet ink paper creates an optical verification for easy on the spot detection. Exposing the paper to an ultra-violet light results in the embedded pattern becoming visible.

Intaglio Printing: The banknote undergoes a high-pressure printing raises the paper structure. A latent image can be produced by using different alignments of the lines. The appearance should change based on the angle that the note is viewed.

Microtext: Banknotes commonly have small text printed at high resolutions. This resolution cannot be achieved by a commercial copier, scanner or printer. When a forgery attempt is made, the small text becomes blurred because of the change in resolution. This ultimately proves a banknote is counterfeited.

Second Line Inspection Methods: A detection of counterfeit that cannot be verified by the naked eye and requires an extra device for detection.

Second Line Inspection technique includes:

Isocheck/Isogram: This method relies on a certain pattern of dots or lines to cause a specific type of pattern when printed or scanned. The hidden verification proves the authenticity of the note.

Fibre-Based Certificates of Authenticity: Using a scanner to illuminate one end of the embedded fibre, the other corresponding end will illuminate. Once illuminated, a fibre string can be identified. This string can be converted into a bit string and combined with other data and a cryptographic hash of itself and is signed using a private key. This can be encoded onto the banknote in the form of a bar code or verification number.

Color and Feature analysis: New image-processing softwares include secret detection algorithm to prevent banknotes from being altered.

Punishment for Counterfeiting Currency in India:

- 1) Counterfeiting currency note or bank notes or knowingly performing any part of the process of counterfeiting such notes- Imprisonment upto 10 years and fine (Section 489-A)
- 2) Knowingly using a genuine or otherwise trafficking in forged or counterfeit currency note or bank notes- Imprisonment for life or imprisonment upto 10 years and fine (Section 489-B)
- 3) Possession with knowledge of such notes for such use, etc- Imprisonment upto 7 years or fine or both (Section 489-C)
- 4) Making or possessing instruments or materials for forging or counterfeiting currency notes or bank notes - Imprisonment for life or upto 10 years and fine (Section 489-D)
- 5) Making or causing to be made or using or delivering documents resembling currency notes or bank notes – Fine upto Rs. 100 (Section 489-E)

Punishment for Counterfeiting Coins in India:

- 1) Counterfeiting coins or knowingly performing any part of the process of counterfeiting such coins- Imprisonment upto 7 years and fine (Section 231)
- 2) Counterfeiting Indian coins or knowingly performing any part of the process of counterfeiting - Imprisonment upto 10 years and fine (Section 232)

- 3) Making or selling or disposing of instrument for counterfeiting coin imprisonment for 3 years and fine (Section 233); for instrument for Indian coin- Imprisonment upto 7yrs and fine(Section 234)
- 4) Possession of instrument or material for counterfeiting coin with knowledge or reason to believe that it may be used for such purpose 3 years imprisonment and fine: for Indian Coins 10 years imprisonment and fine (Section 235)
- 5) Abetting counterfeiting coin outside India punished as if abetting counterfeiting inside India(Section 236)
- 6) Import or export of counterfeiting coins -3 years of imprisonment and fine9 Section237); Indian coin – Imprisonment for life, or imprisonment for 10 years, and fine(Section 238)

SCENE OF CRIME:

CRIME SCENE: Any physical location in which a crime has occurred or is suspected of having occurred.

- **PRIMARY CRIME SCENE:** The original location of a crime or accident
- **SECONDARY CRIME SCENE:** An alternate location where additional evidence may be found.

Securing the Crime Scene:

- First priority is medical assistance to individuals & arresting the perpetrator.
- Ropes or barricades and guards will prevent unauthorized access to the area.
- Every person who enters the crime scene has the potential to destroy physical evidence.
- The lead investigator evaluates the scene & determines the boundaries. They do an initial walk through & develop a strategy.
- Once the scene is secured, lead investigator establishes:
 - a. boundaries of the scene
 - b. perpetrator's path of entrance and exit
 - c. documentation of photographs of physical evidence
 - d. strategy for systematic examination and documentation of entire crime scene

Recording the Crime Scene:

There are three methods of crime-scene recording. They are

- photography,
- sketches, &
- notes

Ideally all the three should be used

Photography:

- The crime scene should be unaltered, unless injured people are involved, objects must not be moved until they have been photographed from all necessary angles.
- If things are removed, added, or positions changed the photographs may not be admissible evidence.
- Photograph should be taken completely.
- Area where crime took place & adjacent areas, various angles should be covered in photography

If crime scene includes a body:

- Take photos to show body's location & position relative to the whole crime scene
- Take close-up photos of injuries & weapons lying near the body
- After the body is removed, photograph the surface underneath.
- When size is significant, use a ruler or other measuring scale
- Digital cameras allow for enhancement & examination in fine detail.
- Videotaping a scene is also becoming popular.

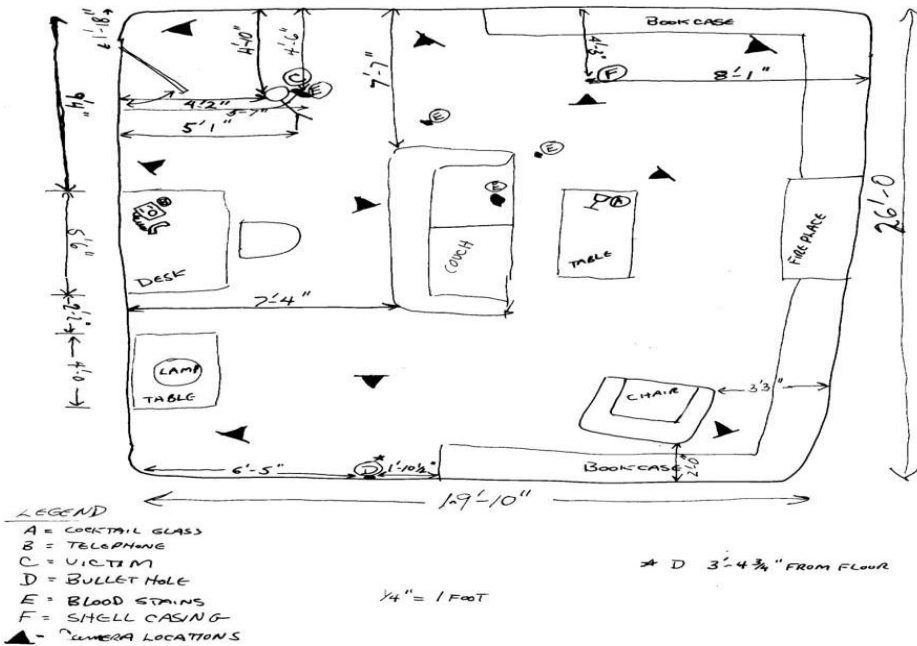
Sketches

- Once photos are taken, sketch the scene.
- A rough sketch is a sketch, drawn at the crime scene, that contains an accurate depiction of the dimensions of the scene & shows the location of all objects having a bearing on the case.
- All measurements are made with a tape measure
- Show all items of physical evidence
- Assign each item a number or letter and list it in the legend
- Show a compass heading designating north
- A finished sketch is a precise rendering of the crime scene, usually drawn to scale.
- Computer-aided drafting (CAD) has become the standard.

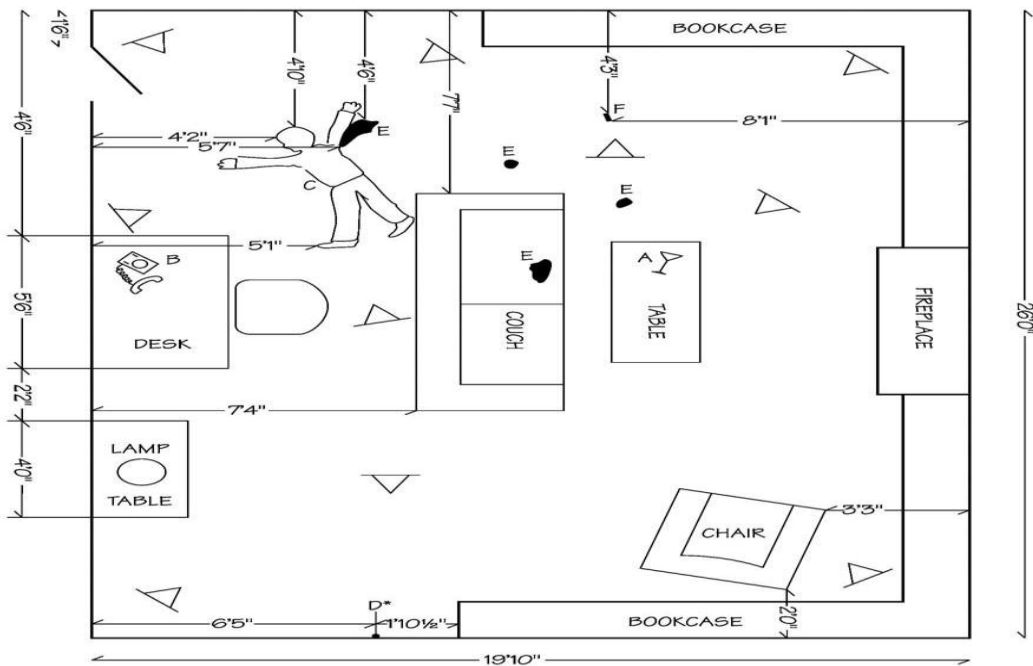
Rough-sketch diagram of a crime scene. Courtesy Sirchie Finger Print Laboratories, Inc., Youngsville, N.C., www.sirchie.com.

CASE 10-789-96
 301 N. CENTRE ST.
 OCT. 6, 1996 11:40 PM
 HOMICIDE

VICTIM: LESTER W. BROWN
 INVESTIGATOR: SGT. L.A. DUFFY
 ASST BY: PTL. R.W. HICKS



Finished-sketch diagram of a crime scene. Courtesy Sirchie Finger Print Laboratories, Inc., Youngsville, N.C., www.sirchie.com.



Notes

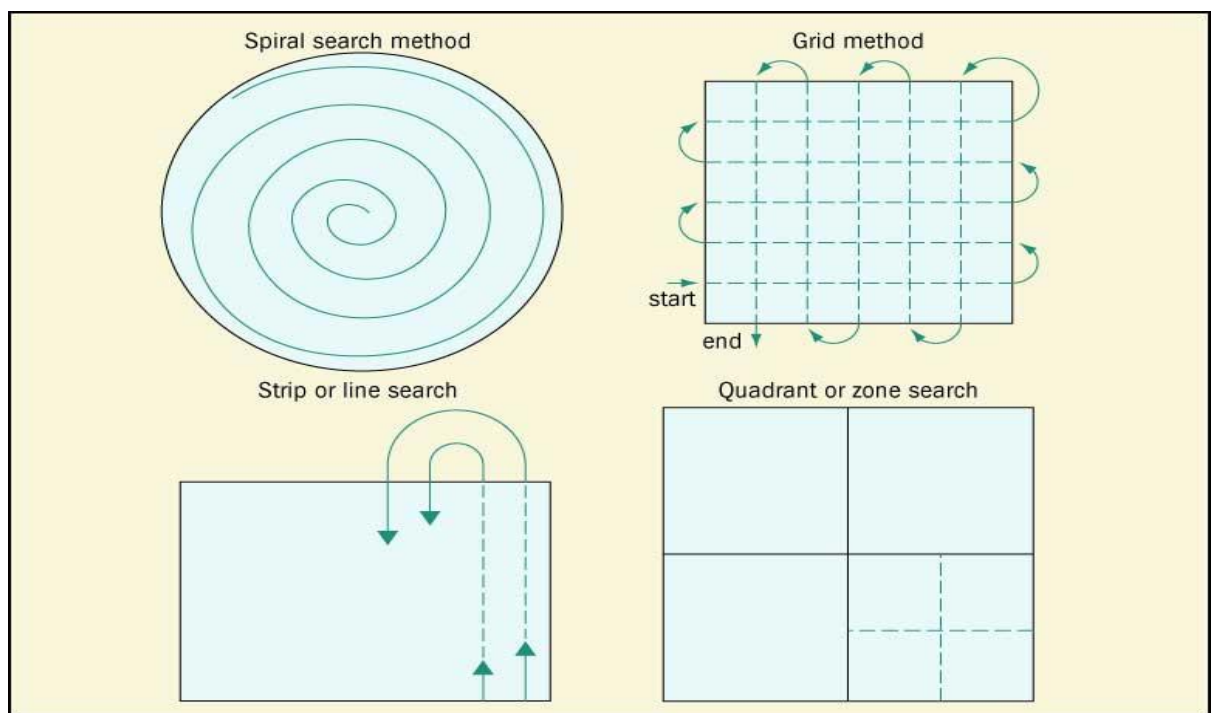
- Note taking must be a constant activity throughout the processing of the crime scene.

- The notes may be the only source of information to refresh memory.
- Tape-recording notes at a scene can be advantageous – detailed notes can be taped much faster than they can be written.

Searching the Crime Scene

- One person should supervise & coordinate.
- Include all probable entry & exit points in search
- What to search for will be determined by the particular circumstances of the crime.
- Examples: Homicide, Hit-and-run
- In most crimes, a search for latent fingerprints is required.

Systematic Search



Tools for Evidence Collection:

- Forceps
- Unbreakable plastic pill bottles w/ pressure lids
- Manila envelopes, glass vials, pill boxes
- Fire evidence must be kept in an airtight container to prevent evaporation of petroleum residues
- Clothing must be air-dried & placed in individual paper bags.

Chain of Custody:

- Chain of custody is a list of all people who came into possession of an item of evidence.

- Chain must be established whenever evidence is presented in court as an exhibit.
- Failure to do so may lead to? Regarding authenticity & integrity of evidence.
- All items should be carefully packaged and marked upon their retrieval at crime sites.
- Normally, the collector's initials & date of collection are inscribed directly on the article.
- The evidence container must also be marked with collector's initials, location of evidence, & date of collection.

Standard/Reference Samples:

- The examination of evidence often requires comparison with a known standard/reference sample.
- A standard/reference sample is physical evidence whose origin is known, such as blood or hair from a suspect, that can be compared to crime scene evidence.
- Such materials may be obtained from the victim, a suspect, or other known sources.
- The presence of standard/reference samples greatly facilitates the work of the forensic scientist.
- Bloodstained evidence must be accompanied by a whole-blood or buccal swab s/r sample obtained from all relevant crime-scene participants.
- A buccal swab is a swab of the inner cheek, performed to collect cells for use in determining the DNA profile of an individual.
- Some types of evidence must also be accompanied by the collection of substrate controls.
- Normally collected at arson scenes.
- A substrate control is uncontaminated surface material close to an area where physical evidence has been deposited; used to ensure that the surface on which a sample has been deposited does not interfere with laboratory tests.

Submitting Evidence to the Lab:

- Evidence is submitted to the lab either by personal delivery or by mail shipment.
- Most labs require that an evidence submission form accompany all evidence submitted.
- Enables the lab analyst to make an intelligent & complete examination of the evidence must be included.
- Provide a brief description of the case history so the examiner can analyze in a logical sequence.
- The particular kind of examination requested for each type of evidence should be delineated.
- A list of all items should be submitted.

Questioned documents:

In forensic science, Questioned Document Examination (QDE) is the examination of documents potentially disputed in a court of law. Its primary purpose is to provide evidence about a suspicious or questionable document using scientific processes and methods. Evidence might include alterations, the chain of possession, damage to the document, forgery, origin, authenticity, or other questions that come up when a document is challenged in court.

Principles of Forensic Document Examination:

Forensic document Examiners often deal with questions of document authenticity. To determine whether a document is genuine, an examiner may attempt to confirm who created the document, determine the timeframe in which it was created, identify the materials used in its preparation or uncover modifications to the original text. Documents can be examined for evidence of alterations, obliterations, erasures and page substitutions. Or the examiner can Study the methods, materials or machines that created the document, providing key Information that can identify or narrow the possible sources of the document. The ink, paper, writing tools, ribbons, stamps and seals Used in production of the document may all reveal important clues. The examiner may even discover valuable evidence in a document's invisible impressions. A key element of document examination focuses on handwriting. Forensic examination and comparison of handwriting, which includes hand printing and signatures, is based on three main principles:

- (1) Given a Sufficient amount of handwriting, no Two Skilled writers exhibit identical handwriting features;
- (2) Every person has a range of natural variation to his or her writing;
- (3) No writer can exceed his or her skill level (i.e., it would not be possible for a marginally literate person who has only learned to produce very basic hand-printed letters to execute perfectly formed, highly skilled cursive writing).

Why and When is Forensic Document examination used?

Since documents are part of daily life, forensic document examiners work a wide variety of cases. Forensic document examiners are called to investigate the authenticity of documents in situations such as:

- counterfeiting
- forgeries
- identity theft
- fraud

- suicides
- homicides
- bank robberies
- kidnappings
- extortion
- stalking
- contested wills
- contested contracts
- medical malpractice
- title/deed lawsuits

Forensic document examiners are most frequently asked to resolve questions of authorship. Is the signature on the mortgage loan genuine? Who wrote the anonymous note? Did the deceased sign the will? By comparing documents found at a crime scene to a suspect's known writing samples, the forensic document examiner can help confirm who wrote the note and include or exclude suspects from the investigation.

Limitations of forensic document examination:

The examination of questioned documents may be hampered or limited by the following factors:

- Non-original evidence
- Insufficient quantity of questioned material
- Insufficient quality
- Insufficient known specimens submitted for comparison
- Lack of comparability between the questioned documents and the known samples
- Lack of contemporaneous writings submitted for comparison
- Distortion or disguised writing

Ballistics:

In forensic science, the study of ballistics is the study of motion, dynamics, angular movement, and effects of projectile units (bullets, missiles and bombs). There are many applications of ballistics within a criminal investigation.

Bullets that are fired at the scene of a crime will be examined in the hopes of discovering several pieces of information. The actual bullets can identify what type of gun the criminals used and whether or not the firearm is connected to any other crime. The amount of damage a bullet has sustained upon hitting a hard surface can help determine approximately where the shooter was standing, what angle the gun was fired from, and when the gun was fired.

Any residue on the bullet can be studied and compared to residue on the hand of a suspect, the gun that fired, or any object that was close by when the firearm was used. This information helps examiner uncover the identity of the shooter. When the bullets are missing, the type of impact they made can still lead investigators to ascertain what kind of bullet that criminal used, and therefore the type of gun as well.

Studying the marking found on a bullet or the impact a bullet made on any surface can establish exactly which gun the criminal used. Every firearm produces slightly different and unique pattern on the shell-casing it fires; the bullets will therefore imprint a distinct pattern upon anything it hits. Once scientists have identified these markings they can easily match them to the appropriate firearm.

There are many experts deeply involved in this study, and they are frequently called upon to help solve crimes. Ballistics details are also commonly input into a large database that can be accessed by law enforcement agencies all across the country. This information can lead to the discovery of the owner of a particular weapon, and assist in tracking down the guilty party who fired the gun.

UNIT- 2

PHYSICAL EVIDENCE

Physical Evidence:

Any material either in gross or trace quantities that can establish through scientific examination and Analysis that a crime has been committed is known as Physical evidence.

Physical evidence utilization in other areas of forensic investigation:

- Provides investigative leads for a case
- Ties one crime to a similar crime or connects one suspect with another
- Corroborates statements from witnesses to or victims of a crime

Common types of Physical evidence:

- Blood, semen, saliva, hair, human or animal, biological samples
- Documents-handwriting, type, ink, indented, obliterations, burned
- Drugs-illegal substance-sale , manufacture, distribution, use
- Explosives- explosive charge material and residues
- Fibers, Hair, Paint
- Fingerprints, latent and visible
- Firearms and ammunition
- Glass-particles, fragments
- Impressions- tire marks, shoeprints, tracks, bite marks
- Organs and physiological fluids-existence of drugs or poisons, alcohol
- Petroleum products-e.g. gas residues, grease or oil
- Plastic bags-e.g. garbage bag in homicide or drug case
- Rubber, other polymers- remnants linked to objects recovered in suspects possession
- Powder residues- gun powder
- Serial numbers- ID numbers
- Soil and minerals-e.g. soil in shoes or safe insulation
- Tool marks-object containing impression of another object
- Vehicle lights- filament condition
- Wood and other vegetative matter wood, sawdust, plant material, linking person or object to the crime scene

Full Service Crime Lab

- **Physical Science Unit-** chemistry, physics, geology on drugs, glass, paint explosives and soil

- **Biology Unit-** biologist and biochemists conduct serology and DNA testing of biological material (Fluids)
- **Firearms Unit-** Examination of firearms, discard bullets, cartridge cases, shotgun shells, ammo, and clothing for residues are performed
- **Document Examination Unit-** handwriting and typewriting studies to ascertain authenticity or source
- **Photography Unit-** Digital imaging, IR, UV X ray
- **Other units:** Toxicology, Latent Fingerprints, Polygraph, Voiceprint, and Evidence collection units

Identification:

Identification has its purpose as the determination of the physical or chemical identity of a substance with near absolute certainty as existing analytical techniques will permit.

Comparison:

Comparison analysis subjects a suspect specimen and a standard/reference specimen to the same tests and examinations for the ultimate purpose of determining whether or not they have a common origin.

Individual characteristics

Individual characteristics- Properties of evidence that can be attributed to a common source with an extremely high degree of certainty

- Ears- Rudin
- Snowflakes- 3×10^{31}
- Fingerprints- Victor Balthazard mathematically determined the probability of two individuals having the same fingerprints is 1 in 10^{60}

Class characteristics

- Properties of evidence that can only be associated with a group and never with a single source
- Probability is important- Paint chip- one layer (one car model) vs.. multiple layers (one specific car)
- Blood example- Product rule- multiply the product of all frequencies = probability one individual possesses a combination of blood factors= 0.44% or 1 in 200
- DNA technology provides sufficient factors to permit individualization of biological materials to a person –However the results and interpretation are dependant on other factors
- Weakness is lack of ability to assign exact or approximate probability to most class physical evidence – (Even for DNA/blood

evidence frequencies of populations are known- still requires approximations- Consider also relatives as potential suspects?)

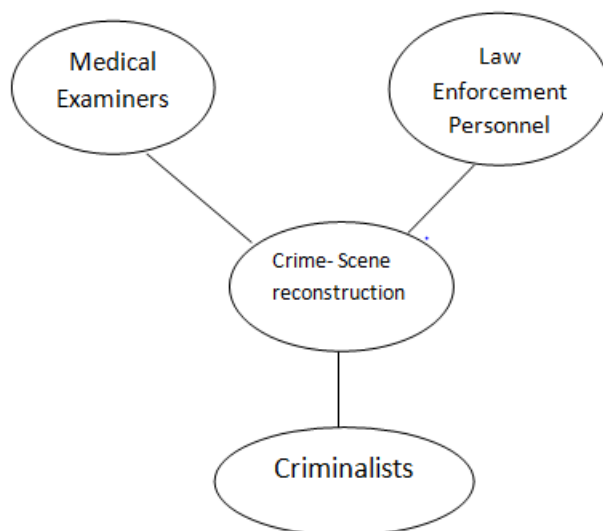
- Rely on personal experience called upon to interpret significance
- Some evidence is subjective- e.g. eyewitness, confessions, informants
- Value of class lies in the ability to provide corroboration of events with data free of human error and bias.
- Most situations, defining significance of class evidence in exact mathematical terms is difficult to impossible
- Collective presence of more than one type of class evidence may lead to extremely high certainty that they originated from the same source

Significance of Physical Evidence

- The weight of physical evidence is left entirely to the jury of laypersons
- Scientifically evaluated evidence take on an aura of special reliability and trustworthiness
- Need to take proper safeguards to avoid unfairly prejudicing a case against the accused
- Can be used to exclude or exonerate – Equally as important as conviction

Physical evidence collection and documentation: Foundation for reconstruction:

- Reconstruction supports a likely sequence of events by the observation and evaluation of physical evidence as well as statements made by witnesses and those involved
- Secure- preserve evidence, safety
- Search – Critical v Supporting v Property
- Record – sketching, measuring, photography, videography etc
- Reconstruct- final goal
- Team



Locard's Exchange Principle:

"Every Contact Leaves a Trace"

The value of trace (or contact) forensic evidence was first recognized by Edmund Locard in 1910. He was the director of the very first crime laboratory in existence, located in Lyon, France.

The Locard's Exchange Principle states that "with contact between two items, there will be an exchange." For example, burglars will leave traces of their presence behind and will also take traces with them. They may leave hairs from their body or fibers from their clothing behind and they may take carpet fibers away with them.

Evidence Examples:

Paint

- Physical and chemical analysis of paint evidence (chips or residue) can indicate its class, such as automobile paint, house paint, nail polish, etc. The evidence can be compared to 40,000 different types of paint classified in a database, which can be used to identify a particular make or model of car or brand of tool.
- Paint evidence can also indicate individual characteristics if an investigator is able to find similarities between two samples, such as the color, number of layers, chemical composition, or a physical match between the edges of two paint chips – one from a tool and one from a crime scene.

Glass

- Glass particles can be found at various crime scenes, such as breaking and entering, hit and run, vandalism, or murder.
- Glass at a crime scene is analyzed to determine its color, surface characteristics, tint, thickness, density, chemical composition, and refractive index (RI).
- The results of the tests provide clues about the crime and help investigators connect the evidence to a suspect or other object used in a crime, such as matching glass from a crime scene to a headlight to a suspect's car.

Explosives

- Explosive substances can be examined to determine its chemical composition to identify the type of explosive used and its origin.
- Traces of explosives found on a suspect's clothing, skin, hair, or other objects may be matched to explosives from the crime scene.
- Materials used to make an explosive device will be compared to evidence found in the suspect's possession to confirm a match.

Fracture Matches

- When an object broken, torn, or cut, two unique edges are formed, which are referred to as fracture lines.
- These edges can be compared by the naked eye or with microscopes to see if they fit together, which indicates that they may have been part of the same object at one time.
- Investigators may compare the edges on pieces of tape, glass fragments, paint chips, pieces of a car from an accident, paper bag, etc. to find possible matches.

Wounds

- Wounds can often be matched to weapons or tool marks on the weapon. Investigators may also be able to determine the weapon's size, shape, and length.
- Analysis of a wound may provides clues to a victim's injuries, characteristics of the suspect (left-handed, right-handed, height, etc.), and positions of the victim and suspect at the time of the incident.

Questioned Documents

- Examiners will analyze a ransom note or other document to find clues to link it to a crime scene or a specific suspect. They will analyze the type of paper used, printing method or handwriting style, and type of ink.
- Other unique features, such as watermarks on stationary or indentations made as someone wrote on a page in a notebook, may provide useful clues.

Insects

- Flies, beetles, and other insects can provide useful clues about a corpse.
- Forensic entomologists use factors such as weather conditions, the location and condition of the body, and their knowledge of the life cycles of insects to help them estimate the postmortem interval or PMI (the time between death and the discovery of the body).

DNA

- Investigators can extract DNA from almost any tissue, including hair, fingernails, bones, teeth and body fluids. The DNA is used to create a profile that can be compared to profiles from suspects or victims.
- CODIS (Combined DNA Index System) is a database maintained by the FBI that is used to find matches to unknown DNA samples from a crime scene.

Skeletal Remains

- Forensic anthropologists analyze skeletal remains to determine four characteristics for a victim: age, sex, race, and stature (height/build).
 - Sex - Determined by examining the pelvis, humerus, and

femur

- ▶ Age and stature – Determined by analyzing the development of the teeth, bone growth, and the length of specific bones, such as the femur.
 - ▶ Race – Determined by analyzing the skull for characteristics that are common among people of different races.
- DNA samples can be collected from bone, teeth, and hair to provide clues to a person's identity. Scientists may also be able to gain clues as to a person's past, recent injuries, or the cause of death based on bone fractures and other signs of trauma.

Body Fluids

- Blood, semen, saliva, sweat, and urine can be analyzed to give investigators information about the crime as well as its victim or the suspect.
- Chemicals and ultra violet light can be used at a crime scene to find body fluid evidence. Areas with potential evidence are swabbed, bagged and collected in vials, which are air tight and have a low risk of cross contamination.

Examples:

- ▶ Vomit and urine can be used to test for alcohol, drugs, and poisons.
- ▶ Cigarette butts may contain dried saliva.
- ▶ Semen containing sperm is valuable for DNA analysis.
- ▶ Blood can provide DNA evidence and blood spatter can provide clues about the crime.

Hair & Fibers

- Hair and fibers may be transferred from the suspect or the suspect's clothes to the victims' and vice versa. For example, a suspect may pick up carpet fibers on his shoes or leave hairs behind at a crime scene.
- Hair can be examined to identify their origin, such as human or animal. Hairs with roots intact can be tested for DNA.
- Fibers are used to make clothing, carpeting, furniture, beds, and blankets. They may be natural fibers from plants or animals or synthetic fibers that are man-made.

Footwear and Tire track examination:

Footwear and tire track can be deposited on almost any surface, from paper to the human body. Prints are divided into three types: Visible, plastic and latent.

A **Visible** print is a transfer of material from the shoe or tire to the surface. This type can be seen by the naked eye without additional aids. For example: bloody shoe prints left on flooring or tracks left by muddy tires on a driveway.

A **Plastic** print is a three dimensional impression left on a soft surface. This includes shoe or tire tracks left in sand, mud or snow.

A **Latent** print is one that is not readily visible to the naked eye. This type is created through static charges between the sole or tread and the surface. Examiners or investigators use powders, chemicals or alternate light sources to find these prints. Examples include shoeprint detected on a tile or hardwood floor, window sill, or metal counter, or tire tracks detected on road surfaces, driveways or sidewalks.

Sample collection:

Examiners use several methods for collecting footwear and tire track evidence depending on the type of impression found. For impression in soil, snow or other soft surfaces, casting is the most commonly used collection method. For imprints, examiners generally try to collect the entire object containing the imprint, such as a whole sheet of paper or cardboard with a shoe print. When that is not possible, for instance, if the print is on a bank counter, the examiner would use a lifting technique to transfer the imprint to a medium that can be sent to the laboratory.

As with any evidence found at the crime scene, shoeprints and tire tracks must be properly documented, collected and preserved in order to maintain the integrity of the evidence. Impression evidence is easily damaged, so steps must be taken to avoid damage to the evidence. This includes securing and documenting the scene prior to collecting any evidence. In the case of impression evidence, general photographs of the evidence location in relation to the rest of the scene are taken, along with high resolution images of the individual imprints or impressions. Examiners may use alternate light sources or chemical enhancers to capture as much detail as possible, especially with latent imprints.

Properly photographing impressions is crucial. Since there is only a slight difference between different shoe sizes, if the photographs are not taken at a 90° angle to the impression, then the true size cannot be produced in order to compare to the actual shoe.

Whenever possible, impression evidence is collected as is and submitted to the laboratory for examination. For shoeprints and tire tracks that cannot be picked up, various lifting techniques are used to recover the evidence. These include: Adhesive lifter, Gelatin lifter, Electrostatic dust-print lifting device etc.

Tools and techniques:

During the examination and comparison, examiners use tools such as dividers, callipers, special lighting and low magnification. Examiners measure the various elements within the tread design as well as the length and width of the impressions, and then compare those measurements to what is seen in the crime scene print or impressions. Low magnification and special lighting are sometimes used to determine if various characteristics are accidental or something that was created during the manufacturing process.

Examiners perform side-by-side comparisons by placing the known shoe or tire alongside the crime scene print so that corresponding areas can be examined. Test prints are also compared to the crime scene print. Digital images on double or triple computer monitors can also be used during the comparison.

UNIT – 3

PERSONAL IDENTIFICATION

Personal identification is the process of establishing the identity of any individual whether living or dead. In living, identification is important in cases of amnesia, unconscious, imposters, issue of identity cards, passports, driving license, legal documents etc. Identification in living is done by the law enforcement agencies to identify perpetrators of crime through trace evidence such as bloodstains, hair, foot/shoe print, fingerprint, bite marks etc. In few cases by knowing the function such as speech, handwriting, gait, voice etc recognition of living can be done.

In cases of natural mass disasters like earthquakes, cyclone, floods, tsunamis etc., or man-made like aircraft disaster, bomb blast, terrorist attacks, murders, victims of war crime etc where the unidentified body or bodies (either dismembered or decomposed or intact body) are in question, the need to identify the identity of an individual is essential for social as well as medico-legal purpose. Personal identification of an unknown deceased is important for both legal as well as on humanitarian grounds. It is important legally for matters related to wills, inheritance, insurance policies, and prosecution of homicides, detection of fraudulent deaths, estate, debts, accident reconstruction and remarriage. Morally it is essential for closure and declaration by surviving relations and friends. Also accurate identification of dead is required for personal and religious, completion of official records and burial or cremation purpose. Visual identification of deceased becomes hard in cases of fire, explosion, advanced stage of decomposition, mutilation, aircraft accidents or bomb blast. In certain cases charred remains are also recovered from a burnt vehicle or building. Identification of dead body can be done during stages of fresh and intact body, putrefied body, mutilated or dismembered, charred remains and lastly with skeletonised remains.

The prime duty in personal identification is to ascertain whether the remains belong to human or not. If the answer is affirmative of being human, further techniques are employed to identify the unidentified body. Personal identification is a field where various branches of science like pathology, genetics, biology, anthropology, physics unite together to derive objective source of identification.

The process of identification begins with collection of ante mortem data i.e. any information or document collected, age, hair colour, sex, tattoos, recent photographs etc that would assist in identification. The following figure explains the various evidences through which personal identification is done.



The principal approach towards identification process is by estimating and detecting characters of the remains that may narrow down the pool of matches. The objective of personal identification is to link an unknown body to a known identity. The approach may include:

- Two sets of evidence have possible origin from the same individual .
- Two sets of evidence have no possible origin from the same individual .
- Insufficient information to prove origin

Identification can be initiated using two stages: first is through technique that lead to positive identification and second stage is identification by limiting probable matches to the individual. Positive identification can be made when the match is sufficient to conclude the common origin of the same individual. Any piece of evidence that might identify the person is relevant. But in some cases there are no clues to suggest identity. Whenever identification is in question it is generalized that DNA analysis is the solution. However, it is not the only method. In spite of one of the advantages of genetics is being able to supply a quantitative

result, the lack of relatives to compare with sometimes invalidates its usefulness. In these circumstances the classical forensic anthropological examination is still useful and exceptional. At that time the anthropological examination is used to assess biological information like age, sex, ancestry and living stature and generates a biological profile of an individual which results in tentative identification. Without a biological profile given by an anthropologist, DNA could be useless.

Though genetics is really an excellent tool for identification, in many circumstances the classical anthropological analysis remains as valid as ever, as emphasized by different authors in many situations within the context of human rights violation such in Bosnia-Herzegovina or in mass disasters like the World Trade Centre victims. There is always an urge to develop new scientific methods for personal identification by studying various morphological and metrical approaches among different populations.

Anthropological techniques lead to the identification through bones, teeth, body and facial features. The persons specializing in anthropometry are familiar with the biological variations in the population, well informed in comparative osteology, craniometry, racial morphology, skeletal anatomy and functions. Hence anthropologists study the origin, behaviour and the physical, social and cultural development of humans in all its aspects.

FORENSIC ANTHROPOLOGY

Anthropometry has a key role in many human growth and identification studies by measuring the human body and its parts for several years. The application of the knowledge in solving practical problems has helped in the investigation of human variations among living populations. These results have introduced a new subject of interest with its practical applicability known as 'Forensic Anthropology'. Forensic anthropology thus represents the application of knowledge and techniques of physical anthropology to problems of medico-legal significance. Forensic anthropologists help the legal agencies to identify the unknown individual (living/dead) during calamities and crime investigation. In cases of unimpaired veracity of bodies, there are not so many problems in identification but identification is much more difficult in impaired veracity of a cadaver by different reasons such as an earthquake, tsunami, floods, a war, any terrorist activities or a brutal murder.

Forensic anthropology is considered to be an applied subfield of physical anthropology. Traditionally, forensic anthropology deals with the analysis of human remains. Occasionally the remains are fragmentary or charred or sometimes decomposed and forensic anthropologists are called to opine about its origin as well as biological characteristics that

assists in positive identification. Role of forensic anthropologists in investigation of unknown is fundamental in field of forensic science.

A current definition for forensic anthropology can be found on the American Board of Forensic Anthropology web site, “Forensic anthropology is the application of the science of physical or biological anthropology to the legal process. Physical or biological anthropologists who specialize in forensics primarily focus their studies on the human skeleton”

Today, forensic anthropology is gaining massive popularity and has come into much public attention with need to identify unknown individual. In 2008, Federal Bureau of Investigation (FBI) and the Department of Defence Central Identification Laboratory under a joint venture formed a working group ‘*The Scientific Working Group for Forensic Anthropology (SWGANTH)*’ to develop and propagate best practice guidelines and standard for the discipline. The SWGANTH consists of representatives from forensic, industrial, commercial and academic communities, including international participants. Forensic anthropologists are specialized and educated to interpret findings from skeletal remains in order to understand variations between humans throughout the globe, across geography, between sexes, during life span and between individuals. It is also important to understand the legal, cultural and scientific challenges towards forensic anthropological analysis.

PHOTOANTHROPOMETRY

Alphonse Bertillon (1853-1914) a French criminologist developed a new method which uses “a system of description and characterisation” which could be used with photographs for identification which he called ‘Bertillonage’. Bertillonage used enlarged photographs to match with the photographs of the skull by using same focal length at a standard distance. Bertillon, who was also a biometric researcher developed a system of description and classification by use of anthropometry and developed an identification system based on physical measurements of head and body. This measurement could be applied to one and only one person and that could be specific to him. Alphonse Bertillon (1890) was first who mentioned, photographs were futile for identification if they were not standardized by using the proper lightening, scale and angles. There is a great degree of variation that occurs in the face during aging of adults that will affect outcomes for face- based systems.

Face is the most distinctive and distinguishable part of the human body. Usually we recognise people by their face and their facial features which help to provide information regarding their age, sex and ethnic background. This uniqueness of face eventually helps us to identify a person and differentiate from another face. Face has its individual shape, dimensions and

features which can be assessed morphologically as well as metrically. Recently, a question towards the identity through surveillance is on rise with increase in frauds. With the raise in number of ascertain cases of disputed identification in CCTV images and other photographic evidence, there arise a need to develop a new scientific methods using facial comparison technique. In cases related to CCTV images, it is mandatory to provide opinion evidence of identity from examination of evidential images commonly it is termed as “facial mapping” or “facial comparison technique” . Facial mapping is a tool for identification of living that involves morphological and metrical analysis. Generally permutation of three approaches is made by expert:

- Morphological Comparison.
- Photoanthropometry.
- Superimposition

This type of image evidence is permissible globally. Example in India, Italy, South Africa, USA and in the UK more than 500 court reports on image evidences are prepared per annum . In morphological comparison, facial features with distinct shape and size are categorised. This technique gives reliable results even with poor quality images. Further statistical analysis is conducted and face with similar feature is differentiated . Various studies have showed that the personal identification process can also be done by using anatomical landmarks and measurements or proportions obtained using landmarks from the photograph or CCTV evidence. This form of identification can be termed as ‘Facial Image Identification’ or ‘Photoanthropometry’. Photo anthropometry is a metric based facial image comparison technique which requires predetermined facial landmarks for measurement of the face from an image. Here proportional analysis of the distances and angles between anatomical landmarks in the images are calculated and compared. Photo anthropometry is now an acceptable tool in the identification with a manual technique. In the present research to overcome the manual method for identification, a new scientific approach towards photo anthropometry has been made by developing a SAAS (Software at a Service) which works on the principle of facial mapping using photographs which reduces time and labour. This type of analysis can be applied to the large amount of identity document fraud, photo analysis, manipulated or disguised facial photographs etc. With superimposition, one image is projected over another in order to study facial similarities and dissimilarities. Superimposition using 3-D (three dimensional) images is more successful. Despite of any method, only confirmation

of non-identity is probable. A distinct consistent difference has more influence than an abundant of similarities.

SEX DETERMINATION:

It is the first step towards a development of any biological profile. Estimating sex involves identification and evaluation of characteristics that shows differences between male and female which can variably be noted. Sex is primarily determined by reproductive organs and hormones, secondly by muscles and distribution of hair and lastly by physiological differences of skeleton like pelvic bone and skull. Sex can be differentiated by sexual dimorphism or through phenotype. Sexual dimorphism usually relates to the differences in morphology (size and shape), physiology and behaviour. In forensic anthropology, morphological differences are very useful for sex determination. Differences in the size and robusticity display a degree of sexual dimorphism. In the skeleton the best criteria for determining sex are in the pelvic bone and secondly from the skull. These differences reflect the fact that females are smaller, less muscular and more gracile. Standards for sex determination from different bones from several human groups can be found in sources on human osteology and forensic anthropology. The range or distribution of sex variation differs between populations with females tending to be more male-like in some group and males more female like in others. The term 'sex' and 'gender' have distinct meaning. For any analysis and estimations done by anthropologists based on skeletal characteristics, 'sex' is appropriately used. Methods that are developed for estimating sex falls into two categories: Non-metric (macroscopic or visual) analysis and metric analysis. Metric analysis includes measurements based on the landmarks to quantitatively evaluate size and shape difference between two sexes. Metric analysis sometimes involves evaluation of single measurements or numerous measurements. Currently from skeletonised remains, sex is being determined through:

- Humeral head diameter
- Deltoid tub. Robusticity
- Gonial eversion
- Genial tubercle robust.
- Browridge
- Mastoid process size
- Temporal line
- Ischio-pubic index
- Femoral head diameter

- Bicondylar breadth
- Sacrum curvature
- Ventral arc
- Ridge on sub-pubic angle
- Sub-pubic concavity
- Shape of symphyseal block
- Ascending ramus width
- Acetabulum size

When any foot or arm or face or other fragmented body parts are recovered at scene of crime, their dimensions can provide valuable information about the gender of the unknown body. There is a statistical correlation ship between body length and body segment which can be calculated using various statistical equations to estimate gender. These dimensional relationships have been of interest to many artists, scientists, anatomists, anthropologists and in medico-legal for many long years. These body segments proportion vary between populations due to genetics and the environment in which they live. Various parts of the body segments respond and develop differently due to the environment and genetics.

AGE DETERMINATION:

Accurate estimation of age represents an important component in forensic anthropological analysis. This determination of age is important in confirming the correct identity during mass disaster when numbers of possible matches are greater. Determining age in children and young people depends on morphological methods such as radiological examination of skeletal and dental growth. In adults, age determination is difficult.

The estimation of biological age in a specimen is related to several biological processes, but particularly the growth, modelling and remodelling of the skeleton, result in age-related changes in the morphology of skeleton components. Age can be estimated by studying the changes in bone growth, development and fusion, formation and eruption of dentals by use of the pattern at known rates. From birth through the growth phase, the criteria for estimating age include: the sequence of dental eruption as well as crown and root development, fusion of epiphyses and apophyses and long bone length . By 20s the growth of bone is complete and age can be determined from degenerative changes in the body. Joints are prone to deterioration and undergoes consistent change over the period of one's life, thus age can be estimated by studying this changes. Age can be determined through:

- Dental eruption
- Bone size and maturity

- Epiphyseal closure
- Cranial sutures
- Sternærib end changes
- Pubic symphysis

Current methods of age assessment include precise morphological methods with error margins of greater than ± 10 years or complex laboratory methods such as racemisation of aspartic acid in dentin or tooth enamel or radiocarbon dating of tooth enamel with accuracy of ± 3 and $\pm 1-2$ years [28]. Both of the latter methods result in high precision age estimation. As such, aspartic acid racemisation and radiocarbon dating currently represent the methods of choice for precise age estimation.

FINGER PRINTS:

No two people have exactly the same fingerprints. Even identical twins, with identical DNA, have different fingerprints. This uniqueness allows fingerprints to be used in all sorts of ways, including for background checks, biometric security, mass disaster identification, and of course, in criminal situations. Fingerprint analysis has been used to identify suspects and solve crimes for more than 100 years, and it remains an extremely valuable tool for law enforcement. One of the most important uses for fingerprints is to help investigators link one crime scene to another involving the same person. Fingerprint identification also helps investigators to track a criminal's record, their previous arrests and convictions, to aid in sentencing, probation, parole and pardoning decisions.

Fingerprints can be found on practically any solid surface, including the human body. Analysts classify fingerprints into three categories according to the type of surface on which they are found and whether they are visible or not: Fingerprints on soft surfaces (such as soap, wax, wet paint, fresh caulk, etc.) are likely to be three-dimensional plastic prints; those on hard surfaces are either patent (visible) or latent (invisible) prints. Visible prints are formed when blood, dirt, ink, paint, etc., is transferred from a finger or thumb to a surface. Patent prints can be found on a wide variety of surfaces: smooth or rough, porous (such as paper, cloth or wood) or nonporous (such as metal, glass or plastic).

Latent prints are formed when the body's natural oils and sweat on the skin are deposited onto another surface. Latent prints can be found on a variety of surfaces; however, they are not readily visible and detection often requires the use of fingerprint powders, chemical reagents or alternate light sources. Generally speaking, the smoother and less porous a surface is, the greater the potential that any latent prints present can be found and developed.

Principles of Fingerprint Analysis

Fingerprints are unique patterns, made by friction ridges (raised) and furrows (recessed), which appear on the pads of the fingers and thumbs. Prints from palms, toes and feet are also unique; however, these are used less often for identification, so this guide focuses on prints from the fingers and thumbs.

The fingerprint pattern, such as the print left when an inked finger is pressed onto paper, is that of the friction ridges on that particular finger. Friction ridge patterns are grouped into three distinct types—loops, whorls, and arches—each with unique variations, depending on the shape and relationship of the ridges:

Loops - prints that recurve back on themselves to form a loop shape. Divided into radial loops (pointing toward the radius bone, or thumb) and ulnar loops (pointing toward the ulna bone, or pinky), loops account for approximately 60 percent of pattern types.

Whorls - form circular or spiral patterns, like tiny whirlpools. There are four groups of whorls: plain (concentric circles), central pocket loop (a loop with a whorl at the end), double loop (two loops that create an S-like pattern) and accidental loop (irregular shaped). Whorls make up about 35 percent of pattern types.

Arches - create a wave-like pattern and include plain arches and tented arches. Tented arches rise to a sharper point than plain arches. Arches make up about five percent of all pattern types.

Uses of Fingerprint analysis:

Fingerprints can be used in all sorts of ways:

- Providing biometric security (for example, to control access to secure areas or systems)
- Identifying amnesia victims and unknown deceased (such as victims of major disasters, if their fingerprints are on file)
- Conducting background checks (including applications for government employment, defense security clearance, concealed weapon permits, etc.).

Fingerprints are especially important in the criminal justice realm. Investigators and analysts can compare unknown prints collected from a crime scene to the known prints of victims, witnesses and potential suspects to assist in criminal cases. For example:

- A killer may leave their fingerprints on the suspected murder weapon
- A bank robber's fingerprints may be found on a robbery note
- In an assault case, the perpetrator may have left fingerprints on the victim's skin
- A burglar may leave fingerprints on a broken window pane
- A thief's fingerprints may be found on a safe

In addition, fingerprints can link a perpetrator to other unsolved crimes if investigators have reason to compare them, or if prints from an unsolved crime turn up as a match during a database search. Sometimes these unknown prints linking multiple crimes can help investigators piece together enough information to zero in on the culprit.

In the absence of DNA, fingerprints are used by the criminal justice system to verify a convicted offender's identity and track their previous arrests and convictions, criminal tendencies, known associates and other useful information. Officers of the court can also use these records to help make decisions regarding a criminal's sentence, probation, parole or pardon.

Collecting Fingerprints:

Collecting Patent Prints

Patent prints are collected using a fairly straightforward method: photography. These prints are photographed in high resolution with a forensic measurement scale in the image for reference. Investigators can improve the quality of the images by using low-angle or alternate light sources and/or certain chemicals or dyes during photography, but this is usually not necessary.

Collecting Latent Prints

One of the most common methods for discovering and collecting latent fingerprints is by dusting a smooth or nonporous surface with fingerprint powder (black granular, aluminum flake, black magnetic, etc.). If any prints appear, they are photographed as mentioned above and then lifted from the surface with clear adhesive tape. The lifting tape is then placed on a latent lift card to preserve the print.

However, fingerprint powders can contaminate the evidence and ruin the opportunity to perform other techniques that could turn up a hidden print or additional information. Therefore, investigators may examine the area with an alternate light source or apply cyanoacrylate (super glue) before using powders.

Alternate Light Source (ALS): It is becoming more commonplace for investigators to examine any likely surfaces (doors, doorknobs, windows, railings, etc.) with an alternate light source. These are laser or LED devices that emit a particular wavelength, or spectrum, of light. Some devices have different filters to provide a variety of spectra that can be photographed or further processed with powders or dye stains. For example, investigators may use a blue light with an orange filter to find latent prints on desks, chairs, computer equipment or other objects at the scene of a break-in.

Cyanoacrylate: Investigators often perform cyanoacrylate (superglue) processing, or fuming, of a surface before applying powders or dye stains. This process, typically performed on non-porous surfaces, involves exposing the object to cyanoacrylate vapors. The vapors (fumes) will adhere to any prints present on the object allowing them to be viewed with oblique ambient light or a white light source.

Chemical Developers: Porous surfaces such as paper are typically processed with chemicals, including ninhydrin and physical developer, to reveal latent fingerprints. These chemicals react with specific components of latent print residue, such as amino acids and inorganic salts. Ninhydrin causes prints to turn a purple color, which makes them easily photographed. DFO (1,2-diazafluoren-9-one) is another chemical used to locate latent fingerprints on porous surfaces; it causes fingerprints to fluoresce, or glow, when they are illuminated by blue-green light.

Other Collection Methods: In addition to the methods identified above, there are special techniques for capturing prints from skin, clothing and other difficult surfaces. Amido Black, a non-specific protein stain that reacts with any protein present, is typically used for developing or enhancing bloody impressions on human skin. To reveal prints on clothing, high-tech methods such as vacuum metal deposition using gold and zinc are showing promise for the investigator. AccuTrans, a liquid casting compound, can be used to lift powdered latent prints from rough, textured or curved surfaces. AccuTrans is basically a very thick liquid that fills in the nooks and crannies of rough or textured areas where conventional print lifting tape encounters difficulty.

Like fingerprint powders, chemical processing can reduce the investigator's ability to perform other techniques that could reveal valuable information. Therefore, any nondestructive investigations are performed before the evidence is treated with chemicals. For example, a ransom or hold-up note will be examined by a questioned documents expert before being treated with ninhydrin, since some formulations of ninhydrin will cause certain inks to run, thus destroying the writing.

Footprints:

For years, criminal investigators and forensic scientists have used fingerprints to determine identity. More recently, footprints have been discovered to be an equally reliable identifier. Every person's foot has a unique set of ridges that make up a print unmatched by any other human being. As with fingerprints, the footprint's pattern is a unique characteristic that can pinpoint any one particular person.

While footprints can be used as a method of forensic science, more often the prints at a crime scene do not come from a bare foot. To compensate, scientists have created methods of identifying shoeprints. The indentations on the ground made by any shoe can be studied, recorded and matched to prints found at other locations. Therefore, if one set of shoeprints is found at the scene of a crime, it can be compared to another set of prints found at a separate crime scene. A matching print tells investigators that the same person was involved in both crimes.

To preserve the prints, detectives take detailed photographs that can be scanned into computers for analysis. In many cases, technicians will make a casting of the print. So that a duplicate may be produced. The casting process involves pouring a dense liquid into the actual shoe imprint and allowing it to set. After the liquid solidifies, the casting can be picked up as one piece so that an exact replica will be available for future reference.

Forensic scientists can also make other determinations about a suspect based on their shoe print. The size of the shoe allows them to estimate the height of the person in question. By comparing how deep the print is in connection with how solid the soil was and whether or not the ground was damp at the time, investigators can gain a better idea of the weight of the person. All of these methods can help determine the criminal's identity.

Process of fingerprint/ Footprint analysis:

Examiners use the ACE-V (analysis, comparison, evaluation and verification) method to reach a determination on each print.

Analysis involves assessing a print to determine if it can be used for a comparison. If the print is not suitable for comparison because of inadequate quality or quantity of features, the examination ends and the print is reported as not suitable. If the print is suitable, the analysis indicates the features to be used in the comparison and their tolerances (the amount of variation that will be accepted). The analysis may also uncover physical features such as recurves, deltas, creases and scars that help indicate where to begin the comparison.

Comparisons are performed by an analyst who views the known and suspect prints side-by-side. The analyst compares minutiae characteristics and locations to determine if they match. Known prints are often collected from persons of interest, victims, others present at the scene or through a search of one or more fingerprint databases such as the FBI's Integrated Automated Fingerprint Identification System (IAFIS). IAFIS is the largest fingerprint database in the world and, as of June 2012, held more than 72 million print records from criminals, military personnel, government employees and other civilian employees.

Evaluation is where the examiner ultimately decides if the prints are from the same source (identification or individualization), different sources (exclusion) or is inconclusive. Inconclusive results may be due to poor quality samples, lack of comparable areas, or insufficient number of corresponding or dissimilar features to be certain.

Verification is when another examiner independently analyzes, compares and evaluates the prints to either support or refute the conclusions of the original examiner. The examiner may also verify the suitability of determinations made in the analysis phase.

DNA Analysis

The **DNA collection and analysis** gives the criminal justice field a powerful tool for convicting the guilty and exonerating the innocent. Only one-tenth of one percent of DNA differs from person to person. Although the DNA between people is so similar the small differences can be used to identify an individual, victim or suspect. This DNA evidence is the most important evidence to lawyers, because it is the most accurate method of identifying someone. The Federal Bureau of Investigation (FBI) has chosen 13 points of Short Tandem Repeats to be used as the base for DNA analysis and aside from identical twins, the chances of these points being the same in two individuals is 1 in 1 billion or greater.

DNA analysis is a fairly new technology. The first use of DNA analysis was in the 1980s to convict a man from Portland, Oregon of raping a 13 year old. In this case, DNA samples were taken from the suspect and from the fetus which had been aborted. The DNA was then analyzed and the results were conclusive. The results were conclusive because a fetus has the mother's and the father's DNA and common sequences between were found between the accused man's DNA and the fetus. The accused also confessed and was convicted.

There are different techniques to analyze DNA. Most labs have the ability to test Nuclear DNA, which is DNA that is found in the Nucleus of every cell. There are other labs that have the ability to use mitochondrial DNA analysis or Y-chromosome analysis. One of the first techniques used to analyze DNA was Restriction Fragment Length Polymorphism or RFLP. This technique analyzes the length of repeating bases in strands of DNA. The repetitions are known as Variable Number Tandem Repeats, or VNTRs, due to the fact that they can repeat from up to thirty times per strand, though the number of time it repeats varies from strand to strand. The RFLP technique also requires the DNA to be dissolved in a specific enzyme that helps break the DNA at specific points. In the case of RFLPs, a large sample of DNA that has not been contaminated is needed.

Another method of DNA analysis is Short Tandem Repeat (STR) Analysis . Unlike RFLP, STR analysis can use a smaller sample of DNA. This is because scientists can use a process

known as Polymerase Chain Reaction or PCR to amplify or make copies of the DNA and produce the desired amount of material needed. Once the DNA has been amplified STR analysis looks at how many times base pairs repeat at a specific location. This can be repetitions of two (dinucleotide), three (trinucleotide), four (tetranucleotide) or five (pentanucleotide) base pairs. Investigators have found that base pairs of four or five seem to be the most accurate.

A special method to analyze DNA is through Y-Marking analysis or analysis of the Y chromosome. This type of analysis helps identify DNA from different males. Another method that is special is Mitochondrial DNA Analysis. This type of analysis uses DNA from the mitochondria of a cell. It has been found that this type of DNA is most useful in helping to solve cold cases because degraded DNA (DNA that has been improperly stored or stored too long) can be analyzed and can help find a perpetrator. A new special technique Single Nucleotide Polymorphism or SNP are most often used to determine a person's chance of contracting a certain disease. Forensic scientists rarely use SNP, but did to help successfully identify victims of several September 11th victims after other identification methods failed.

Blood Evidence: Basics and Patterns

The discovery of blood in a case opens up a mini investigation within the investigation. This is because an investigator must initially determine if a crime has been committed. It's important to determine if a crime has been committed because the presence of blood does not necessarily mean that there ever was a crime. This determination has to be made in a case where a person is reported missing since it will help investigators. The blood found can then be tested and see if it belongs to the victim; if the blood does belong to the victim there is a possibility that a crime has been committed and that the case could change. Blood evidence also comes in to play in criminal cases. Blood found on the blade of a knife could mean that a crime was committed and someone was stabbed- but it could also mean that the victim sliced their own finger. Even though there may be a crime where someone has been stabbed, it has to be determined that a crime was committed with that particular knife. The red substance that has been found is tested. Initially the blood is tested to determine if it is blood, and then if it is human blood. Once the substance has been tested and it's been determined that it is blood and it is human blood, it can be determined if the blood came from the victim or the suspect. Blood evidence isn't just collected off of weapons, but can also be collected off of the floor or other surfaces in a crime scene. This blood is also tested to determine if the blood came from the victim or the suspect.

Besides testing, investigators use blood stain patterns to help determine if a crime was committed. There are different types of blood stain patterns that an investigator looks for, these patterns are as follows:

- Drip Stains/Patterns – blood stain patterns that are created due to the force of gravity acting on liquid blood.
- Blood Dripping into Blood
- Splashed (Spilled) Blood
- Projected Blood (with a syringe)
- Transfer Stains/Patterns -A transfer bloodstain pattern is created when a wet, bloody surface contacts a surface that is not bloody. With this type of pattern, part or the entire original surface may be recognizable, a full or a partial shoe print, for example.
- Spatter Patterns- Blood spatter patterns are created when an exposed blood source is subjected to an action or force greater than gravity (internally or externally)
- Castoff- A blood stain pattern that is created when blood is released or thrown from a bloody object in motion.
- Impact –A blood stain pattern resulting from an object striking liquid blood
- Projected-A blood stain pattern that is produced by blood being released under pressure– for example, arterial spurting.

Investigators also look for the following blood stain patterns:

- Shadowing/ Ghosting- When there is an empty space or “void” in the spatter. This indicates that there was an object in the way.
- Swipes and Wipes- Swipes occur when blood on a surface is smeared. Wipes occur when a bloody object brushes against a surface.
- Expiratory Blood – Blood that is coughed or breathed out. This is indicated by a misty pattern that resembles high velocity spatter results.

Blood Stain Pattern Analysis

There are many different factors to consider when analyzing **blood stain patterns**. The first thing that an investigator wants to determine is what kind of pattern is being presented. Blood stain patterns can be presented as:

- Drip Stains/Patterns
 - Blood Dripping into Blood
 - Splashed (Spilled) Blood
 - Projected Blood (with a syringe)
- Transfer Stains/Patterns

- Blood Spatter
 - Castoff
 - Impact
 - Projected
- Shadowing/ Ghosting
- Swipes and Wipes
- Expiratory Blood

When an investigator is analyzing drip stains/ patterns, blood spatter, shadowing/ghosting, and expiratory blood there are different factors they have to look at, these factors include:

- Whether the velocity of the spatter is low, medium or high
- The angle of impact

A low velocity spatter is usually four to eight millimeters in size and is often a result of dripping blood after a victim sustains an injury such as a stab or in some cases a punch. For example, if a victim is stabbed and then walks around bleeding, the drops of blood that are left behind are low velocity. The low velocity drops in this example are passive spatters. Low velocity spatter can also result from pools of blood around the body and transfers. A medium velocity spatter is a result of a force anywhere from five to a hundred feet per second .This type of splatter can be caused by a blunt force such as a baseball bat or an intense beating. This type of spatter is usually no more than four millimeters. This type of spatter can also be a result of a stabbing. This is because arteries can be hit if they are close to the skin and blood can spurt from these wounds. This is classified as projected blood. A High velocity spatter is generally caused by a gunshot wound but can be from a wound from another type of weapon if enough force is used.

Once the type of velocity is determined it's important to determine the angle of impact. These two factors are important to find so that it's possible for a point of origin to be determined. A general observation that can be made by investigators about the angle without any calculations being involved is that the sharper the angle, the longer the "tail" of the drop is. The angle of impact is determined by dividing the width by the length of the drop. Once the angle is determined investigators then take the arcsine (inverse sine function)of that number and then use stringing (the use of strings to chart the trajectories of all the blood droplets in the air) to determine the point of origin (where the stings converge).

Collection and Preservation:

The **collection and preservation of blood stain evidence** is important because this evidence can be used to type blood or run DNA analysis.

There are two different types of blood that can be collected at a crime scene: liquid and dried blood. Liquid blood evidence is generally collected from blood pools but can be collected off of clothing as well, using a gauze pad or a sterile cotton cloth. Once the sample is collected it must be refrigerated or frozen and brought to the laboratory as quickly as possible. The sample must first be dried thoroughly at room temperature. It is important to get the sample to the laboratory as quickly as possible because after 48 hours the sample might be useless. If the sample has to be mailed it should be completely air dried before packaging. If the sample isn't completely dry when it needs to be packaged, the sample should be rolled in paper and labeled and then put into either a brown paper bag or a box. The paper bag or box is then sealed and labeled again. It is important to only place one item per container to avoid contamination and samples should not be placed in plastic containers. Samples shouldn't be in plastic containers because if the sample is still damp the moisture from the sample can cause microorganisms that can destroy the evidence. Also, due to this fact, samples should not be in any container for more than two hours.

Dried bloodstains can be found on small objects, larger objects and on clothing. When dried blood is found on a small object the entire object can be sent to the lab after it's been properly packaged and labeled. When dried blood is found on a larger object that is transportable, an investigator should cover the stained area with paper and tape the paper to the object to avoid contamination. If the object that is stained is not transportable there are different ways that an investigator can collect the sample. One option is to cut out the stained area of the large object. If the portion is cut out the sample is packaged the same way as described above but a control sample should also be provided in a separate package. Another option is to use fingerprint tape and lift the sample as well as the surrounding control area. If this method is used it is important for investigators to not touch the sticky side of the tape with bare hands and the investigator should run an eraser or some type of blunt object over the placed tape to ensure that contact is made with the dried stain. The lifted stain is then be packaged and labelled, then delivered to the laboratory. Another way to collect a sample off of an object is to use a clean sharp object to scrape flakes of the stain into a paper packet. The last two methods of collection of a dried bloodstain on a large object require the use of distilled water to dampen the stain before rolling a thread in the stain or absorbing the stain with a cotton square. These two methods are not recommended due to the risk of contamination. When dried blood is found on clothing the entire article of clothing should be packaged and labelled and delivered to the lab.

It is important for the investigator to remember to keep each sample separated so that there is no contamination between samples.

Semen Analysis

In semen analysis, an alternative light source like a laser is used to find stains on bed sheets or clothing. Once a stain is found it is sent to be tested to determine the type of biological fluid it is. If the biological fluid is not blood the other options are saliva, urine or **semen**. DNA profiling starts from the identification of a stain as seminal fluid. Once this is determined it is important for the DNA analyst to determine if sperm is present in the fluid. It's important to determine if sperm is present because it contains a great deal of DNA, which could help to identify a suspect. Once it has been determined that sperm is present, the analyst must determine which item of evidence or swab sample has the most sperm so that getting a DNA profile is more likely.

Sperm is identified by using a combination of general cell staining and bright field microscopy. This has been around for forty years. This is the most popular method to detect sperm but it is not the best method because it takes hours for an analyst to search for sperm. However, it is more common because sperm that has been isolated from a sexual assault has lost most if not all of the sub-cells that are needed for morphological identification. There is a method that has been developed called SPERM HY-LITER™. This method is a fluorescent monoclonal antibody-based kit which is used for microscopic identification. "Forensic Detection of Sperm from Sexual Assault Evidence" describes the kit as follows:

SPERM HY-LITER™ is designed to provide positive identification of sperm using a unique monoclonal antibody that has been chemically tagged with an Alexa 488 fluorophore. The kit incorporates a second fluorescent dye, 4',6-diamidino-2-phenylindole (DAPI) that will stain all cell nuclei; this is a fluorescent analogue of the KPIC stain currently used in most DNA forensic laboratories. By combining both fluorescent dyes, SPERM HY-LITER™ provides several visually confirmatory steps for the identification of sperm. Sperm can be visualized in the fluorescein channel (the fluorescent spectra of Alexa 488 falls conveniently within the emission maximum for fluorescein); all cell nuclei can be seen in the DAPI channel; and using specialized dual filter 'cubes,' epithelial nuclei and sperm can be visualized simultaneously.

Although semen can easily be identified through testing, finding sperm may not always be possible. Forensicscience.ie explains that semen in men who have had a vasectomy does not contain sperm, so in cases like this further confirmatory tests must be done.

Medico legal importance of Age:

In medico legal cases, the age of a person is determined by medical officer on requisition from the police officer or magistrate. Age is an important factor in following situations:

- Judicial punishment
- Juvenile punishment
- Rape cases
- Kidnapping cases
- Employment
- Attainment of majority
- Evidence
- Marriage
- Identification

UNIT- 4

FORENSIC MEDICINE

Forensic Medicine or Legal Medicine deals with the application of Medical Knowledge to AID in the administration of Justice. It's a Practical Science Bridging the LAW & MEDICINE, Which are the EYES of the Society. (Medical Aspects of Law).

Forensic Medicine can be broadly divided into :-

- Clinical Forensic Medicine :- deals with the examination of the LIVING individuals.
- Forensic Pathology :- Deals with interpretation of Autopsy Findings in the Medico-Legal investigation of Death (Forensic Thanatology – study of Death).

Medical jurisprudence: Deals with the legal responsibilities of the Physician with particular reference to those arising from Physician-Patient relationship, such as Medical Negligence, Consent, Rights and Duties of Doctors, Serious Professional Misconduct, etc., (in short, deals with the Legal Aspects of Practice of Medicine)

Medical Ethics : Deals with the Moral Principles which should guide the members of the Medical Profession in their dealings with each other, their Patients and the State.

Medical Etiquette : Deals with the conventional laws of courtesy observed between the members of the medical profession.

Medico-Legal work in Ancient India:

- The first treatise on Indian Medicine was the “Agnivesa Charaka Samhita”
- “Charaka Samhita” lays down an elaborate Code regarding the training, duties, privilege and Social Status of Physicians.
- prescribes punishment for wrong treatment.

History of Forensic Medicine

- Kautilya's Arthashastra states that Death can be caused by :-
- Stopping the Breathing by 4 ways (Strangling, Hanging, Asphyxiation or Drowning)
- Physical Injuries in 2 ways (by Beating or by Throwing from a Height)
- Poisoning (poisons, snake or insect bite, or narcotic Drugs)
- Kautilya's Arthashastra describes the necessity of Autopsy in establishing the Cause of Death. It states that a Post-mortem shall be conducted on any case of Sudden (Unnatural) Death, after smearing the body with oil to bring out Bruises, Swellings and other injuries.

Medico-Legal work in British INDIA

- The earliest Hospital was Established by Sir Edward Winter in Chennai in 1664 for treatment of Sick Soldiers.

- The incidence of Custodial Death and its Certification by Medical Practitioners was reported in Chennai in 1678.
- The earliest Medical Certificate was issued by Edward Bulkley and Samuel Browne, after examining Mr. John Nicks on Aug 16th 1693.

Medico-Legal Autopsy

- 1st post-mortem was conducted at Bologna, Italy
- In India, The first Recorded Medico-Legal Autopsy was conducted in Chennai by Dr Edward Bulkley on 28th Aug 1693 on the body of Mr. James Wheeler, Member of Council.
- In 1914, Lt. Colonel D. G. Crawford in his “A History of Indian Medical Service” states that “A Very important part of a Civil Surgeon’s duties is performance of Medico-Legal Post-mortem”.

Scope of Forensic Medicine

- Forensic Medicine deals almost entirely with Crime against Persons.
- In present days almost all the offences against the Human Body requires medical opinion in order to deliver an impeccable justice in the court of law.
- The primary interest is to provide the source of information about medical science to confine the needs of the Law.
- Forensic Medicine is mostly an exercise of common sense combined with the application of Knowledge and experience acquired in the other branches of medicine
- Forensic Medicine involves Observation of Facts, Collection of evidence for the construction of right inference based on Medico-Legal Examination.

CONSENT

- Voluntary agreement, compliance or permission for a specified act or purpose.
- Indian Contracts Act, Section 13 states that “two or more persons are said to consent when they agree upon the same thing in the same sense”.
- To be legally Valid, the consent given must be intelligent and informed.

Types of Consent

- IMPLIED CONSENT
- EXPRESSED CONSENT :-
 - Oral
 - Written
 - INFORMED CONSENT (The corner stone of medical practice)

Post-Mortem Examination (Autopsy):

Post mortem examination is an investigative scientific Dissection of Dead Body.

TYPES

- Clinical or Academic Autopsy:- Performed with the consent of Relatives.
- Medico-Legal Autopsy:- is performed on the Authorization of the Legal Authorities in circumstances relating to suspicious, sudden, obscure, unnatural and Criminal Deaths.

Aims & Objectives of Medico legal Autopsy:

- To find out the cause of Death, whether natural or unnatural.
 - To find out the manner of Death, whether accidental, suicidal or homicidal.
 - Estimate the Time Since Death.
 - To establish the identity when not known.
- Document all the injuries, find out how the injuries occurred and their time of infliction.
- To collect evidence in order to identify the object causing Death and to identify the Criminal.
 - To retain relevant organs and tissues as Evidence.
 - In newborn to determine whether Stillborn, Deadborn or liveborn.

Rules of Medico-Legal Autopsy:

- Body should be labeled as soon as it arrives in the mortuary.
- Conducted only when there is an official order Authorizing the Autopsy.
- Autopsy should be conducted as early as possible, with out undue delay.
- Autopsy should be conducted in day light as for as possible.
- The medical officer must go through the inquest report & Hospital Records and collect as much information as possible pertaining to the circumstances of Death.
- The body must be identified by the Police Constable, and his name must be recorded.
- In unidentified bodies, the marks of identification, photographs, finger prints, etc., must be taken
- No unauthorized persons should be present at the autopsy.
- Details of examination should be noted verbatim by an assistant.
- Nothing should be erased and all alterations must be initialed.
- Even if the body is decomposed, complete autopsy is a must.

EVIDENCE (sec 3 of IEA 1872)

- Evidence means and includes all statements which the court permits or requires to be made before it by witnesses, in relation to the matter of fact under inquiry.

- For the evidence to be accepted by the courts, it must be properly identified as to what it is, and where it was found.
- Chain of custody : It is a method to verify the actual possession of an object from the time it was first identified, until it is offered as evidence in the court.

Types of Evidence

- Direct Evidence :- The witness testifies directly of his own knowledge as to the facts in dispute.
- Circumstantial Evidence :- Tends to Prove the ultimate fact in issue. (Presumptive Evidence) – it's the Evidence derived from Circumstances as distinguished from direct and positive proof.
- Substantial Evidence :- The Evidence which a reasonable man will accept as adequate for arriving at the decision in a case.
- Corroborative Evidence :- The Evidence that concurs with another evidence. The witness of the eye is positive.
- The Medical witness or the Expert witness is only corroborative.
- Documentary Evidence :- includes all the documents produced for inspection of the court. Document means any matter expressed by means of letter, figures or marks. Ex :- Medical Certificate, Medico-Legal Report, Dying declaration.
- ORAL EVIDENCE :- In all cases Oral Evidence must be Direct. It must be evidence of a person who Saw, Heard or Perceived.

Exception to Oral Evidence :- dying declaration, Expert opinion expressed in a treatise, Evidence of a doctor recorded in a lower court, Evidence of a witness given in a previous judicial proceedings,

- Hearsay Evidence :- Any statement made by any person other than the Witness, giving evidence in the court.

Dying Declaration:

- It's the statement ORAL or WRITTEN made by a person who is Dying as a result of some unlawful act, relating to the material facts of his death or bearing on the circumstances. (Section 32 I.E.A.)
- Before recording the statement the Doctor should certify that the person is conscious & his mental faculties are normal (COMPOS MENTIS)

WITNESS:

- Sections 118 to 134 of I.E.A. deals with Witnesses
- All persons are competent to Testify unless the prevented from doing so.

TYPES OF WITNESSES :-

- **Common Witness** :- First hand knowledge rule.
- **Expert Witness** :- Is a person who has been trained or is skilled in technical and Scientific subject, and Capable of drawing inferences, opinions and conclusions from the facts observed by himself, or noticed by others. Ex :- doctors, firearm expert, finger printing expert, etc.,

INQUEST:

Legal inquiry into the cause, manner and circumstances of any unnatural, sudden and suspicious deaths.

TYPES OF INQUEST:

Police Inquest: This is the usual type of inquest conducted in India. The officer incharge of a police station, not below the rank of Sub-Inspector (called the investigation officer of that particular case), on receipt of information of death informs the executive magistrate and proceeds to the place where the dead body is found. He conducts the inquest in presence of two witnesses, who are in respectable position in the society (Panchayat head). He comes to a conclusion of the apparent cause of death, as judged by him and prepares a Inquest report. If death is purely due to disease he may hand over the body to the relatives of the deceased to bury the body according t their religion customs. If he suspects some foul play or the cause of death remains obscure, he sends the body to the nearest authorized centre for post-mortem examination, along with a copy of the inquest report.

Magistrate Inquest: The executive magistrate appointed by the state government(Collector, R.D.O or Thasildar) conducts the inquest in the following circumstances.

1. Dowry deaths
2. Death in police custody
3. Death during police interrogation
4. Death due to police firing
5. Death in a psychiatric hospital
6. Exhumation

Coroner's Inquest: Coroner is a person qualified either in Medicine or Law or Both, appointed by the Government. He conducts the inquest in all unnatural and suspicious deaths. He is empowered to summon any person for enquiry. Coroner's court is a court of enquiry, but he is not empowered to conduct a trial. This type of inquest is done in United Kingdom and in some states of USA. This type of inquest is no more in India. Lastly withdrawn from Bombay in 1999.

Medical Examiner System of Inquest: This is the type of inquest prevalent in most states of USA and also in many advanced countries. A medical examiner (forensic expert) is appointed to perform the functions of coroner. One receipt of information of a death, the medical examiner visits the scene of crime and conducts the inquest. Thus he is able to gather first – hand evidence which is interpreted in proper perspective owing to his knowledge of medical science and autopsy is conducted by him. This is said to be the superior most type of Inquest.

CONSENT

Voluntary agreement, compliance, permission or acceptance for the act proposed by another, for a specified act or purpose is known as Consent.

Indian Contracts Act, Section 13 states that “Two or more persons are said to consent when they agree upon the same thing in the same sense”, to be legally valid, the consent given must be intelligent and informed.

Types of consent:

Implied consent: The behaviour or the act of another person itself indicated that he has consented for the act; you can take it for granted that he/she has given the consent.

Expressed consent:

- Oral consent
- Written Consent
- Informed consent (The coroner stone of medical practice) – The doctor examining r treating a patient without the consent amounts to the offence of assault. A doctor after examining a patient must explain to the patient and/or the relatives:

- 1) What is the disease or problem he is suffering from?
- 2) What is his treatment plan, for that disease or condition?
- 3) What are the alternative treatments available?
- 4) What are the advantages and disadvantage of his proposed treatment?
- 5) What are the advantage and disadvantage of alternate line of treatment?

Then allow the patient to choose what type of treatment he needs; the law believes that the patient himself is one who os best cared of his health and so he is the one to decide what is good or bad to him and what is to be done to his health, which is he feels the best.

Informed refusal: When the doctor feels that, a particular type of treatment will suit the patient best and may also result in some other complications at later course of life if the patient does not accept for his proposed treatment plan, then the doctor has to inform in detail all these and still if the patient refuses, the doctor has to bring all in writing and get it signed by the patient

THANATOLOGY

Thanatology is the study of Death.

DEATH : Death is the complete and irreversible cessation of Circulation, Respiration and Brain Functions. As long as circulation of oxygenated blood is maintained to the Brain Stem, Life continues to exist.

Suspended Animation : The vital Functions of the body comes down to a minimum level, just compatible with Life. The person appears apparently DEAD. Seen in:

- 1) New born
- 2) Electrocution
- 3) Drowning
- 4) Hypothermia
- 5) Induced voluntarily by Practice (yoga)
- 6) Drugs – barbiturates

Vegetative State : Breaths Spontaneously. Stable Circulation. But unaware of Self and Environment. Seen in :

Diffuse Bilateral Cerebral Hemisphere Disturbance, with an Intact Brain Stem.

Brain Stem Death :

- ⊙ Irreversibly Unconscious
- ⊙ Irreversibly Apnoe

Diagnosis of Brain Stem Death

British Code or Harvard Criteria:

1) Preconditions:

- a) *Comatose Patient on a ventilator*
- b) *Positive Diagnosis of Cause of Coma – Irreversible Structural Brain Damage.*

2) Exclusion:

- a) Hypothermia
- b) Drugs
- c) Severe Metabolic or Endocrine Disturbances

3) Tests:

- a) Brain Stem Reflexes
- b) Apnoea Test

Types of Death:

- ⊙ Somatic or Clinical Death

☉ Molecular or Cellular Death - Death of cells and tissues individually.

According to Causative Agent:

- 1) Natural
- 2) Unnatural – Homicidal, Suicidal, Accidental

MODE of DEATH:

COMA: Insensibility which involves the central portion of the Brain Stem and may cause Death. Coma is clinical symptom and not a cause of Death.

- Compression of Brain
- Drugs - opium, cocaine, alcohol.
- Metabolic – uremia, diabetes.
- Infection – pneumonia, infectious fever
- Others – thrombosis & embolism epilepsy, hysteria, etc.

SYNCOPE: Sudden stoppage of action of Heart due to vasovagal attack resulting from reflex parasympathetic stimulation

BP falls suddenly causing cerebral anaemia & rapid unconsciousness.

CAUSES : 1) Anaemia – sudden blood loss

- 2) Deficient power of Heart
 - MI, Poisons, Fatty degeneration
- 3) Vagal inhibition
- 4) Exhausting diseases.

ASPHYXIA: Interference with respiration, or Lack of oxygen in respired air

- Due to which the Organs and Tissues are deprived of Oxygen (together with failure to eliminate Carbon dioxide)
- Leading to unconsciousness & Death

ANOXIA: Gordon and his co-workers in 1994 claimed that the only mode of Death is ANOXIA.

- 1) Anoxic Anoxia
- 2) Anaemic Anoxia
- 3) Stagnant Anoxia
- 4) Histotoxic Anoxia

POST-MORTEM CHANGES

Time Since Death:

- ☉ Interval between time of Death and the time of conducting Post-Mortem.

- ⊙ This question arises most commonly in cases of Unwitnessed or Unreliably witnessed Deaths.
- ⊙ Reliably witnessed Simultaneous Deaths.
- ⊙ Determination of TSD is an indispensable component of Corpus Delicti.

EARLY CHANGES:

- ⊙ Changes in the Skin
- ⊙ Changes in the Eyes
- ⊙ Algor mortis
- ⊙ Livor mortis
- ⊙ Rigor mortis

LATE CHANGES:

- ⊙ Decomposition:

Putrefaction & its modifications:

- Adipocere
- Mummification

IMMEDIATE CHANGES:

- Complete and irreversible cessation of functions of Brain, Heart and Lungs.
- Muscles of the body become flaccid. (Primary flaccidity)
- Corneal and Pupillary reflexes are abolished.

1) INSENSIBILITY & PRIMARY FLACCIDITY of MUSCLES

- Earliest Sign of Death, but not considered positive because it is also seen in cases of deep coma and Narcosis.

2) PERMANENT STOPPAGE of CIRCULATION

- Stoppage of Circulation for more than 5min, but under certain circumstances, even after stoppage of Respiration Heart may continue to beat for more than 10 min. E.g.: Hanging

Tests for Stoppage of Circulation:

1) Auscultation:

2) Icard's Test :

- 1% alkaline solution of fluorescein, if injected subcutaneously, will gradually spread around with a greenish hue, if there is a minute capillary circulation.

3) Ligature Test :

A ligature is tied around the root of a finger, If there is little amount of circulation present, the finger will become swollen & red and the proximal part of the ligature will become blanched.

4) Magnus's Test :

A light is placed between webs of fingers, if there is capillary circulation still present there will be a reddish-glow, But if there is no circulation, the light will have a yellow, waxy hue.

5) Finger Nail Test :

A finger is pressed with another finger, if there is circulation, it will become blanched and when pressure is released, it will again become red.

6) Arterial Spurting Test :

If there is littlest circulation still present and a small artery is nicked, the arterial blood will spurt.

7) Heat Test :

When heat is applied momentarily over the skin, there will be formation of a blister, with congestion at that place, if there is slightest circulation present.

8) ECG :

Continued flat wave in all the leads, for continuous 5min signifies stoppage of Heart.

Tests for Stoppage of Respiration:

1) Feather Test

2) Mirror Test

3) Winslow's Test - A pot containing water or mercury is placed over the chest and a beam of light is focused on it from a fixed source. The reflected image seen on the opposite side will move if there is slightest movement of the chest.

Tests for stoppage of Brain function

1) Absence of motor and sensory functions.

2) Testing brain stem reflexes.

3) EEG.

Changes in the EYES:

☉ CORNEA :

- Loses its lustre

- Becomes dull, hazy, and finally opaque and wrinkled.

- TACHE NOIR SCLEROTICA (A film of cell debris and mucus forms two yellow triangles of desiccated discolouration on the sclera each at the side of the iris, which becomes brown and then black)

☉ INTRA OCCULAR TENSION :

- Falls so rapidly that by 2hrs after death, the tension is nearly zero.

- Eye balls appears sunken.

⊙ PUPILS : Dilated and fixed (no reaction to light), later becomes constricted (with onset of rigor-mortis).

CHANGES in RETINA:

⊙ Fragmentation or segmentation of blood columns appear within minutes after death called as “TRUCKING”.

⊙ Retina is Pale for the 1st two hrs.

⊙ At about 6hrs, the disc outline is hazy and becomes blurred in 7 to 10 hrs.

Chemical changes in the vitreous humor

- There is a steady raise in the potassium level after death.

ALGOR MORTIS :(Cooling of the Body)

⊙ There is a constant balance between heat production and heat loss during life. After death heat production is lost, hence the body starts cooling.

⊙ The body loses heat by Conduction, Convection and Radiation.

⊙ Body surface starts losing heat rapidly, but the inner body Core temperature does not alter until a gradient is established between the core body temperature and the environment.

⊙ There is no significant change in the Core Body temperature for sometime (1 to 2 hrs)

⊙ Once the gradient is established, then the body starts losing heat at a constant rate.

⊙ The rate of cooling is proportional to the difference in temperature between the body and the surface (Newton’s Law)

⊙ Temperature is measured by using a Chemical thermometer from RECTUM or ABDOMEN.

TIME SINCE DEATH :

$$\frac{\text{Normal body Temp – Rectal Temp}}{\text{Rate of fall of Temp / hour}} = \text{Time since death}$$

EX: $\frac{37 - 35.5}{1.5} = 1 \text{ Hr.}$

Postmortem Caloricity:

The temperature of the body raises for the first few hours after Death.

- When the regulation of heat production has been severely disturbed before death, as in sun stroke.

- When there is great increase in heat production in the muscles due to convulsions, Ex: tetanus, strychnine poisoning.

- Excessive bacterial activity, as in septicæmic conditions, cholera and other fevers.

LIVOR MORTIS(Post mortem staining, Post mortem Hypostasis)

- ⊙ After stoppage of circulation, the blood which is fluid in nature, gradually settles down in the toneless capillaries of the dependent parts of the body.
- ⊙ Seen externally as purplish discolouration through the skin.
- ⊙ Those parts of the body which is in actual contact with the surface, do not show PMS, As the capillaries are pressed by the weight of the body- known as areas of “contact flattening”.
- ⊙ Postmortem lividity begins as mottled patches ranging from 1 to 2 cms in diameter
- ⊙ These patches gradually increase in size and coalesce with each other to form an uniform area of staining – 2 to 3 hrs.
- ⊙ If the position of the body is altered, these patches gradually disappear, and appear in the new dependent parts.
- ⊙ Fixation of PMS in 6 to 8 hrs.
- ⊙ PMS disappears with the onset of putrefaction.
- ⊙ PMS may not develop at all if the body is tossed and turned continuously as seen in fast flowing water in rivers.
- ⊙ PMS can not be appreciated well in dark coloured persons.
- ⊙ PMS may not be appreciated even in fair skinned bodies if they have bled profusely or were severely anaemic.
- ⊙ PMS has to be differentiated from Contusion.

Medicolegal importance

- ⊙ It is a sign of death
- ⊙ Helps in estimating the time of death
- ⊙ Indicates the posture of the body at the time of death
- ⊙ Deliberate disturbance in the posture of the body
- ⊙ Some times the colour may indicate the cause of death

RIGOR MORTIS

- ⊙ A state of stiffening of the muscles with slight shortening of the fibers.
- ⊙ Appears in all the muscles, both skeletal and smooth muscles.
- ⊙ Mechanism : ATP depletion
- ⊙ Order of appearance :
 - Proximo-distal spread

- ⊙ Time of appearance : starts in 3 to 6 hrs
 - takes 12 hrs to complete
 - stays for another 12 hrs
 - disappears in next 12 hrs

Conditions simulatng rigor mortis

- ⊙ Heat stiffening
- ⊙ Cold stiffening
- ⊙ Gas stiffening
- ⊙ Cadaveric spasm or instantaneous rigor :
 - the group of muscles which were at strenuous work during life goes into a sudden state of stiffening, instead of passing to primary flaccidity after death.
 - Its of great Medico Legal Importance.

Conditions altering the onset and duration of rigor mortis

- ⊙ Age : - Does not occur in a foetus of less than 7 months old
 - in healthy adult it develops slowly and well marked
 - in children and old it is feeble and rapid
- ⊙ Muscular state : onset is slow and duration is long in cases where muscles are healthy and at rest before death.
- ⊙ NATURE OF DEATH : In deaths from diseases causing great exhaustion and wasting, the onset is early and duration is short.
- ⊙ Atmospheric condition :
 - onset is slow and duration is long in cold winter
 - onset is fast and duration is short in hot weather

Medico Legal Importance

- ⊙ It's a sign of death
- ⊙ Helps in estimation of Time Since Death
- ⊙ Indicates the position of the body at the time of Death.

Decompositions (Putrefaction)

- ⊙ It is a process of gradual destruction of body tissues by combined lytic action the body enzymes & microorganism after death.
- ⊙ It takes place in 2 steps -
 - 1) Autolysis
 - 2) Putrefaction

Autolysis

- ⊙ Cell becomes permeable after death with release of cytoplasm containing enzymes.
- ⊙ The proteolytic enzymes causes chemical digestion and disintegration of the organs.
- ⊙ Autolysis is increased by heat & stopped by freezing.
- ⊙ Autolysis is an aseptic process result in maceration of dead foetus in the uterus.
- ⊙ Auto disintegration occurs in
brain – liquefaction
stomach & GI tract, pancreas

Putrefaction

- ⊙ Colour changes
- ⊙ Evolution of gases
- ⊙ Liquefaction of tissues

Colour change

- ⊙ 1st sign of decomposition -Greenish discolouration in the right iliac fossa which become evident in 12-24 hrs in summer and 1 to 3 days in winter
- ⊙ Caecum – Hb + H₂S ---> Sulphmethaemoglobin
- ⊙ (greenish discolouration)
- ⊙ Then spreads to the entire abdomen, then extends to the chest, neck, face & last to the limbs.
- ⊙ Colour gradually changes to dark green then finally black.
- ⊙ The putrefaction bacteria spread easily in fluid and colonize the venous system
- ⊙ The superficial veins of the limbs, chest, abdomen, & neck are stained greenish blue due to haemolysis of red cells and stains the walls of the vessels – MARBLING – (36 to 48 hrs)
- ⊙ Which should be – differentiated from filigree burns due to lightening.

Evolution of foul smelling gases

- ⊙ The main gases are ammonia, carbon dioxide, hydrogen sulphide, phosphorated hydrogen & methane.
- ⊙ In early stages, these gases are non –inflammable, later with the formation of enough hydrogen sulphide the gases become inflammable.
- ⊙ Abdomen gets distended
- ⊙ Diaphragm is pushed up compressing the lungs and heart. Blood stained frothy fluid exudes from the mouth and nostrils

- ⊙ (Postmortem purge) – which can be mistaken for pulmonary oedema or drowning. (which is due rupture of pulmonary and pharyngeal vessels)
- ⊙ Distention of breast in females and penis and scrotum in males.
- ⊙ Involuntary urination, defaecation, seminal ejaculation and delivery of dead foetus occurs in this stage.
- ⊙ Gas bubbles accumulate in all the tissues
- ⊙ Subcutaneous tissues becomes emphysematous
- ⊙ Eyes bulge from their sockets
- ⊙ Tongue is forced out between swollen lips
- ⊙ Blisters are formed between the epidermis and dermis, first and lower surface of trunk and thighs.
- ⊙ Epidermis becomes loosened (skin slippage) producing large, fragile sacs of clear or pink red serous fluid.
- ⊙ These blisters gradually enlarge, join together and rupture, exposing large areas of slimy pink dermis
- ⊙ By three days the face is so discoloured and bloated that identification becomes very difficult.

Liquefaction of tissues

- ⊙ Colliquative putrefaction begins from 5 to 10 days
- ⊙ The abdomen bursts and contents of abdomen comes out of the cavity
- ⊙ The omental, mesentric and perineal fat liquefy into a translucent, yellow fluid filling the body cavities between the organs.
- ⊙ All encapsulated internal organs are converted into bags of putrid fluid and subsequently burst open into the thoraco abdominal cavity
- ⊙ First organ to putrefy:
adrenals , pancreas, spleen, liver, lungs, heart.
- ⊙ Kidneys and urinary bladder putrefy late
- ⊙ Prostrate in males and uterus in females are the last internal organs to undergo putrefaction
- ⊙ The muscles become soft, loose and are converted into a thick semisolid pinkish mass and are gradually separated from the bones.
- ⊙ The cartilages and ligaments are softened in the final stage.

Skeletonisation

- ⊙ In an exposed body flies, maggots, ants, cockroaches, rats, dogs, vultures etc., may reduce the body to skeleton in a few days.
- ⊙ When the body is in water it may be attacked by fishes, crabs etc., and the body is skeletonised within a few days.
- ⊙ Uncoffined body buried in a shallow grave-moderate delay of putrefaction
- ⊙ If deeply buried, low temperature, exclusion of air, markedly delays putrefaction
- ⊙ The main factors affecting skeletonisation are:
Seasonal, Climatic variations, Amount of soil water, Access of air, Acidity of soil water
- ⊙ In India, an unconfined buried body is reduced to skeleton within one year
- ⊙ Bodies placed in airtight coffins, decay process may not occur for several decades.

Conditions affecting putrefaction

Temperature

Begins above 10°C, optimum between 21°C to 38°C

Arrested below 0°C and above 48°C

Moisture

- ⊙ Moisture is necessary for putrefaction
- ⊙ Bodies recovered from water, if left in the air decompose rapidly
- ⊙ Organs which contain Water decompose more readily than the dry ones
- ⊙ Air - Free air access hastens putrefaction

Clothings

- ⊙ Initially clothing's hasten putrefaction by maintaining body temperature
- ⊙ Putrefaction is delayed under tight garments
(ex : belts, socks, undergarments, boots, etc)
which dries out the blood from that part and thereby prevents entry of internal organisms
- ⊙ Clothing's prevent the access of airborne organisms, flies, insects, etc

Manner of buried

- ⊙ Bodies buried soon after death, putrefaction is less
- ⊙ Delayed if buried in dry, sandy soil,
or in a grave deeper than 2 meters
- ⊙ Delayed in coffined bodies (exclusion of air, water and access of insects)
- ⊙ Salt and lime delay putrefaction

Putrefaction is rapid

- ⊙ In a body buried in a damp, marshy or shallow grave

- ⊙ In porous sandy soil, than in soils with excess of clay
- ⊙ Putrefaction is more rapid, if changes of decomposition are already present at the time of burial
- ⊙ In acid peaty soils, even the bones may be destroyed.

Internal

1. Age

- ⊙ Bodies of children putrefy readily than the old people.
- ⊙ Bodies of new born who have not been fed, decompose slowly
- ⊙ If fed before death or if there are any injuries on the body, decomposition is rapid

2. Sex

no difference of effect

3. Condition of the body

- ⊙ Fat bodies putrefy quickly than lean bodies, due to larger amount of fluid, excess fat and greater retention of heat.

4. Cause of death

bodies of persons dying from Septicaemia, Peritonitis, Inflammatory and septic conditions, Asphyxia, Putrefaction is rapid in infection due to Cl.Welchii (ex), Acute intestinal obstruction, Abortion, Gas gangrene

Putrefaction is delayed if death due to wasting diseases, Anaemia, Debility, Poisoning by phenol, zinc chloride, strychnine, chronic heavy metal poisoning (arsenic, lead, mercury)

5. Mutilation:

- ⊙ Bodies with wounds putrefy rapidly
- ⊙ In dismemberment –
 1. limbs putrefy slowly
 2. Trunk putrefy rapidly
- ⊙ In advanced putrefaction, no opinion can be given as to the cause of death, except in causes of poisoning, fractures, fire arm injuries etc.

Medico-legal Importance

- ⊙ When involves face, the features are well preserved which helps to establish the identity
- ⊙ To know cause of death, injuries are preserved
- ⊙ Time since death is calculated

Mummification

- ⊙ Modified putrefaction

- ⊙ Dehydration, drying and shriveling of the cadaver
- ⊙ Occurs due to evaporation of water
- ⊙ Begins in exposed parts of the body – face, limbs then extends to the entire body including internal organs
 - ⊙ Skin is shrunken and contracted, dry, brittle, leathery and rusty – brown in colour
 - ⊙ Stretched tightly over the body prominences such as cheek, chin, ribs, hip and adheres closely to the bone.
 - ⊙ Mummification may be partial in some cases, with only head or limb being affected
 - ⊙ Internal organs become shrunken, hard, black and become a single mass or may disappear
 - ⊙ Body loses weight, becomes thin, stiff and brittle
 - ⊙ Mummified bodies if protected, can be preserved for years.
 - ⊙ Mummified bodies are practically odourless
 - ⊙ It takes 3 months to 1 year to develop
 - ⊙ Absence of moisture, continuous action of dry warm air are necessary for mummification.
 - ⊙ Mummification of new born may occur if left in a trunk or cupboard (warm and dry atmosphere)
 - ⊙ Marked dehydration favours mummification
 - ⊙ Mummification occurs in bodies buried in shallow graves in dry sandy soils
 - ⊙ Chronic arsenic and antimony poisoning favours the process of mummification.
 - ⊙ Occasionally some parts of the body shows mummification and some parts show adipocere.

TIME SINCE DEATH

- ✓ To know when the crime has been committed
- ✓ A starting point for the Police
- ✓ Exclude some subjects & to search for the likely culprit
- ✓ To check on a subject's statement
- ✓ The exact time of death can not be fixed, rather a range of time between which death was presumed to have taken place, can be estimated
- ✓ Longer the Postmortem interval, Less accurate is the estimated TSD

TO GIVE A OPINION:

- ✓ All the available history,

- ✓ Local physical & environmental factors at the scene of Crime, such as fire, open windows, environmental temp, etc
- ✓ The range of TIME is at best an educated guess, based on Scientific Knowledge and Experience.

The following are considered to give a opinion of Time Since Death:

- ✓ Cooling of the body
- ✓ Postmortem staining
- ✓ Rigor mortis
- ✓ Decomposition and it's modifications : Mummification & Adipocere

Presumption of Death:

- ✓ Arise in connection with civil cases
- ✓ A person is presumed to be ALIVE, if there is nothing to suggest the probability of his Death with in 30 years
- ✓ But, if proof is produced that the same person is not been heard of for 7 yrs by his Relatives & Friends, Death is Presumed.

Presumption of Survivorship:

- ✓ Arise in connection with INHERITANCE of Property, when 2 or more persons DIE in a common Disaster. Ex : Earth quake, Plane Crash, etc.
- ✓ The Question of who SURVIVED Longer, may arise.
- ✓ The case is decided on facts & Evidence available.
- ✓ In the absence of such evidence, Age, Sex, Constitution Nature & Severity of injuries and the Mode of Death are taken into Consideration

TOXICOLOGY

The toxicology is defined as science which deals with knowledge of source, character and properties of poisons, their symptoms in the body, their pharmacological actions and treatment.

Definition of Poison

Poison is a substance introduced in the body to produce ill-effect, disease or death. It may be of any origin like synthetic, mineral, animal or vegetable. It may be introduced through any route like mouth, nostril, anus, vagina, ears, eyes, or by injection or inhalation.

Definition of Drug

Drug is defined as any substance to be introduced in the human body for diagnosis, investigation, treatment or prevention of any disease.

MEDICO-LEGAL ASPECTS OF POISONING

Poisoning in India is quite common. There are instances of human and cattle poisoning. Cattle poisoning is mostly intentional to kill the cattle of the neighbour. Human poisoning can be accidental, suicidal or homicidal:

1. **Accidental Poisoning:** Most of the poisoning is accidental. In children most of the poisoning is accidental as they consume tablets or syrup in the household accidentally. Accidental poisoning can occur in agricultural workers when spraying insecticides. It can occur if a person drinks unsafe water contaminated with arsenic, etc.

2. **Suicidal Poisoning:** Nowadays, suicides by poisoning is very common among farmers, especially in Andhra Pradesh and Punjab. They consume insecticides when they are unable to pay agricultural loans. Aluminium phosphide and organophosphorus compounds are first choice followed by organochloro compounds. Suicide by poisoning is also common in housewives.

3. **Homicidal Poisoning:** Poison is very commonly used for homicides, especially on young children who are done away with this easily. Arsenic is commonly used followed by opium, aconite, dhatura, strychnine and potassium cyanide. If the intention is not to kill but rob, stupefying agents like dhatura, *Cannabis indica* or chloral hydrate are used.

CLASSIFICATION OF POISONS

Poisons are classified according to the symptoms which they produce in the body. Generally, poisons are classified as follows:

Classification 1: Based on Structure

1. **Corrosives:** Strong acids and alkalis.

2. **Irritants:** They may be of three types:

(a) **Inorganic**

(i) *Non-metallic:* Phosphorus, chlorine, bromine, iodine, etc.

(ii) *Metallic:* Arsenic, antimony, mercury, copper, lead, etc.

(b) **Organic**

(i) *Vegetable:* Castor oil seeds, croton oil, Madar.

(ii) *Animal:* Snakes, insect bites, cantharides.

(c) **Mechanical:** Glass, hair, diamonds, etc.

Classification 2: Based on Area of Action and Method

Systemic Poisons

(a) **CNS acting**

I. *Affecting brain:*

- (i) *Somniferous*: Opium, barbiturates, etc.
- (ii) *Inebriant*: Alcohol, ether, chloroform, etc.
- (iii) *Deliriant*: Dhatura, belladonna, Cannabis, etc.

II. *Affecting spinal cord*: Nux vomica, etc.

- (b) **Affecting peripheral nerve**: Conium, Curare, etc..
- (c) **Cardiac poisons**: Aconite, digitalis, oleander, tobacco, hydrocyanic acid, etc.
- (d) **Asphyxiants**: Carbon dioxide, carbon monoxide, coal gases, etc.

ROUTES OF ADMINISTRATION

The following are the routes of administration of poisons:

1. Oral, i.e. through mouth.
2. Through inhalation, i.e. by nose/mouth.
3. Through application on skin, mucous membrane like mouth, vagina, anus, nose.
4. Through injection like intramuscular or intravenous.
5. On application on injuries like abrasion, cut wounds or lacerated wounds.

ACTION OF POISON

The actions of poisons on the body are classified as:

1. Local
2. Remote
3. Systemic
4. General.

When the poison acts on the site of application it is called local effect. Sometimes, poisons may act at a particular place like liver or kidney, then it may be called remote or remote local effect. When a poison affects a particular system like CNS, cardiovascular or GI tract, its effects are called systemic. When multiple organ systems are affected, the effects are called general. It may be possible that poison may affect in more than one way like local and systemic too or affect all systems as in general effect.

Factors Modifying Action of Poisons

The following factors modify the action of poisons in the body:

1. **Quantity**: It is a general rule that more the quantity of poison in the body, more will be its effect. But in some cases, too much of poison can also trigger vomiting which may throw out majority of the poison. A large quantity of poison may sometimes change the mode of action of the poison. Arsenic in large doses may cause death by shock while in small doses it may produce only gastrointestinal symptoms.

2. **Form:** If a poison is administered in gaseous form it acts fastest, while solution acts faster than solid form. Sometimes, the effect of one poison may be countered by another poison which is also taken along with it. If somebody takes silver nitrate and hydrochloric acid together, he will not have any poisonous effect as both poisons would react with each other and produce nonpoisonous silver chloride. Solubility of the poison is also important as some poison may not be water soluble but may dissolve in acid secretion of the stomach. The action of poison may also be altered if an inert substance is mixed with poison as it may reduce absorption from the stomach. If a poison is highly diluted with water, it may not affect at all.

3. **Mode of Administration:** If a poison is introduced into the body via gaseous route it acts the fastest. Parenteral route acts faster than oral route. The mode of administration should be appropriate for the desired effect. Snake venom is very poisonous if injected but harmless if taken by mouth. Application of poison on intact skin acts quite slow as compared to poison applied on mucous membrane.

4. **Condition of the Body:** It has been found that less doses of poison is required for children and old people as compared to young adults. Males tolerate poison better than females. The body may have anaphylactic reaction with any drug or poison and death may be reported even with small doses. Allergies are genetically inherited and may run in families. If a person is already habituated to a particular poison like alcohol, opium, datura or barbiturates, etc., he may be able to tolerate higher doses as compared to a normal non-addicted person. Drug reaction may occur in body and may potentiate the effect of poison or render it useless. The sedative, hypnotic drugs have positive potentiating effect on level of alcohol once taken. A healthy person can tolerate poison better than a sick person or persons having systemic disorders like hypertension, or diabetes.

FEATURES OF POISONING

Features of Poisoning in Living

It depends upon the nature of poison taken by the person to cause certain characteristics suggesting

poisoning but generally following features may be seen:

1. The onset of illness is sudden in a previously healthy person except in chronic poisoning in which it is insidious.
2. The symptoms usually start within 1 hour of consumption of some food, water or drug, if the poison has been given by oral route.

3. The symptoms start increasing and may cause severe bodily disorders even leading to death. Symptoms may start decreasing once a certain time is passed.
4. It may be possible sometimes that persons who have consumed food or water along with a sick person may also show similar symptoms.
5. The final proof of poisoning lies in detection of poison in blood, urine, vomits or faeces. Similar poison can also be detected in left over food or water.

Features of Poisoning in the Dead:

The poisoning in a dead person can be established by post-mortem findings, analysis of viscera and circumstantial evidence.

1. **Post-mortem Findings:** The post-mortem should be done very carefully in cases of poisoning. There may be stains of poison on the body or on clothes. Some parts of vomitus may also be seen on clothes or on body. The colour of skin may also point toward the kind of poison. Cherry red appearance in cases of carbon monoxide poisoning may be seen. The skin may appear jaundiced in phosphorus poisoning. If corrosives have been taken, mouth or lips may show changes. Marks of injection may be seen if a poison has been given by injection. But in some poisoning cases, no external findings may be seen. The internal examination of the body may reveal the following features in the alimentary canal:

- (a) Congestion
- (b) Softening
- (c) Ulceration of mucous membrane
- (d) Perforation.

Congestion: Congestion in the stomach is caused by all irritant poisons. It is more marked at cardiac end. It may appear in patches or may be diffused all over the mucous membrane. Congestion in intestine may be confused with post-mortem staining. Post-mortem staining is always present at the dependent portion of stomach/intestine while congestion may be uniform all over mucous membrane.

Softening: Due to effect of corrosive poisons, the mucous membrane may be softened usually at cardiac end and greater curvature. In softening the mucosa is not detached.

Ulceration: Corrosive or irritant poison can cause erosion of mucous membrane. The margins become thin and friable.

Perforation: Perforation of the wall of stomach may be possible in sulphuric acid poisoning or other irritant poisoning.

2. **Viscera Analysis:** It is very important to preserve viscera to establish poisoning. The whole stomach along with contents, part of small intestine with contents, part of liver, one

half of each kidney and spleen (whole) along with samples of blood are preserved in saturated solution of common salt for viscera analysis. The qualitative and quantitative analysis of viscera must be done at the forensic sciences laboratory. Sometimes, the poison may not be detected in the viscera. It may be due to:

(a) poison having already been extracted out by vomiting or gastric lavage.

(b) poison having already been metabolised in the body and death may be due to other sequelae. In such cases, the clinical findings should be taken into consideration to decide the cause of death.

3. Circumstantial Evidence: Sometimes, a bottle of poison may be detected from the site or parts of poison may be seen on clothes. Vomitus may be seen on the scene of crime. The suicide note may be found in some cases.

POISON INFORMATION CENTERS

In 1994, National Poison Information Centre was started at the All India Institute of Medical Sciences, New Delhi. WHO has provided its software on poisons (INTOX) from where complete information about poison regarding its composition, diagnosis, clinical features and treatment is made available to public. Second centre was opened at the National Institute of Occupational Health, Ahmedabad. New centres have also come up at the Government General Hospital, Chennai, Industrial Toxicology Research Centre, Lucknow and Amrita Institute of Medical Sciences, Cochin. The Government of India plans to open more centres all over India. All these centres can be assessed by common public or medical community to know about nature and treatment of any poison.

UNIT- 5

INJURIES AND SEX RELATED ISSUES

WOUNDS

The wound is defined as forcible disruption of continuity by mechanical violence of tissue of the body like skin, cornea, or mucous membrane.

Classification of wounds:

Commonly, wounds are classified as follows:

1. **Incised Wound:** The incised wound is produced by a sharp weapon such as knife, razor, etc. It is always broader than the edge of the weapon causing it due to restriction of cut tissues. It is spindle-shaped and gaping. The length of the incised wound is greater than its depth. The edges are smooth, clean cut and everted. If an incised wound is caused by a heavy weapon like *gandasa*, the edges of the wound may show contusion. The direction of incised wound should always be noted. The commencement of incised wound is deeper and it gradually becomes shallower and tails off towards the end. The tailing off of an incised wound shows the direction by which the weapon was drawn off. The incised wound bleeds more, as the blood vessels are clean cut and hence bleed more. Small incised wounds on wrist may cause death due to excessive bleeding.

2. **Stab or Punctured Wounds:** Stab wound is an incised wound where depth is more as compared to breadth. It is caused by sharp, pointed and cutting instruments. Stab may have both edges clean cut if the cutting instrument has sharp edges on both sides, or one side blunt and another clean cut if instrument had one sharp and other blunt side. Stab wounds are called penetrating wounds when they pass through tissues, enter a body cavity like thorax or abdomen. A sharp, pointed, cylindrical or conical instrument may produce a wound with circular margins. A blunt pointed instrument may produce circular margins with laceration. The depth of stab wound may be equal to or less than the length of the blade of the instrument causing it. In rare cases depth may be even more than the length of the blade as while forcing the instrument inside, the blow may depress the tissues of the part struck and the blade may reach deeper tissues. This is usually seen in stabs over the abdomen.

Perforating Wounds: When punctured wound perforates the body there may be entry and exit wound. The wound of entry is usually larger with inverted margins and wound of exit is smaller with everted edges.

3. **Lacerated Wounds:** The lacerated wounds are caused by application of great blunt force on the body, e.g. hit by *lathi* or blow, or in road traffic accidents. These wounds do not generally correspond with the shape or size of the instrument causing them. The margins are

irregular, torn, swollen and contused. The underlying tissues show extravasation of blood with muscle tears. Fracture of bones may be seen. The lacerated wound as a rule do not bleed as heavily as incised wound because in this vessels are crushed and they bleed less. The lacerations are of the following types:

(a) Split: Split laceration occurs when the soft tissues are caught between hard inside surface like bone and the force applied. Scalp lacerations are common. These lacerations sometimes look like incised wound with naked eye examination. So, they may be called incised-looking wound'. But on examination by lens, the margins can be observed. They are irregular, not clean cut as in case of incised wound. The hair follicles would be seen crushed, not cut.

(b) Stretch laceration: They are due to over-stretching of skin by blunt force.

(c) Avulsions: These glacerations are caused due to grinding compression of force such as the wheel of a car passing over limbs, shearing a large area of skin.

(d) Tears: When the body hits a hard object, it can produce tears, e.g.hit by a projected handle of a car in road traffic accidents.

(e) Cut laceration: These are produced by heavy cutting weapon like *gandasa*. Here, careful examination would reveal margins that are irregular and not clean cut. The contusions may be seen around margins with crushed hair follicles.

INJURY:

Injury is damage to the body caused by external force. This may be caused by accidents, falls, hits, weapons, and other causes. Major trauma is injury that has the potential to cause prolonged disability or death

Injuries by Mechanical Violence

DEFINITION OF MECHANICAL INJURY

The mechanical injury is defined as “damage to any part of the body due to application of mechanical force”. This damage may cause loss of tissue. The injury which is associated with loss of tissue is usually referred to as wound. The other common types of injuries are contusions or bruises and/abrasions.

Bruises or Contusions

These are caused by application of blunt force like *lathi*, fall from height, road traffic accident, hit with a hard object like stone, hammer (Fig. 12.1), etc. Due to the application of force on the skin, the underlying subcutaneous blood vessels rupture, which causes extravasation of blood in subcutaneous tissues. This is called ‘ecchymosis’. There is no discontinuity in the outer layer of the skin. Bruises are quite painful. The sites of bruises are quite tender and swelling can be seen. Ecchymosis is observed over the seat of injury in 1-2

hours, although it may appear early where the skin is very thin as of scrotum and eyelids. Sometimes, ecchymosis is seen after 1 or 2 days if the deeper tissues are involved. Sometimes ecchymosis is seen quite away from the seat of injury, e.g. in scalp. Here they may gravitate into eyelids, commonly called **black eye**.

Extent of ecchymosis is dependent on following factors:

1. Nature and severity of force.
2. Vascularity of area.
3. Amount of subcutaneous fat.
4. Looseness of underlying cellular tissues.
5. Medical condition of the victim.

The more severe the force is, more severe are the contusions. Ecchymosis is severe in soft tissues like eyelids, scrotum and vulva where vascularity is very high. In places where subcutaneous fat is more like abdomen, ecchymosis is less appreciated. If underlying tissues are loose like those in scalp, ecchymosis may be seen at distal places. In children, bruises are easily produced due to delicate skin. In women and old persons the bruises are easily produceable as compared to young men. In bleeding disorders like purpura, scurvy, haemophilia and pathological condition like leukaemia, there is a tendency to bleed more in bruises.

Abrasions

Abrasions are injuries where there is discontinuity in the skin due to loss of superficial epithelial layer

of the skin. These are produced as a result of blow, fall, slide or being dragged.

The following are the different type of abrasions:

1. **Scratches:** They are produced by a sharp weapon like needle or pin.
2. **Grazes:** They are produced as a result of friction like fall on a rough surface.
3. **Pressure Abrasions:** These are due to sustained pressure on the area just like the ligature mark in hanging, strangulation, etc.
4. **Imprint Abrasions:** Sometimes, the pattern of the object is seen on the skin just like tyre marks or marks of radiator in road traffic accidents.
5. **Other Abrasions:** Sometimes natural abrasions also occur like 'nappy abrasion' which is seen in infants due to excoriation of skin over areas usually covered by nappy like groin and buttocks. It may be confused with mechanical violence.
6. **Contused Abrasions:** If more mechanical violence is used, the abrasion may be contused too, in such cases it may be referred to as contused abrasion or abraded contusion.

ELECTRICITY

Deaths due to electricity are quite common in rainy season. The deleterious effects of electricity depend on following factors:

1. **The Nature of Current:** High voltage currents are very dangerous to life. Even low voltage currents of high amperes are dangerous. Alternating currents are more dangerous than direct currents as they produce contraction of muscles by which a person is not able to release the grip on the wire through which the current is flowing. The domestic supply is 210–220 volts alternating current. The current up to 50 volts does not produce deleterious effects. Various cases have been reported where people have survived very high voltage current also.

Judicial electrocution or electric chair:

This form of execution is quite common in Europe, and America and other countries. In this, the person is made to sit on an iron chair with shaven head and is strapped. A high voltage current, about 1800 volts, is passed through his head twice for about 60 seconds. One electrode is kept on his shaven head and one on leg.

2. **Resistance of Body:** The deleterious effects of electricity also depend upon the amount of resistance offered by the body. The human body is a bad conductor of electricity, but if wet, resistance is decreased. If a person is wearing wet clothes or carrying a metallic article touching the ground or where he is not wearing shoes, the body offers less resistance and the person may die easily with less current.

3. **Duration:** Greater the duration of current, more the damage. Even low voltage current for a long duration can cause spasm of muscles and the person may not be able to release himself and die.

Causes of Death

Low voltage currents up to 220 volts cause death by ventricular fibrillation while midvoltage currents up to 1000 volts cause ventricular fibrillation and respiratory centres failure. High voltage current above 1000 volts causes direct respiratory centres failure. Delayed death may occur due to infection, paralysis, etc.

Post-mortem Findings

1. **Joule Burn or Endogenous Burns:** These are characteristic electric marks found on the skin. They are round with a shallow crater surrounded by a slightly raised ridge of skin with a grey ashy base. Clouding of cornea, cataract, retinal haemorrhages, memory loss, convulsions, paralysis, deafness, dumbness, headache, etc. may be seen in many cases.

2. **Filigree Burns:** They are reddish brown arborescent markings (superficial burns) on the skin. These are erythemas which may show the path of passage of electric current in dendritic fashion. These are typical of lightning. They disappear in a few days. Besides these, singeing of hair, blisters etc. may be seen. The clothes where lightning enters may be burnt. Metallic articles like keys, belt buckle or part of pen may be found magnetised. Rigor mortis may start early and pass off early. The findings mentioned above may be seen. The internal findings are not characteristic. There may be extensive congestion in brain. Internal organs are found to be congested. Rupture of ear drums may be seen and it may resemble the shape of the object through which electricity enters. Microscopically, honeycomb vacuolisation of keratin may be seen. Bullae may be present in and under the epidermis. Epidermal nuclei at the periphery appear hyperchromatic, distorted and fusiform showing a streaming pattern. Joule Burn is typical of electrocution. Metallic particles may be demonstrated in the burn area.

Flash Burns

When a person comes near the high voltage current due to proximity, the current jumps from source to body area and involves large area of skin. These are called 'flash burns'. The face is usually pale, eyes are congested in most cases. Burns may be seen at the point of entrance and exit. Sometimes, burn at the point of exit may not be there as it is large in area. Internally most of the organs are found to be congested. Tardieu's spots may be seen in brain and other organs. There are no other significant internal findings.

ASPHYXIA:

- Asphyxia literally means Pulselessness.
- In Forensic Medicine, Asphyxia means Lack of Oxygen.
- Asphyxia is best described as an interference with the respiration due to any cause – mechanical, environmental or toxic.

Causes of Asphyxia

- SMOTHERING: Closure of external orifices.
- HANGING, STRANGULATION or THROTTLING: Occlusion of air passage by pressure on the neck.
- CHOKING : Occlusion of air passage from within.
- SUFFOCATION: Lack of oxygen in the Atmosphere, or inhalation of irrespirable gases.
- TRAUMATIC ASPHYXIA: Restriction of respiratory movements of the chest or Abdomen.
- DROWNING: Prevention of Gas exchange in the lung by FLUIDS.
- CYANIDE POSIONING: Inability to utilize oxygen by peripheral tissues .

- SEXUAL ASPHYXIA
- GAGGING
- BURKING
- OVERLYING
- CAFÉ CORONARY

Mechanical Asphyxia:

- Obstructive – Smothering, gagging, Choking, Café coronary.
- Constrictive – hanging, Strangulation, Throttling, bansdola
- Restrictive – Traumatic, Burking.
- Replacement – Drowning.

SIGNS OF ASPHYXIA:

➤ CLASSICAL SIGNS :-

- 1) Oedema and Congestion of organs :
- 2) Petechial Haemorrhages :
- 3) Cyanosis :

➤ NON-SPECIFIC SIGNS :-

- 1) Abnormal fluidity of blood
- 2) Dilatation of Right Chambers of Heart

SPECIFIC SIGN :- Indicates the exact way in which the FATAL chain of events was initiated.

- ligature mark on the neck in HANGING.
- Finger nail abrasion on the neck in Manual Strangulation (Throttling)
- fluid in the air passage in DROWNING.

Congestion and Oedema

- When the neck is compressed as in hanging, the venous return gets obstructed, leading to CONGESTION.
- Congestion is associated with tissue swelling, if there is continued venous obstruction.
- When circulation stops completely, the walls of the capillaries become permeable resulting in exudation of fluid from the capillaries into the neighbouring tissues leading to OEDEMA.

Petechial Haemorrhages

- Due to impaired integrity of capillary walls, the Red Blood Cells escape through, producing small bleeding points, varying from Pinpoint to Pinhead size.

- They are commonly seen in the sclera, conjunctiva and serous membranes such as pleura & pericardium.

Cyanosis

- The colour of oxygenated blood is SCARLET RED. When the Haemoglobin is not fully saturated with Oxygen i.e., haemoglobin is reduced, the blood assumes a bluish colour, called Cyanosis.
- for cyanosis to be evident, there should be at least 5 grams of reduced Haemoglobin per 100 ml of blood.

Suffocation

- Suffocation is a type of Mechanical Asphyxia cause by obstruction to the passage of air into the lungs. [Excluding Constriction of the Neck and Drowning]
- Environmental Causes :- by reduction of oxygen in the atmosphere. This occurs in decompression, high altitude and vitiated atmosphere (irrespirable gases)

Hanging

- Hanging is a form of asphyxia caused by suspension of the body by a ligature around the neck. The constricting force being the weight of the body.
- Hanging is the preferred method of choice for committing suicide.
- Hanging is almost always suicidal, unless proved otherwise.

Types of Hanging

- On the basis of the degree of suspension
 - Complete Hanging
 - Partial Hanging.
- On the basis of the Position of KNOT :
 - Typical Hanging
 - Atypical Hanging.

Cause of death in Hanging

- Asphyxia
- Venous congestion
- Combined asphyxia & Venous congestion
- Cerebral Anaemia
- Reflux Vagal inhibition
- Fracture dislocation of cervical vertebra

Delayed deaths

- Infection

- Oedema of Lungs / Larynx
- Hypoxic encephalopathy
- Infarction of Brain
- Brain Abscess
- Cerebral softening

Post-mortem Appearance

- Ligature Mark :- The ligature leaves a furrow of its own width and pattern.
- The bed of the ligature mark is PALE.
- The edges are abraded (reddish-brown)
- Ecchymosis and congestion of adjacent skin may be seen.
- The pattern of the ligature material often gets imprinted on the skin as a Pressure Abrasion.
- The ligature mark is usually situated above the Hyoid bone, oblique, passing backwards and upwards symmetrically on either sides to the point of suspension
- Microscopically, the ligature mark displays the usual characteristics of abrasion, showing desquamation and flattening of cells of the epidermis.
- If death has occurred quickly, vital reactions may be quite difficult to demonstrate.

Other external findings

- Face congested.
- Cyanosis of lips and nail beds.
- Post-mortem staining : Glove and Stockings Fashion
- Petechial Haemorrhages in the lower limbs if the body is suspended for a long time.
- Head is tilted away from the knot.
- Tongue is protruded and may be bitten.
- Salivary stains at the angle of mouth.
- If the knot presses on the cervical sympathetic ganglia, the eye on that side remains open, and the pupil dilated. [Le facie sympathique]

Neck Dissection

- Neck is examined after removal of brain and thoracic contents [blood less field of dissection]
- superficial incisions of the grooves may show small haemorrhages in the underlying layers of the skin, caused by direct trauma caused by the ligature.
- Contusion of the muscles of the neck, especially sternocleidomastoid and platysma.

- The intima of the carotid arteries show transverse splits with extravasation of blood in their wall.

Hyoid bone

- Occasionally hyoid bone is fractured.
- Fracture is more common above the age of 40 years.
- Abduction fracture [antero-posterior compression fracture]
- The broken piece of bone have an outward angulation.
- The subcutaneous tissues immediately above and below the ligature mark are congested.
- The tissues underneath the ligature mark are pale and parchment like.
- The lymph nodes of the neck above and below the ligature mark, shows evidence of congestion, stasis & haemorrhage.

Lynching

- It's a form of homicidal hanging where the person suspected to be involved in dacoit, murder or rape is overpowered by a mob, and hanged forcibly in public.

Post-mortem hanging

- Occasionally, after a victim has been murdered, and the body may be suspended to simulate suicidal hanging.
- Findings of asphyxia will not be evident and the actual cause of death may be easily found out on Autopsy.

	Antemortem Hanging	Postmortem Hanging
Ligature Mark	Prominent furrow	Not characteristic
Salivary dribbling	present	absent
Drag marks	absent	present
Rope fibres	May be seen	absent

STRANGULATION

Definition:

Mode of violent asphyxial Death accomplished by constricting the neck, externally by hands (manual strangulation / throttling) or by a ligature (ligature strangulation) or any other means but without suspending the body.

Mugging – foot, knee, bend of elbow – compressing force.

- *Bansdola*
- *Garroting*
- *Never suicidal, mostly homicidal; occasionally accidental.*
- *Mild playful tweak on neck – vagal inhibition – No signs in autopsy*

Symptoms of Strangulation

- Compression neck is sudden & symptoms of occlusion of air passage is complete and victim is powerless to call up insensible (unconscious) die instantaneously.
- Incomplete occlusion:- face cyanosed, bleeding from the mouth, nostrils and ears, hands clenched, convulsions - death
- Rapid Insensibility---- Death almost Painless

Causes of Death

1. Asphyxia (Anoxic hypoxia)
2. Cerebral Ischaemia
3. Venous congestion
4. 50% cases cardiac arrest
5. Pale face – Rapid death (cardiac arrest) cyanosed face – slow death

Postmortem appearance in ligature strangulation

Ligature mark

- Well defined & grooved slightly.
- Level – below the thyroid cartilage,
- Completely encircling the neck
- Horizontal
- Multiple marks - several rounds of ligature & more than one knot
- Oblique: Dragging or the victim was sitting & assailant standing behind the victim
- Base of the ligature mark: Pale with reddish ecchymosed margins (hrs after death – dry, hard, parchment like)
- Imprint pressure abrasion of ligature material
- Abrasions & ecchymosis of adjacent skin

- Some times no marks ligature is present if the ligature material is soft & yielding like scarf/stockings or if removed soon after death
- Minute fibers from the ligature material on the ligature mark - adhesive cello tape
- Asphyxial signs – face swollen, cyanosed, Petechiae over the face and conjunctiva, eyeballs prominent , open and congested, pupil dilated, lips blue, frothy blood coming out through the mouth & nose.
- Larynx & trachea – congested, frothy mucus
- Lungs marked congestion haemorrhagic patches, Petechiae, dark fluid blood on cut section
- Emphysematous bullae
- Viscera congested and Petechiae may be present

MANUAL STARNGULATION (THROTTLING)

Autopsy findings: Signs of asphyxia

- Bruising of neck due to assailants fingers grasping the neck. Bruises: circular unusually, dark red or purple in color 1-2 cms size due to finger tips if fingers slide over neck then elongated bruise.
- Abrasions (linear & Crescentic) – by finger nails of assailant (victim in an attempt to get loosen the hand grip of assailant from the neck).
- Rope / loincloth – suddenly thrown over head & quickly tightened around neck – loses consciousness instantly so there may not be signs of struggle, then tie ligature to kill. This way it is possible to over power a healthy strong man & kill him.
- Accidental – scarf, dupatta, caught in moving machinery belt / vehicle
- When one hand is used: bruise mark by thumb on one side & four fingertips – obliquely downwards, out wards & placed one below the other
- sometimes 4 finger marks clustered together. Red / purple bruise marks sometime turn into brown, dry & parchment like afterwards
- When both hands used to throttle:- Thumb marks of one hand & finger marks of other hands on either side of throat will be seen.
- Bruise & Abrasions also on mouth, nose, cheek forehead, lower Jaw or any other part of the body –marks of struggle.
- Some times ribs & injuries to organs in side the chest & abdomen, when assailant kneels over chest.

DROWNING

- Type of asphyxial death caused by displacement of air from the lungs by any fluid, usually water.

Classification

- According to the type of water
 - fresh water drowning
 - sea or salt water drowning
- According to water detection in the lungs
 - wet drowning
 - dry drowning

According to the period of survival

- Drowning – immediate
- Near drowning – rescued but died within 24 hours
- Secondary drowning – death after 24 hours due to complications

POSTMORTEM FINDINGS

A. NON SPECIFIC SIGNS

I. External :

- Wet hair and clothing
- Adherent particles such as sludge, mud or sand
- Wrinkled skin over palms & soles
- Cutis anserina (goose skin)
- Cyanosis
- Bleeding from ear
- Broken nails

Injuries: abrasion, laceration, contusion or by Aquatic animals.

Hypostasis – face, chest limbs.

SPECIFIC SIGNS

1. Froth over nose and mouth (the sign of drowning)
 - fine, tenacious, white or blood tinged, recurrent repeatedly
2. Cadaveric spasm: weed and plants may be in tight grip.

NON SPECIFIC

Internal:

- Congested organs
- Oedema easily appreciable in lungs
- Fluid blood in heart and vessels
- Petechial haemorrhage (Tardieu spots) over pleura & pericardium
- Sand & mud particles in nose, mouth or in oropharynx

- Water in stomach

SPECIFIC SIGNS:

- Air passage
- fine leathery or tenacious white blood stained froth in trachea & bronchi
- Sand, mud or sludge particles in trachea, bronchi or terminal bronchiole

Laboratory tests:

Gettler's test:

- To find out the type of water with chloride concentration from right and left ventricular blood.

To find out ante mortem drowning

1. Diatom test
2. Serum magnesium
3. Serum Strontium

Medico Legal importance:

1. Accidental drowning
2. Suicidal drowning
3. Homicidal drowning

Flootation time:

- 18 to 24 hours in summer
- 24 to 48 hours in winter

Sex related issues:

Sexual violence is a significant cause of physical and psychological harm and suffering for women and children. Although sexual violence mostly affects women and girls, boys are also subject to child sexual abuse. Adult men, especially in police custody or prisons may also be subject to sexual violence, as also sexual minorities, especially the transgender community. Sexual violence takes various forms and the perpetrators range from strangers to state agencies to intimate partners; evidence shows that perpetrators are usually persons known to the survivor.

The World Health Organisation (WHO) defines Sexual Violence as "any sexual act, attempt to obtain a sexual act, unwanted sexual comments/ advances and acts to traffic, or otherwise directed against a person's sexuality, using coercion, threats of harm, or physical force, by any person regardless of relationship to the victim in any setting, including but not limited to home and work." (WHO, 2003) Sexual assault, a form of sexual violence, is a term often used synonymously with rape. However, sexual assault could include anything from

touching another person's body in a sexual way without the person's consent to forced sexual intercourse --- oral and anal sexual acts, child molestation, fondling and attempted rape.

Forms of Sexual Violence include:

- Coerced/forced sex in marriage or live in relationships or dating relationships.
- Rape by strangers.
- Systematic rape during armed conflict, sexual slavery.
- Unwanted sexual advances or sexual harassment.
- Sexual abuse of children.
- Sexual abuse of people with mental and physical disabilities.
- Forced prostitution and trafficking for the purpose of sexual exploitation.
- Child and forced marriage.
- Denial of the right to use contraception or to adopt other measures to protect against STIs.
- Forced abortion and forced sterilization.
- Female genital cutting.
- Inspections for virginity.
- Forced exposure to pornography.
- Forcibly disrobing and parading naked any person.

Health consequences of sexual violence

Sexual violence, in addition to being a violation of human rights, is an important public health issue as it has several direct and indirect health consequences. Survivors of sexual violence may present to health care services with varying signs and symptoms. For those survivors who do not reveal a history of sexual violence, the following signs and symptoms should prompt one to suspect the possibility of sexual abuse/assault:

Physical health consequences:

- Severe abdominal pain.
- Burning micturition.
- Sexual dysfunction.
- Dyspareunia.
- Menstrual disorders.
- Urinary tract infections.
- Unwanted pregnancy.
- Miscarriage of an existing fetus.
- Exposure to sexually transmitted infections (including HIV/AIDS).
- Pelvic inflammatory disease.

- Infertility.
- Unsafe abortion.
- Mutilated genitalia.
- Self-mutilation as a result of psychological trauma.

Psychological health consequences:

Short term psychological effects:

- Fear and shock.
- Physical and emotional pain.
- Intense self-disgust, powerlessness.
- Worthlessness.
- Apathy.
- Denial.
- Numbing.
- Withdrawal.
- An inability to function normally in their daily lives.

Long term psychological effects:

- Depression and chronic anxiety.
- Feelings of vulnerability.
- Loss of control/loss of self-esteem.
- Emotional distress.
- Impaired sense of self.
- Nightmares.
- Self-blame.
- Mistrust.
- Avoidance and post-traumatic stress disorder.
- Chronic mental disorders.
- Committing suicide or endangering their lives.

STERILITY:

Sterility is defined as an ability of a living organism to effect sexual reproduction.

MEDICAL EXAMINATION FOR STERILITY

In male-Semen is examined. It is collected by masturbation, after one week of abstinence. If normala)

The volume in each ejaculated is 3-5 ml.

b) There are 60-120 millions of spermatozoa in each ml of semen.

- c) Of the total -80% spermatozoa are motile.
- d) Of the total – 80% spermatozoa have complete and intact morphology (Each spermatozoon is 50-55 micron long, his head, Neck, body & tail, head being 5x3micron2)-

In female-In fertile, she has)

Normal secondary sexual characters.

- b) Normal development of genitals.
- c) Normal menstruation
- d) Ovulation present
- e) Uterus of normal size
- f) Patent fallopian tubes
- g) Normal hormonal balance

POTENCY:

Potency is defined as an ability to carry out and consummate sexual intercourse, usually referring to the male.

Impotence is defined as physical incapability to sustain erection to accomplish sexual intercourse. In males, penile erection may be very feeble or absent. Even if erection is maintained for some time, it may not last till the Sexual act is completed. Sterility means inability to produce children. An impotent person may or may not be sterile while a sterile person may or may not be impotent. But in some cases, both conditions are present.

Examination of a Male Person for Impotence

The court may direct a doctor to examine a person and report whether he is impotent or not. Such

examinations are usually ordered in rape cases, unnatural sexual offences or divorce cases where impotence is alleged, or in cases of disputed paternity. The doctor should conduct complete physical examination. History of systemic diseases like hypertension, diabetes mellitus should be elicited. In local examination, development of penis, scrotum, pubic hair, etc. should be noted. If possible, cremasteric reflex should be elicited. A brief neurological examination should be done. If nothing wrong is found, the opinion regarding impotence should be given in negative format stating that there is nothing to suggest that this person is not capable of performing sexual intercourse.

VIRGINITY:

Virginity is the state of a person who has never engaged in sexual intercourse.

Signs of Virginity:

- Breasts: hemispherical, firm and rounded
- Nipple: small, undeveloped, areola is pink
- Labia majora: firm, elastic, rounded and completely
- Labia minora: soft, smooth, small. Sensitive and pink in colour
- Fourchette & posterior commissure: Intact
- Vaginal Wall: closely approximated
- Vaginal mucosa: Rugose, reddish, sensitive to touch.
- Hymen: intact, deeply situated in children and superficial after puberty, soft to firm in consistency and usually annular or semilunar in shape.

True Virgin: Hymen is intact and the woman has had no sexual intercourse. It only admits tip of little finger in Vagina

False Virgin: Hymen is intact but the woman has had sexual intercourse. It can easily admit two fingers in Vagina.

Medico legal importance of Virginity:

Divorce, Defamation(Chastity), Rape

NATURAL SEXUAL OFFENCES

Rape

Definition

Rape in India is defined (under Section 375 of the I.P.C.) as an unlawful sexual intercourse by a man,

1. With his own wife under the age of 15 years, or
2. With any other woman under the age of 16 years with or without her consent, or
3. With any other woman above the age of 16 years, against her will, without her consent, or
4. With her consent—when her consent has been obtained by putting her or any person in whom she is interested in fear of death or hurt, or
5. With her consent—when the man knows that he is not her husband and the consent is given because she believes that he is another man to whom she is or believes herself to be lawfully married, or
6. With her consent—when at the time of giving such consent, by reason of unsoundness of mind, intoxication or the administration of any stupefying or unwholesome substance, she is unable to understand the nature and consequence of what she has given consent to.

Age

No age is safe for rape. Children are easily abused as they can offer less resistance. Small infants even at the age of 4–6 months have also been abused. Even older women are not safe from rape. For committing rape, the law of India does not presume any limit under which a boy can be considered physically incapable of committing rape. In such cases, the development of child along with development of sexual organs has to be taken into consideration while deciding if he is capable of performing rape or not.

Socio-economic Status

Incidences of rape is reported more from lower socio-economic strata, as they tend to live in unsafe and crowded areas.

Examination of the Victim

The examination of victim should be done carefully as per provisions of law as they are different from one state to another in India. As per the recent judgement of Punjab and Haryana High Court, it is mandatory to get the rape victim examined only by a female doctor. In Delhi, only a gynaecologist does the medical examination of a rape victims. The examination of a rape victim should be under the supervision of a female medical practitioner.

Consent

The consent to examine a rape victim should be taken before commencement of examination. It should be in writing. As per the provisions of law, police or court has no power to compel a woman to submit private parts for examination to a medical practitioner, male or female.

Examination of the Victim

After taking consent, the medical examination should be started in presence of a female attendant or witness if a male doctor examines the patient.

No attempt should be made to undress the woman. She should be politely asked to remove clothes. The exact time of examination, name of the person who brought the victim, a short factual summary of incidence should be recorded in medico-legal report in the register, which has been approved by the state administration.

Two marks of identification of the victim should also be noted. A short description of the place of occurrence of the event, details of the act, relative position of parties, whether ejaculation occurred or not, pain during the act, loss of consciousness during the act or efforts to resist should be recorded. The general behaviour and mental state of the victim should be noted. The detailed examination should begin in the following order:

1. **Clothes:** If clothes are same as ones worn by her at the time of sexual assault, they should be carefully examined for the presence of blood or seminal stain or any other discharge. The clothes especially undergarments should be preserved for examination by Forensic Science Laboratory.

2. **Injuries:** The physical examination of the body especially forearms, wrist, face, breasts, chest, inner aspects of thighs, and back should be done to look for scratches, abrasions or bruises caused as a result of struggle/compression. Teeth marks if any may be observed on breasts, nipples, lips, or cheeks. Swabs from teeth bite should be taken for the presence of saliva.

3. **Genitals:** The examination should be preferably done in lithotomy position. The pubic hair should be examined first, if they are found to be matted, they should be cut off with a pair of scissors to look for

spermatozoa. They should be preserved in a dry bottle for examination at Forensic Science Laboratory. Dried seminal stains on external genitals/thighs can be scrapped carefully, or moistened with normal saline and slides may be made for microscopic examination. If bloodstains are present, they should also be preserved in a similar manner. Bruise or laceration, if any, on external genitalia may be carefully noted. The examination of hymen should be carefully done now. In a case of rape, hymen may have fresh radiate tears (more in posterior half), the edges of which may be red, swollen or painful if the examination of the victim is done within 24 hours. These tears heal within 5 or 6 days, and look like small tags of tissue after 10 days. Frequent sexual intercourse/delivery destroys hymen completely. There may be cases where hymen may be found to be intact and not lacerated. In such cases, the distensibility of hymen can be recorded. The fourchette and posterior commissure are not usually injured in cases of sexual assault. The degree of injury is dependent on the force used. In small children, the hymen usually escapes injury, as it is deep seated but becomes red and inflamed. The vaginal secretions from the posterior fornix should be taken either by introducing a plain sterile cotton swab or by introducing 1 ml pipette and sucking the contents. The contents should be immediately transferred to a microscopic slide in the form of a thin film, and should be fixed. The slide can be viewed for spermatozoa. In married women, spermatozoa may be present because of previous sexual intercourse. He spermatozoa can be seen up to 1–7 days in vagina after the last sexual intercourse. Even if spermatozoa are not present, the estimation of acid phosphatase level can be done in fluid obtained from posterior fornix to detect presence of seminal fluid.

Examination of the Accused

In India, the examination of the accused is done on a written request of the police. The person is brought, under the custody of police, to a medical officer for examination. As per the law, whenever a person is arrested for committing sexual assault, a doctor should medically examine him as early as possible. In most states in India, the examination of the accused is conducted either by medical officers working in emergency services or a dermatologist and venereologist is called upon for examination. In some centres where forensic experts are available, such cases are referred to them. The examination of the accused should be recorded in medico-legal register duly authorised by the state government. The police constable who has brought him should identify the accused. This should be recorded in the report. The consent of the accused is not necessary for examination as per the provisions of the law of India. In fact, a reasonable amount of force can also be applied to collect evidence from this person. The marks of identification should be noted and left thumb impression of the accused may be taken on medico legal report itself. The medical officer should record preliminary data and then proceed for complete examination. The examination of clothes should be done to detect semen/bloodstain or tears. Undergarments should be especially looked for stains and should be preserved for examination by Forensic Science Laboratory. A complete physical examination involving all systems like cardiovascular, alimentary, respiratory and nervous should follow. The complete body, especially inner aspects of thighs should be examined for mud, blood or seminal stains. The genitalia should be examined. Pubic hair, if matted, should be cut and preserved. The penis should be examined for injury or some stain, circumcision, presence of smegma or discharge. The cremasteric reflex may be elicited to rule out neuronal loss. If it is suspected that a person is suffering from STD, relevant evidence may be collected.

After the examination is over, the doctor has to give opinion on two accounts:

1. Whether the person is capable of performing sexual intercourse or not?
2. Whether there is an evidence of recent sexual intercourse? The capability to perform sexual intercourse depends on erection of the penis. It is naturally assumed that all normal males who have well developed sexual organs are capable of erection, thus can perform sexual intercourse. So, the opinion about capability to perform sexual intercourse is given in a double negative form like “there is nothing to suggest that this person is not capable of performing sexual intercourse.” If it is suspected that the person may have some erectile dysfunction, he should be examined for chronic diseases like diabetes, hypertension, chronic alcoholism, neuropathies, or some psychic reasons. The opinion about recent sexual activity

can be given if some stain/injury/redness is seen on the penis/scrotum. Previously, it was thought that absence of smegma could indicate recent sexual activity. Now it is not relied upon, as smegma collection depends on personal hygiene and circumcision. Samples may be collected of vaginal epithelial cells, which adhere to penis during sexual intercourse, by taking a wet swab around penis and making microscopic slides. These vaginal cells are rich in glycogen and stain readily with iodine and can easily be inspected microscopically. Previously, it was common to preserve semen in accused for which accused used to be asked to provide sample by masturbation. In non cooperative accused, it was obtained by doing prostatic massage. Now, this is not done. Sample of blood obtained from finger is preserved on a gauze piece, and is dried and then sealed for examination by Forensic Science Laboratory.

SEXUAL DEVIATIONS

The common sexual deviations are described as follows:

1. **Sadism:** This is a sexual perversion where infliction of pain, torture and humiliation to partner act as sexual stimulants. It may be seen in both the sexes but is common in males. Male may inflict injuries by beating with hands or sticks, or sometimes sexual organs may be targeted, foreign bodies may be inserted in vagina and breast may be contused or sometimes, the sadist may get so excited, that he may murder the victim (lust murder) or he may eat her body (necrophagia) after raping her corpse (necrophilia).
2. **Masochism:** It is just opposite of sadism where gratification is obtained by getting beaten, tormented or humiliated by the sexual partner. It is common in males but occurs in females also. The females may invite males to inflict pain on her or abuse her.
3. **Fetishism:** This perversion is seen in males only. In this, male gets sexual gratification just by seeing some part of the woman or her article like undergarment, shoes, clothes, etc.
4. **Transvestism:** It is the desire to wear the clothes of the opposite sex. It is quite common in homosexuals. Some transvestites may seek medical treatment to change their gender.
5. **Exhibitionism:** It is a deviation in which exhibitionist gets pleasure by showing his genitals to women, girls, or small children He may also make some lewd gesture. It is a punishable offence under Section 294 of the I.P.C.
6. **Scoptophilia:** It is deriving sexual pleasure in anticipation of exposure of one's genitalia or observing genitalia of another with orgasm brought by masturbation during or after the event. Some people get excitement by listening to or making obscene phone calls.

7. Voyeurism (Peeping tom): It refers to repetitive seeking for situations where person of the opposite sex is undressing, taking bath or having sex. It is also like watching porn movies. The males who are involved in this are often called peeping toms.

8. Paedophilia: It is defined as preferential sexual activity with children. It may be limited to watching them nude or showing genitalia to them or touching young ones to their nubile sex organs. If sexual intercourse is done, it comes into the category of rape or sodomy as the case may be. Many celebrities have, in the recent past, been accused of paedophilia. Some perverts enjoy watching porn movies involving children.

9. Necrophilia: It is a perversion when a person attains sexual gratification by watching dead nude body or doing sex with a dead body. Some people are so pervert that they eat some parts of the dead body too. It is called as 'necrophagia'. This is a punishable offence where term may extend up to one year or a fine is charged or both are implemented.

10. Troilism: In this, a person gets sexual gratification by watching his own wife performing sexual intercourse with some other man.

11. Nymphomania: It is often described as excessive sexual desire in woman where she enjoys having multiple sex partners or desires excessive sexual activity.

12. Satyriasis: It is an excessive sexual desire in males who may seek multiple sex partners or need sex more frequently as compared to normal men. Such men often visit brothels to seek sexual gratification, or have multiple sex partners.

13. Frotteurism: It is a sexual deviation in which the person gets pleasure by rubbing with bodies of opposite sex like in crowded bus, train or fairs. They may try to rub their genitalia against bodies of opposite sex in such situations. It is punishable in India.

14. Undinism: This is a sexual deviation where the person gets pleasure by watching a person of opposite sex doing urination or defecation in public or asking them to urinate on him or her.

MEDICO-LEGAL ASPECTS OF SEXUAL OFFENCES

Rape Trauma Syndrome :After rape, woman passes through great mental trauma. According to Sutherland and Scherl, rape trauma syndrome consists of psychological responses in victims of rape, of shock, dismay and non-specific anxiety. Burgess et al. defined rape trauma syndrome in two stages:

(a) *Immediate or an acute disorganisation phase* consists of emotional reactions of several kinds like feeling of guilt and humiliation.

(b) *A long term reorganisation phase* during which victim readjusts her life as far as possible. She may have nightmares and phobia during such time. In western countries, rape crisis

centres are set up to deal with rape trauma syndrome. In such centres, psychological support is offered through counselling.

GUIDELINES FOR MEDICAL EXAMINATION AND REPORTING FOR SEXUAL VIOLENCE

The following guidelines are for health professionals when a survivor of sexual violence reports to a hospital. The guidelines describe in detail the stepwise approach to be used for a comprehensive response to the sexual violence survivor as follows:

- I. Initial resuscitation/ first Aid
- ii. Informed consent for examination, evidence collection, police procedures
- iii. Detailed History taking
- iv. Medical Examination
- v. Age Estimation (physical/dental/radiological) – if requested by the investigating agency.
- vi. Evidence Collection as per the protocol
- vii. Documentation
- viii. Packing, sealing and handing over the collected evidence to police
- ix. Treatment of Injuries
- x. Testing/prophylaxis for STIs, HIV, Hepatitis B and Pregnancy
- xi. Psychological support & counseling
- xii. Referral for further help (shelter, legal support)

Informed consent: A survivor may approach a health facility under three circumstances:

- a) on his/her own only for treatment for effects of assault;
- b) with a police requisition after police complaint; or
- c) with a court directive.

Doctors shall inform the person being examined about the nature and purpose of examination and in case of child to the child's parent/guardian/ or a person in whom the child reposes trust. This information should include:

- a) The medico-legal examination is to assist the investigation, arrest and prosecution of those who committed the sexual offence. This may involve an examination of the mouth, breasts, vagina, anus and rectum as necessary depending on the particular circumstances.
- b) To assist investigation, forensic evidence may be collected with the consent of the survivor. This may include removing and isolating clothing, scalp hair, foreign substances from the body, saliva, pubic hair, samples taken from the vagina, anus, rectum, mouth and collecting a blood sample.

c) The survivor or in case of child, the parent/guardian/or a person in whom the child reposes trust, has the right to refuse either a medico-legal examination or collection of evidence or both, but that refusal will not be used to deny treatment to survivor after sexual violence.

d) As per the law, the hospital/ examining doctor is required/duty bound to inform the police about the sexual offence. However, if the survivor does not wish to participate in the police investigation, it should not result in denial of treatment for sexual violence.

Emphasize that seeking treatment is critical for the survivor's well-being.

- The survivor or guardian may refuse to give consent for any part of examination. In this case the doctor should explain the importance of examination and evidence collection, however the refusal should be respected. It should also be explained that refusal for such examination will not affect/compromise treatment. Such informed refusal for examination and evidence collection must be documented.

- In case there is informed refusal for police intimation, then that should be documented. At the time of MLC intimation being sent to the police, a clear note stating “informed refusal for police intimation” should be made.

- Only in situations, where it is life threatening the doctor may initiate treatment without consent as per section 92 of IPC.

- The consent form must be signed by the person him/herself if s/he is above 12 yrs. Of age. Consent must be taken from the guardian/ parent if the survivor is under the age of 12 years.

- In case of persons with mental disability, please refer to section on “Persons with Disabilities”

- The consent form must be signed by the survivor, a witness and the examining doctor.

- Any major 'disinterested', person may be considered a witness

Medical/surgical history

- Menstrual history (Cycle length and duration, Date of last menstrual period).If the survivor is menstruating at the time of examination then a second examination is required on a later date in order to record the injuries clearly. Some amount of evidence is lost because of menstruation. Hence it is important to record whether the survivor was menstruating at the time of assault/examination

- Vaccination history is important with regard to tetanus and hepatitis B, so as to ascertain if prophylaxis is required.

Sexual violence history

- Be sensitive to the survivor as she has experienced a traumatic episode and s/he may not be able to provide all the details. Explain to him/her that the process of history taking is important for further treatment and for filing a case if needed.
- Create an environment of trust so that the survivor is able to speak out. Do not pass judgmental remarks.
- A relative could be present with the consent of the survivor, if s/he is comfortable.
- Details of the date, time and location of incident of sexual violence should be recorded.
- In case of more than one assailant, their number should be recorded along with the names and relation if known.
- One must note who is narrating the incident- survivor or an informant. If history is narrated by a person other than the survivor herself, his/her name should be noted. Especially if the identity of assailants is revealed it is better to also have a countersignature of the informant.
- The doctor should record the complete history of the incident, in survivor's own words as it has evidentiary value in the court of law.
- Use of any Physical violence during assault must be recorded with detailed description of the type of violence and its location on the body (eg. Beating on the legs, biting cheeks, pulling hair, kicking the abdomen etc.).
- Note history of injury marks that the survivor may state to have left on the assailant's body as it can be matched eventually with the findings of the assailant's examination.
- If any weapon(s) were used such as sticks, acid burns, gun shots, knife attacks etc.; if the use of drugs/alcohol was involved. Verbal threats should be recorded in survivor's words, eg. harming her or her near and dear ones.
- Information regarding attempted or completed penetration by penis/ finger/ object in vagina/ anus/ mouth should be properly recorded. There could also be other acts such as masturbation of the assailant by the survivor, masturbation of the survivor by the assailant, oral sex by the assailant on the survivor or sucking, licking, kissing of body parts. Information about emission of semen, use of condom, sucking or spitting along with the location should be clearly stated. Information about emission of semen outside the orifices should be elicited as swabs taken from such sites can have evidentiary value. Information regarding use of condom during the assault is relevant because in such cases, vaginal swabs and smears would be negative for sperm/semen.
- While recording history of sexual violence, it is important to enquire and record in simple language whether these acts occurred or not. A clear differentiation should be made between

a 'negative' and 'not sure' history. If the survivor does not know if a particular act occurred, it should be recorded as “did not know”.

- One should not feel awkward in asking for history of the sexual act. If details are not entered it may weaken the survivor's testimony. The details of history are what will also guide the examination, treatment and evidence collection and therefore seeking a complete history is critical to the medical examination process, sample collection for clinical & forensic examination, treatment and police intimidation.
- In case of children, illustrative books, body charts or a doll can be used if available, to elicit the history of the assault. When it is difficult to elicit history from a child, please call an expert.
- Details of clothing worn at the time of assault should be recorded.
- Post assault Information should be collected on activities like changed clothes, cleaned clothes, bathed/ urinated/ defecated/ showered/ washed genitals (in all cases) and rinsing mouth, drinking, eating (in oral sexual violence)/ had sexual intercourse after the incident of sexual violence. This would have a bearing on the trace evidence collected from these sites.
- If vaginal swabs for detection of semen are being taken then record history of last consensual sexual intercourse in the week preceding the examination. It should be recorded because detection of sperm/semen is a valuable evidence. While seeking such history, explain to the survivor why this information is being sought, because the survivor may not want to disclose such history as it may seem invasive.
- Information related to past abuse (physical/sexual/emotional) should be recorded in order to understand if there is any health consequence related to the assault. This information should be kept in mind during examination & interpretation of findings.
- Relevant Medical & Surgical History: Relevant medical history in relation to sexually transmitted infections (gonorrhoea, HIV, HBV etc.) can be elicited by asking about discharge per-urethra/per-anus, warts, ulcers, burning micturition, lower abdominal pain etc. Based on this information reexamination/ investigations can be done after incubation period of that disease. If there is vaginal discharge, record its type, i.e., texture, colour, odour, etc.
- Relevant surgical history in relation to treatment of fissures/injuries/scars of ano-genital area should be noted.

Examination for injuries

- Presence of injuries is only observed in one third cases of forced sexual intercourse. Absence of injuries does not mean the survivor has consented to sexual activity. As per law, if resistance was not offered that does not mean the person has consented.

- The entire body surface should be inspected carefully for signs of bruises, physical torture injuries, nail abrasions, teeth bite marks, cuts, lacerations, fracture, tenderness, any other injury, boils, lesions, discharge specially on the scalp, face, neck, shoulders, breast, wrists, forearms, medial aspect of upper arms, thighs and buttocks
- Describe all the injuries. Describe the type of injury (abrasion, laceration, incised, contusion etc.), site, size, shape, colour, swelling, signs of healing, simple/grievous, dimensions. Mention possible weapon of infliction such as - hard, blunt, rough, sharp, etc. Refer to Annexure 2 for noting time of injury
- Injuries are best represented when marked on body charts. They must be numbered on the body charts and each must be described in detail.
- Describe any stains seen on the body - the type of stain (blood, semen, lubricant, etc.) its actual site, size and colour. Mention the number of swabs collected and their sites.

Local examination of genital parts/other orifices

A. External genital area and Perineum is observed carefully for evidence of injury, seminal stains and stray pubic hair. Pubic hair is examined for any seminal deposits/ stray hair. Combing is done to pick up any stray hair or foreign material, and sample of pubic hair, and matted pubic hair is taken and preserved. If pubic hair is shaven, a note is made.

B. In case of female survivors, the vulva is inspected systematically for any signs of recent injury such as bleeding, tears, bruises, abrasions, swelling, or discharge and infection involving urethral meatus & vestibule, labia majora and minora, fourchette, introitus and hymen.

- Examination of the vagina of an adult female is done with the help of a sterile speculum lubricated with warm saline/ sterile water. Gentle retraction allows for inspection of the vaginal canal. Look for bruises, redness, bleeding and tears, which may even extend onto the perineum, especially in the case of very young girls. In case injuries are not visible but suspected; look for micro injuries using good light and a magnifying glass/ colposcope whatever is available. If 1% Toluidine blue is available it is sprayed and excess is wiped out. Micro injuries will stand out in blue. Care should be taken that all these tests are done only after swabs for trace evidence are collected.

- Per speculum examination is not a must in the case of children/young girls when there is no history of penetration and no visible injuries. The examination and treatment as needed may have to be performed under general anaesthesia in case of minors and when injuries inflicted are severe. If there is vaginal discharge, note its texture, colour, odour.

- Per-Vaginum examination commonly referred to by lay persons as 'two-finger test', must not be conducted for establishing rape/sexual violence and the size of the vaginal introitus has no bearing on a case of sexual violence. Per vaginum

examination can be done only in adult women when medically indicated.

- The status of hymen is irrelevant because the hymen can be torn due to several reasons such as cycling, riding or masturbation among other things. An intact hymen does not rule out sexual violence, and a torn hymen does not prove previous sexual intercourse. Hymen should therefore be treated like any other part of the genitals while documenting examination findings in cases of sexual violence. Only those that are relevant to the episode of assault (findings such as fresh tears, bleeding, edema etc.) are to be documented.

- Genital findings must also be marked on body charts and numbered accordingly.

C. Bleeding/swelling/tears/discharge/stains/warts around the anus and anal orifice must be documented. Per-rectal examination to detect tears/stains/fissures/hemorrhoids in the anal canal must be carried out and relevant swabs from these sites should be collected.

D. Oral cavity should also be examined for any evidence of bleeding, discharge, tear, odema, tenderness.

Collection of samples for hospital laboratory/ clinical laboratory

- If requested by police radiographs of wrist, elbow, shoulders, dental examination etc. can be advised for age estimation.

- For any suspected fracture/injury- appropriate investigation for the relevant part of the body is advised.

- Urine Pregnancy test should be performed by the doctor on duty and the report should be entered.

- Blood is collected for evidence of baseline HIV status, VDRL and HbsAg.

Collection of samples for central/ State forensic science laboratory

- After assessment of the case, determine what evidence needs to be collected. It would depend upon nature of assault, time lapsed between assault and examination and if the person has bathed/washed herself since the assault.

- If a woman reports within 96 hours (4 days) of the assault, all evidence including swabs must be collected, based on the nature of assault that has occurred. The likelihood of finding evidence after 72 hours (3 days) is greatly reduced; however it is better to collect evidence up to 96 hours in case the survivor may be unsure of the number of hours lapsed since the assault.

- The spermatozoa can be identified only for 72 hours after assault. So if a survivor has suffered the assault more than three days ago, please refrain from taking swabs for spermatozoa. In such cases swabs should only be sent for tests for identifying semen.
- Evidence on the outside of the body and on materials such as clothing can be collected even after 96 hours.
- The nature of swabs taken is determined to a large extent by the history and nature of assault and time lapse between incident and examination. For example, if the survivor is certain that there is no anal intercourse; anal swabs need not be taken.
- Request the survivor to stand on a large sheet of paper, so as to collect any specimens of foreign material e.g. grass, mud, pubic or scalp hair etc. which may have been left on her person from the site of assault/ from the accused. This sheet of paper is folded carefully and preserved in a bag to be sent to the FSL for trace evidence detection.
- Clothes that the survivor was wearing at the time of the incident of sexual violence are of evidentiary value if there is any stains/tears/trace evidence on them. Hence they must be preserved. Please describe each piece of clothing separately with proper labeling. Presence of stains - semen, blood, foreign material etc - should be properly noted. Also note if there are any tears or other marks on the clothes. If clothes are already changed then the survivor must be asked for the clothes that were worn at the time of assault and these must be preserved.
- Always ensure that the clothes and samples are air dried before storing them in their respective packets. Ensure that clothing is folded in such a manner that the stained parts are not in contact with unstained parts of the clothing. Pack each piece of clothing in a separate bag, seal and label it duly.

Body evidence:

- Swabs are used to collect bloodstains on the body, foreign material on the body surfaces seminal stains on the skin surfaces and other stains. Detection of scalp hair and pubic hair of the accused on the survivor's body (and vice-versa) has evidentiary value. Collect loose scalp and pubic hair by combing. Intact scalp and pubic hair is also collected from the survivor so that it can be matched with loose hair collected from the accused. All hair must be collected in the catchment paper which is then folded and sealed.
- If there is struggle during the sexual violence, with accused and survivor scratching each other, then epithelial cells of one may be present under the nails of the other that can be used for DNA detection. Nail clippings and scrapings must be taken for both hands and packed separately. Ensure that there is no underlying tissue contamination while clipping nails.

- Blood is collected for grouping and also helps in comparing and matching blood stains at the scene of crime.
- Collect blood and urine for detection of drugs/alcohol as the influence of drugs/ alcohol has a bearing on the outcome of the entire investigation. If such substances are found in the blood, the validity of consent is called into question. In a given case, for instance, there may not be any physical or genital injuries. In such a situation, ascertaining the presence of drug/alcohol in the blood or urine is important since this may have affected the survivor's ability to offer resistance. Urine sample may be collected in a container to test for drugs and alcohol levels as required.
- Venous blood is collected with the sterile syringe and needle provided and transferred to 3 sterile vials/ vaccutainers for the following purposes: Plain Vial/Vacutainer – Blood grouping and drug estimation, Sodium Fluoride - Alcohol estimation, EDTA – DNA Analysis.
- Collect oral swab for detection of semen and spermatozoa. Oral swabs should be taken from the posterior parts of the buccal cavity, behind the last molars where the chances of finding any evidence are highest.

Genital and anal evidence

- In the case of any suspected seminal deposits on the pubic hair of the woman, clip matted portion of the pubic hair; allow drying in the shade and placing in an envelope.
- Pubic hair of the survivor is then combed for specimens of the offender's pubic hair. A comb must be used for this purpose and a catchment paper must be used to collect and preserve the specimens. Cuttings of the pubic hair are also taken for the purpose of comparison or to serve as control samples. If pubic hair has been shaved, do not fail to make a mention of it in the records.
- Take two swabs from the vulva, vagina, anal opening for ano-genital evidence. Swabs must be collected depending on the history and examination. Swabs from orifices must be collected only if there is a history of penetration. Two vaginal smears are to be prepared on the glass slide provided, air-dried in the shade and sent for seminal fluid/spermatozoa examination.
- Often lubricants are used in penetration with finger or object, so relevant swabs must be taken for detection of lubricant. Other pieces of evidence such as tampons (may be available as well), which should be preserved.
- Swab sticks for collecting samples should be moistened with distilled water provided.

- Swabs must be air dried, but not dried in direct sunlight. Drying of swabs is absolutely mandatory as there may be decomposition/degradation of evidence which can render it unusable.
- Vaginal washing is collected using a syringe and a small rubber catheter. 2-3 ml of saline is instilled in the vagina and fluid is aspirated. Fluid filled syringe is sent to FSL laboratory after putting a knot over the rubber catheter.
- While handing over the samples, a requisition letter addressed to the FSL, stating what all samples are being sent and what each sample needs to be tested for should be stated. For example, "Vaginal swab to be tested for semen". This form must be signed by the examining doctor as well as the officer to whom the evidence is handed over.
- Please ensure that the numbering of individual packets is in consonance with the numbering on the requisition form. Specimens sent to the Forensic Science laboratory will not be received unless they are packed separately, sealed, labeled and handed over.

Sample collection:

Materials commonly preserved from accused: His clothings, his pubic hairs, foreign pubic hairs, scalp hair, swab from glans, urethral swab, swab from teeth bite mark if any, blood.

How the possibility of corroboration-

- 1) DNA profile & Blood Group factors collected from victim matches with the DNA/ Blood Gr. of the accused,
- 2) Group factor from saliva of bite mark can match with that of victim,
- 3) Matching of pubic hairs,
- 4) Presence of Sexually Transmitted Disease in accused matching with victim,
- 5) Presence of Semen in vagina & vaginal cell on glans penis,
- 6) Rupture of Hymen & Rupture of frenulum of penis,
- 7) Sign of struggle on body and garments,
- 8) Matching of teeth bite mark pattern,

Minimum list of articles required for sample collection-

As generally urethral swab is the sample to be collected, here is the short list for the items required for the collection-

1. Two glass slides (if smear is required),
2. One swab stick
3. One vial/ test tube,
4. Leucoplast,
5. Match box

6. Gala stick to seal and brass seal of hosp/Dept,

7. Own named stamp

8. cotton/blotting paper,

9. Paper envelop- large, small,

10.Thread

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